Environmental Assessment of the Alaskan Continental Shelf

Program Work Statements

FY 1979

Volume II

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

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P ROGRAM

WORK STATEMENTS

FOR FISCAL YEAR 1979

(October 1, 1978 - September 30, 1979)

VOLUME II

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.

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VOLUME II

For information purposes the contents of Volume I are given.

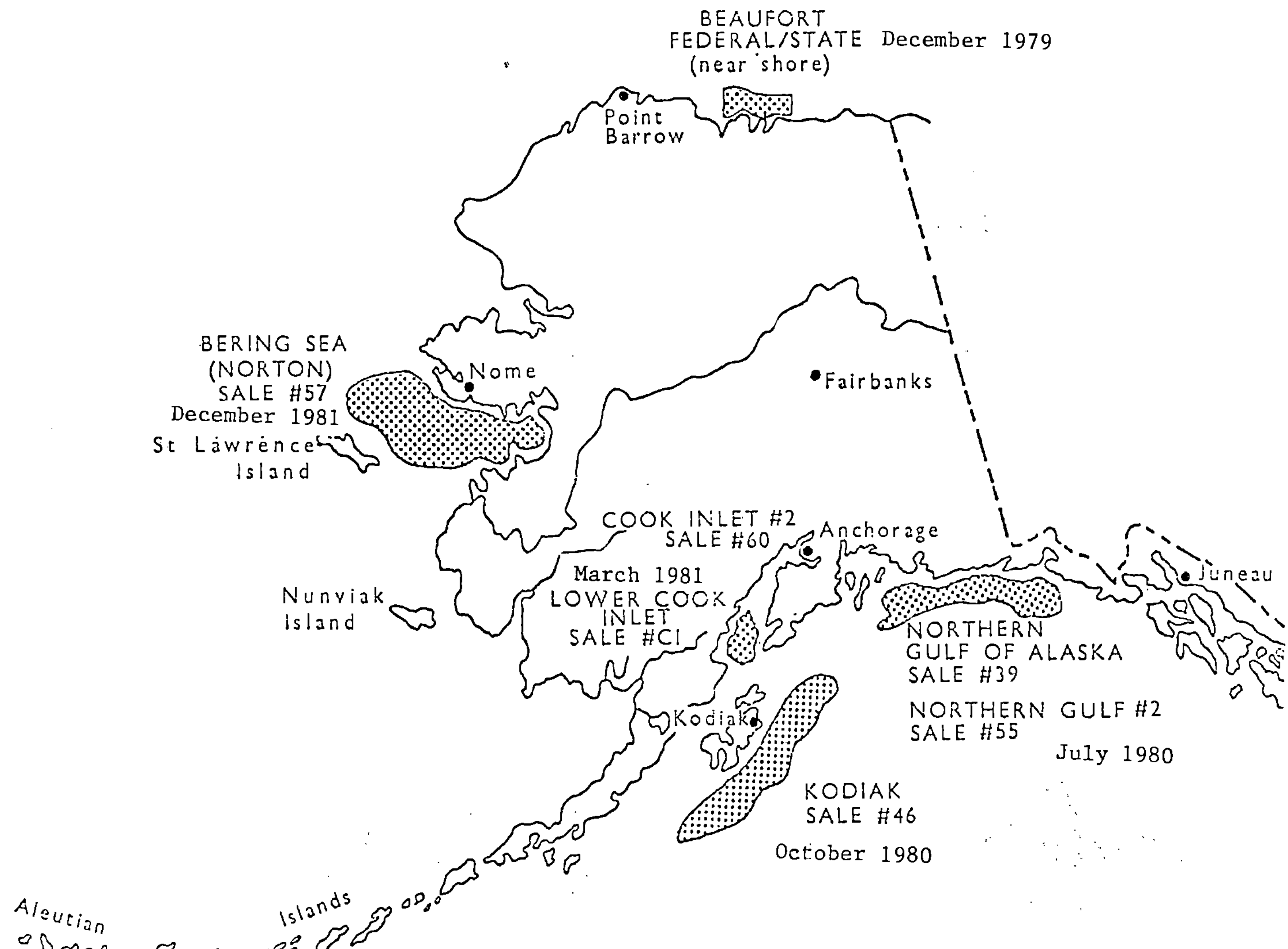
CONTENTS

VOLUME I

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

Date: 6/6/78
Contract: 03-5-022-56
Task Order: 2
R.U. #: 350
Proposal #: OCS 79-1

RENEWAL PROPOSAL
FY '79

to

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Outer Continental Shelf Environmental Assessment Program
Boulder, Colorado 80302
% of Juneau Project Office

ALASKA OCS PROGRAM COORDINATION
Research Unit 350

Total Cost $90,079
Lease Areas: N/A

Sea Grant Program
University of Alaska
Fairbanks, Alaska 99701

D. H. Rosenberg, Director
Alaska Sea Grant Program
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7086

A. B. Frol, Director
Administrative Services
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7340

Keith B. Mather
Vice Chancellor for Research and
Advanced Study
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7282

TECHNICAL PROPOSAL

I. Title and Task Statement Number

Alaska OCS Program Coordination
Research Unit 350
October 1, 1978-September 30, 1979

II. Principal Investigator

Mr. Donald H. Rosenberg
Director
Alaska Sea Grant Program
University of Alaska

III. Cost of Proposal

A. Science $90,079
B. Logistics $0
C. Total $90,079
D. N/A

IV. Background:

The large interdisciplinary research program being undertaken by the University of Alaska for NOAA requires internal coordination and special monitoring to insure the maximum efficiency of the scientific programs. Field logistics, equipment acquisition, personnel, contract reporting, data distribution, and information exchange, all required by the program, are beyond the normal scope of the University administration structure and require a central coordination to avoid duplication and confusion.

V. Objectives:

This project provides for the continuation of the OCS coordination office at the University of Alaska. This office has monitoring authority over all Task Orders under the University of Alaska's contracts with NOAA. This monitoring effort is limited to evaluation of the scientific effort being consistent with work statements, field data collection for consistency with Data Management Plans, establishment and maintenance of Data Management Schedules and the completion and submission of all required reports. The office also provides keypunch service for both the University and other OCS research units, as identified by the Juneau project office, in order to insure timely submission of all identified environmental data.

VI. Strategy and Approach:

The management staff consists of the following personnel:

Donald H. Rosenberg	Coordinator
Raymond S. Hadley	Data Manager
Monique Schamell	Keypunch Operator
Cathy Williams	Accounts Clerk

In addition the following person is provided by the University:

Helen Greschke	Typist

The responsibilities of key personnel are as follows:

Donald H. Rosenberg acts on behalf of the University of Alaska in any contract negotiations and in general supervision of the project.

Raymond S. Hadley is responsible for the day-to-day management of the University's OCS contract, including all phases of Data Management, logistic coordination, and report submission; he also acts as a point of contact between the Project Offices and Principal Investigators. In the role of data manager, Mr. Hadley supervises the work of Ms. Schamell, the keypunch operator and Ms. Williams, the OCS accounts clerk.

Technical management for the task orders supported by this office is provided by the Principal Investigators of those task orders. This task order provides logistics, data, and contractual and fiscal management as outlined below. The University of Alaska agrees that the Principal Investigator can travel to the Juneau 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 have been allocated as "Administrative Travel" in previous FY budgets of this R.U. and remain for use during this fiscal year.

This office expects to undertake the following specific actions in partial fulfillment of the objectives of this work statement:

1. Environmental Data Management

   a. To code data and to provide keypunching and supervision of transfer to magnetic tape of data collected by the task orders under this contract.

   b. To submit data management plans for those task orders, or new task orders, as necessary.

   c. To submit data, procedures, and documentation as specified in those data management plans.

   d. To establish and submit schedules for data submission in accordance with data management plans.

   e. To provide keypunching for up to 30,000 cards for task orders outside the contracts specifically covered by this office. This will be done at the discretion of and request from the Project Office providing the data to be keypunched is properly formated and in a readable form.

2. Logistics

   a. To coordinate comments concerning the logistic project instructions received from the Project Offices. It must be emphasized that timely receipt of the preliminary instructions is required. In so responding, charts of cruise tracts and lists of personnel to be involved in the operation, including necessary information for security clearance will be provided when possible and where appropriate.

b. Cruise reports will be formated and submitted, along with ROSCOP II forms, by this office as required by contract.

c. Copies of smooth plots and other cruise information are archived as received from the Project Offices by the Institute of Marine Science Data Processing Office. They are readily available to all Principal Investigators involved in the OCSEAP Program.

3. Reports

a. To coordinate and aid in the preparation of all reports as required by the contract.

b. To insure that all required reports are submitted in accordance with the contract.

4. Fiscal and Contract Management

General contract management will be carried out by this office to insure that each aspect of the contract is carried out for the benefit of both the government and the University. Fiscal management will be maintained by this office over contract 03-5-022-56. Fiscal management of contract 03-5-022-55 will continue to be maintained by the Business Office of the Geophysical Institute.

5. Sorting Center

Future contracts for Sorting Center work for OCS may be negotiated through this office. Currently we know of no work extending into FY '79, with the exception of possible work from R.U. 5 which is coordinated under this contract.

A. Sampling Methods:

Not applicable.

B. Analytical Methods:

Not applicable.

VII. Deliverable Products:

A. Digital Data

This project acts as a conduit for data gathered under other task orders of this contract. Where necessary, the personnel of this task order format digital data to conform with OCS formats. Once the data is properly formated, the data is keypunched, listed and spot checked. After all questionable entries are resolved, the data is read on to magnetic tape, a D.D.F. is filled out and the total package is forwarded to the Contract Data Manager. Throughout this process, contact is maintained with the Principal Investigator responsible for the data to insure accurate data submission.

Range checks are not performed. The accuracy of the data received by this office is the responsibility of the Principal Investigator.

This process, by past experience, insures that data submitted are as complete and accurate as possible. Any errors subsequently discovered will be traced and corrected through this office during the lifetime of the task order on whose behalf the data was submitted.

B. Narrative Reports

Quarterly, annual and final reports for task orders under this contract are submitted to this office for copying and forwarding to the appropriate project office, including the project reports on the activities of this office.

Further, cruise reports, ROSCOP II, D.D.F and Data Submission Schedules are either prepared or funnelled through this office. This system provides for a single contact point when information concerning the reporting requirements of this contract are needed by the government or the University.

C. N/A.

D. N/A.

E. N/A.

F. The budget of this proposal, in part, constitutes the cost-estimate for data reduction CPF 8(a) for all task orders under this contract.

VIII. Special Sample and Voucher Specimen Archival Plans:

This office has agreed and continues to agree to negotiate a reasonable plan for collecting and maintaining Voucher Specimens for all appropriate tasks under our jurisdiction. As of this time, no such plan exists to our knowledge. We agree to review any plan proposed by NOAA/OCS, making comments and to reach an agreeable solution.

IX. Logistics Requirements:

N/A.

X. Anticipated Problems:

The nature of this task order is to handle the problems in contractual compliance for all task orders under this contract. We, therefore, do not anticipate any problem in solving problems that do arise.

XI. Information Required from Other Investigators:

Information necessary to create data and report submissions must come from other Principal Investigators. This information is readily obtained from the investigators under the contract managed by this task. Any work done for investigators outside this contract must be funnelled through the appropriate Project Office, which takes responsibility for delivering all necessary information.

XII. Activity/Milestone Chart:

See Attachment 1.

XIII. Outlook:

The nature of this task precludes the necessity of answering this section in an independent manner. This task must be maintained for the duration of involvement by the University in OCSEAP and, therefore, is dependent on the level of effort for all tasks assigned to the University. The level of funding in the future is also dependent upon the number and nature of those tasks assigned to the University. Basically, level funding in proportion to the total contracts, adjusted to allow for inflation, will be necessary. Should the program expand, however, additional funds may be necessary.

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 this R.U. 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 for each of the tasks falling under the jurisdiction of this office. 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 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 sorting or other laboratory procedure." NODC Taxonomic Code will be used where appropriate for FY '79 data submission.

g. 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. If the Chief Scientist represents the contracts covered by this office, the form will be sent through this office.

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 Continental Shelf Environmental Assessment Program to which funds were provided by the Bureau of Land Management, Department of Interior."

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)

Not applicable for R.U. 350. Other tasks of contract 03-5-022-56 will have data submission schedules which will be updated quarterly by this office in coordination with the principal investigator of said tasks.

MILESTONE CHART

0 – Planned Completion Date

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

RU # 350 PI: D. H. Rosenberg

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			0												
Annual Report						0									
Quarterly Report									0						
Quarterly Report												0			
Final Report (if not renewed)															0

Date: 6/16/78
Contract: 03-5-022-56
Task Order: 23
R.U. #: 351
Proposal #: OCS 79-2

RENEWAL PROPOSAL
FY '79

to

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Outer Continental Shelf Environmental Assessment Program
Boulder, Colorado 80302
Juneau Project Office

MARINE LOGISTICS SUPPORT
Research Unit 351

Total Cost $18,000
Lease Areas: N/A

Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

Dolly Dieter
Principal Investigator
University of Alaska
Seward, Alaska
(907) 224-5261

J. R. Moore, Director
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7531

A. B. Frol, Director
Administrative Services
University of Alaska
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

I. Marine Logistics Support
Research Unit #351

II. Principal Investigator:

Ms. Dolly Dieter
Marine Superintendent
Institute of Marine Science
University of Alaska

III. Cost of Proposal

A.	Science:	$18,000
B.	Logistics:	-0-
C.	Total:	$18,000
D.	Lease Areas:	N/A

IV, V, VI. This project will provide general logistical and sea-going technical support for all OCS-related research at the University of Alaska. One marine technician position is requested. This individual will support the scientific cruises proposed for FY79 by other University R.U.'s. In addition to duties at sea, this technician is responsible for shorebase equipment maintenance for various OCS projects.

VII. B. Quarterly, annual, and final reports will be submitted in accordance with the contract.

VIII. N/A

IX. N/A

X. N/A

XI. N/A

XII. See attached Milestone Chart.

XIII. Apparently, this project is winding down. Should a further need for additional technical support or R/V Acona ship time be necessary, we hope to be contacted.

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 for each of the tasks falling under the jurisdiction of this office. 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 volumes 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. If the Chief Scientist represents the contracts covered by this office, the form will be sent through this office.

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 fudning 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."

MILESTONE CHART

0 - Planned Completion Date

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

RU # 351 PI: Dolly Dieter

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			0												
Annual Report						0									
Quarterly Report									0						
Quarterly Report												0			
Final Report (if not renewed)															0

1. COVER SHEET FORMAT

Proposal Date: June 23, 1978

Contract #: 03-5-022-81

Task Order #: E(2,4,6,7,8,9)F(2,11)

NOAA Project #:

Institution ID#: 100-FCAD

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

FY 1979 RENEWAL PROPOSAL

Research Unit Number 356

TITLE: Environmental Assessment of Selected Habitats in the Beaufort Sea Littoral System

Cost of Proposal: $ ~~$165,551~~ 105,500 [handwritten initials] Lease Areas Beaufort 100 %

(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)

NOTE: PLEASE INCLUDE APPROPRIATE AGENCY SIGNATURES ON THIS OR AN ATTACHED SHEET.

Principal Investigator:

[signature]
A. C. Broad
Department of Biology
Western Washington university
Bellingham, WA 98225

(206) 676-3632

Officer authorized to sign for the University:

[signature]
Sam P. Kelly, Dean for Graduate Affairs and Research
Western Washington University
Bellingham, WA 98225

(206) 676-3170

Financial Officer:

[signature]
Harriet Axlund, Project Fiscal Officer
Western Washington University
Bellingham, WA 98225

(206) 676-3200

3. Technical Proposal

I. Title: Environmental Assessment of Selected Habitats in the Beaufort Sea Littoral System

Research Unit: 356

Contract Number: 03-5-022-81

Proposed Dates of Contract: at least through September, 1981.

II. Principal Investigator: A. Carter Broad

III. Cost of Proposal for Federal Fiscal Year:

A. Science $~~165,551~~ 105,500 ALB

B. PI provided logistics --

C. Total $~~165,551~~ 105,500 ALB

C. Distribution of effort by Lease Area:

1. Beaufort Sea: $~~165,551~~ 105,500 ALB
100 %

IV. Background: This project began in 1975 as "Littoral Survey of the Beaufort Sea." Although there have been three changes of project title since that time and, for 1976 and 1977, extensions of work into the Chukchi area, the major thrust has been toward comprehension of the functioning of that portion of the Beaufort coast variously called intertidal, littoral, nearshore or inshore. Our concern has been centered on the zone between the upper reaches of customary wind-driven "tides" and the part of the marine environment where we interface with the work of Carey (RU6)--usually at about 20m depth. Within this region, our work in 1975 and 1976 was centered mainly on the littoral or nearshore zone (upper shoreline to 2m depth). Beginning in 1976 and continuing through 1978 we have increasingly concentrated on the inshore region between 2m and 20m deep. In this Beaufort Sea littoral (and inshore) system, we have investigated: 1) the structure of the biotic communities that exist: originally in enumerating and quantifying species present, ultimately working toward comprehension of the way the system responds to perturbations; and the ultimate sources of energy and nutrient materials; 2) the stability or annual variability in species composition at selected habitats; 3) reproductive activities of major species as shown by periodic samples and the significance of the littoral zone as a nursery area.

Specific projects that contribute to these objectives are:

A. Characterization of littoral communities including marsh and beach plant communities. This part of our work was completed (reconnaissance aspect) in 1976 for the Beaufort Coast and 1977 for the Chukchi. Data include species lists and abundance criteria. This portion of the work of RU356 is an arctic equivalent of that of Zimmerman (RU79) in the Gulf of Alaska and Bering Sea, and uses, as appropriate, the same techniques and the same data reporting format.

B. Repetitive sampling of selected beach and littoral marine transects for data on seasonal and annual population fluctuations and phenological (seasonal) phenomena such as reproduction. This program was begun in 1976 and continues through 1978 with transects extended to cross lagoons or to depths greater than 2m. This program interfaces in several respects with the Beaufort Sea barrier island-lagoon ecological process study of LGL, limited (RU467).

C. Effects of various perturbations (enrichment, inundation by sea water, cover by sand, contamination with oil) on the physical structure of salt marsh communities at two selected sites. This study also is concerned with ecological processes in salt marshes and possible contributions of salt marshes to food webs of the littoral, marine system. Ecological work in salt marshes was begun in 1977.

D. Characterization of the benthic and epibenthic biota of the inshore region (between 2m and 20m). This program was begun in cooperation with RU6 in 1976 when the R/V ALUMIAK first became available. In 1977 we continued the sampling of the Beaufort inshore area. In 1978, this sampling will be almost entirely within the Beaufort lease zone. Carey (RU6) continues to sample benthos of water deeper than 20m.

E. Food of selected Beaufort littoral species with especial reference to detrivores and the role of peat of terrestrial origin in Beaufort littoral food webs. This project, begun in 1977, continues in 1978. We have found peat fragments in the stomachs of Beaufort invertebrates and have demonstrated in the laboratory that amphipods (Gammarus) and isopods (Saduria) will ingest peat. We are less certain of the nutritional contribution made by peat (or by the epiflora). Current research is addressed to this and to additional major species. Other aspects of this general problem are of concern to the LGL group (RU467).

F. The biota of the "Boulder Patch." Reimnitz (RU205) and others have reported the existence of boulders on the sea bottom near Narwhal Island in the Beaufort lease zone and have documented by photography the existence of a rich, sessile community not otherwise known from samples of the inshore zone. We will investigate these sites in 1978 to characterize this community (species and quantitative data) and to estimate its extent.

G. Determination of benzopyrene hydroxylase activity in Beaufort littoral and nearshore fishes (see Payne and Penrose, 1976. Science : 191 : 945). This project began in 1977 with work on technique and should be completed in 1978. Data obtained should provide a pre-development baseline. Whatever levels of activity are obtained should be "background" or due to natural hydrocarbons.

The work remaining and addressed in this request is:

A. Laboratory analysis of samples taken in 1977 and 1978.

~~B. Possible--as indicated by 1978 data--follow-up to include another summer's diving in the "Boulder Patch" area.~~

B ~~C~~. Continuation of the study of food and energy sources of Beaufort littoral and nearshore species.

~~D. Possible final visit to marsh sites to assess experiments begun in 1977 and 1978.~~

V. Objectives: The general objectives have been referred to above. The specific objectives of this fiscal year are:

A. Continue laboratory analysis of nearshore and inshore Beaufort samples. At this time, we have nearly completed analysis of the 1977 samples taken from R/V ALUMIAK. We still have littoral samples from the Beaufort and from selected Chukchi sites that have not been done. In 1978, we will add samples from the Boulder Patch, the third ALUMIAK cruise, and the final year of littoral sampling. These must be sorted, species identified, weighed, and the data reported.

~~B. Follow-up sampling of the Boulder Patch. There currently is reason to believe that there will be a need to return to the Boulder Patch in 1979 to confirm 1978 observations and to help assess effects of local extirpations.~~

B ~~C~~. Complete investigations of food and energy sources of littoral and inshore Beaufort species. It is likely that a third season will be required to complete this work.

~~D. Final visit to marsh sites. Perturbation experiments begun in 1977 were assessed through that growing season and in 1978. New experiments have been added in 1978. A final visit in 1979 to assess both one and two-year old environmental insults is indicated. Our plots survived the 1977-78 winter and have been identified again in 1978 by personnel now in the field. A 1979 assessment of 1977 experiments is feasible.~~

These objectives are consistent with the statement of goals for this unit contained in the REVISED ~~April 27~~ request for renewal proposal from Drs. Weller and Norton.

VI. General Strategy and Approach: Our laboratory methods are those used previously and are reported briefly below. The procedure is standard in sorting laboratories. In exceptional instances, we subsample, but usually we count entire samples.

If we do further field work in the Boulder Patch, the strategy will be that used in 1978 unless the current field season experience should indicate otherwise. This strategy is reproduced from our 1978 proposal:

> Grabs and dreges are frequently used to obtain density data and to determine distribution patterns of marine benthic biota. Collection of biota by these methods has two serious limitations: (1) many species may not be sampled that could easily be observed by divers; and (2) grabs and dredges are not efficient on hard, rocky substrates. In numerous studies of marine organisms, direct observation and collection with the use of SCUBA has greatly enhanced the quality of information obtained. For this study, the use of SCUBA will be valuable in describing this rock community and its associated biota.
>
> Three divers and a boat tender, based on Narwhal Island, will sample the area from about July 20 to August 19 when it is expected the sites will be mainly ice free. The use of a 21-foot Boston Whaler (or equivalent) for transportation to and from dive locations and housing and wet lab facilities on Narwhal Island will be required. Housing facilities provided by OCSEAP in Prudhoe Bay will be needed between sampling trips.
>
> Sampling sites will be selected for the presence of suitable substrata. Sites will be located by exploratory dredging and with a recording sonograph. Sonograph recordings are extremely useful for locating bottom growth because of the characteristic echoes from rocky bottom areas. Quantitative sampling will assure that representative specimens of all algae and invertebrates are collected for identification. Water temperature, salinity and turbidity measurements will be taken in the field in addition to hydrographic and meteorological measurements on the surface. Underwater photographs of the biota and of the community will be taken at all sites for subsequent determinations of cover per species.

Laboratory studies of food of Beaufort Sea species will be based on gut and fecal pellet analyses of animals captured in the field. In addition, feeding and uptake experiments will be conducted. Specific experiments for 1979 will depend upon results obtained in 1978.

~~The final visit to marsh sites will be to measure cover and plant growth in experimental plots established in 1977 and 1978.~~

Divers will work in teams of two with one alternate diver standing by as a safety precaution. Divers will rotate between active and standby duty, and dives will be made on successive days or as frequently as weather permits. During sampling, one diver will be responsible for the photography and the other collection of organisms. Both divers will record observations concerning the community on underwater notepads. Dive times should range between 30 and 40 minutes with two dives being done per day. A rest and warm-up period will follow the first dive before the divers re-enter the water the second time. The spare diver and boat tender on the surface will record meteorological and hydrographic data, assist the divers and transcribe data wherever necessary. All divers will have at least the equivalent of a B.S. degree in Marine Zoology, Botany, or Biology as well as expert diver experience.

Samples in salt marshes will be based on standard plant ecological methods of estimating percent cover by species, plant height (growth), production during a season (biomass) in quadrats treated variously (saltwater, sand, oil, etc.) and quadrats not treated.

VIII. Analytical methods: Our principal task for 1979 will be laboratory analysis of samples. These samples are field screened and preserved. In our laboratory in Bellingham, the samples are sorted to remove and categorize all organisms, organisms are identified and further sorted by species, each species is counted and wet weighed. The specimens from each sample are preserved and stored pending instructions for permanent archiving. The raw data are entered into computer storage and reported to NODC (intertidal data format). For quarterly and annual reports, these data are standardized to per unit bases (per m^2 for benthic, per 50m tow for epibenthic) or otherwise treated for statistical analyses. Procedures used are those employed since 1975 and have been reported in detail previously.

The general methods employed in examination of gut contents and fecal pellets and in feeding experiments have been described in our 1978 annual report (Broad et al., 1978, in Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the year ending March, 1978. NOAA/BLM in press).

IX. Deliverable Products

A. Digital Data: Our digital data are those of Intertidal data format 030 (NODC File Type 030). The attached summary of File Type 030 indicates those data collected or to be collected and submitted. Not all data are pertinent to every sample (for example, measurements along a transect line when there is only one site per station). We do not use numbered photographs. Our sampling procedure does not utilize grids. We do not report lengths, ages, or displacement volumes of specimens nor are these data pertinent to our samples. We do not measure either pH or atmospheric pressure. Except for plant data, we can not report dry weights of organisms collected until an OCS policy on long-term storage of specimens has been set. Obviously, drying soft-bodied animals is inconsistent with specimen storage.

The attached digital data products schedule indicates that data to be submitted during the period covered by this contract include some we had hoped to submit earlier. This slippage in our milestone chart has been noted below and elsewhere.

B. Narrative reports: In addition to the usual quarterly and annual reports, we will submit during this year a paper for publication dealing with the littoral and nearshore benthic biota of the Beaufort Sea, and one on a new sampling device. Papers on marsh ecology and food of marine invertebrates are in process and may be submitted this year. There will be special sections in reports on the biota of the Boulder Patch and on benzopyrene hydroxylase activity levels in Beaufort fishes. Both of these could ultimately be published.

C. Visual data: Charts and maps will accompany reports and manuscripts as appropriate. We are working on a set of maps somewhat comparable to the Atlas produced by RU79, but this probably will not be ready this year.

D. Other, non-digital data: not applicable.

X. Quality Assurance Plan: Our monitoring instruments are all relatively simple and are calibrated in our lab before each field season.

A. Our salinity/temperature records (Y51 model 33 SCT meters) are to the nearest whole part (salinity) or Celsius degree (temperature). We check our instruments against known standards at the start of the field season and (for temperature) periodically during the season. Thermometers are checked against an ice-water mixture. Other instruments used (compasses, wind guages, etc.) are not calibrated since the accuracy of reading probably is less than errors of calibration. A non-functioning instrument is obvious to the user.

B. Our quantitative samples are taken with essentially non-adjustable bottom grabs ($0.1m^2$ Smith-McIntyre, $0.023m^2$ Ekman or Ponar) or are only roughly quantitative (dredges, trawls, plankton nets, traps, other collecting). Certain data have been taken by counting organisms within quadrat frames of fixed sizes ($0.25m^2$, $0.0625m^2$). Benthic samples are screened in the field and all material retained on a 0.516mm screen is preserved as the sample. Preservation is with 10% hexamine-buffered formalin.

C. Analysis of biological samples has been treated above. We maintain continuous contact with the Marine Sorting Center of the University of Alaska to assure taxonomic uniformity between our unit and others.

D. Our raw data are reported to NODC on File Type 030 (Intertidal Data format). The same data are stored in our computer. We use various programs to recall, standardize and analyze data for specific purposes. Examples of these are: species lists by area or by depth intervals; quantitative data (number per m^2) by location; Shannon-Weaver diversity indices by station or by more general location; salinity/temperature profiles; beach profiles; sediment distribution; etc.). In addition, all field notes, journals, sample inventories, data sheets on which computer cards are based, and computer cards containing the data are filed.

XI. Specimen Archival Plan: We have retained all specimens and samples collected since 1975 and are waiting for instructions on permanent storage.

XII. Logistic Requirements: Logistics requirements are estimated on the attached sheets--but these are largely guesses since details of field operations can not be known until after the coming field season.

XIII. Anticipated Problems: Because what is proposed is a continuation of existing programs, we do not anticipate any problems--provided that the current (1978) Boulder Patch diving expedition is successful.

Contingency Plan

Our only field operations will be a possible follow-up on the Boulder Patch investigation and a final visit to the marsh sites. There is almost no way that weather could prevent the latter, and, if ice makes diving at the Boulder Patch impossible, we would use the same divers and gear (with quite different logistic requirements) for a similar operation in Simpson Lagoon, the Colville delta, or the mouth of the Canning River.

XIV. Information Required from Other Investigators: We are dependent on none, but see Section IV for relationships with R.U. #'s 6, 205, 467.

XV. Management Plan: The Principal Investigator will be the project manager. He will be supported within the university by a Bureau for Faculty Research and Computer Center. Dr. Schneider will be responsible to the PI for experimental and other work at NARL, Barrow. Dr. Mason will be responsible to the PI for research in Arctic marshes. Mr. Koch will be responsible to the PI for laboratory operations in Bellingham. A computer programmer (part time) will be responsible to the PI for data management and liason with NODC.

An updated milestone chart is attached but the next section deals with an extension of this.

Intertidal Data

Common to all records
- *File Type
- *File Identifier
- *Record Type
- *Station Number (Record Types 2,3, and 4)
- *Sequence Number (" " " " ")

Record Type '1' - File Header
- *Vessel Name/Cruise Number
- *Cruise Dates
- *Senior Scientist/Investigator/Institution

Record Type '2' - Station Header
- *Geographic Position
- *Date/Time
- *Surface Water and Air Temperatures
- *Salinity
- *Secchi Depth
- *Weather (codes)
- *Wind/Sea State (codes)
- *Beach Exposure Direction
- *Substrata Type (code)
- *Habitat Description (codes)

Record Type '3' - Site Header
- Catalog/Photograph Numbers
- *Gear Type (code)
- *Transect Number/Direction
- *Meter Number
- *Sample/Zone/Arrow Number
- *Qudrat Size/Elevation/Slope
- *Substrata and Surface Topography Types (codes)
- *Collection Time
- *Sieve Size
- *Dilution Volume
- *Sediment Volume
- *Grain Size
- *Grab Number
- *Patch Grid Size
- *Total Work Area
- Number of Grids Occupied
- *Distance of Net Tow

Record Type '4' - Sample Data
- *EDS Taxonomic Code/Subspecies (code)
- *Sex (code)
- *Sample Condition (code)
- *Percent Coverage
- *Count of Species
- *Wet and Dry Weights
- Minimum/Maximum/Mean Lengths
- Minimum/Maximum/Mean Widths
- Minimum/Maximum/Mean Age
- *Small/Medium/Large Frame
- Displacement Volume
- *Dilution Volume
- *Plant Height

Record Type '5' - Individual Sample Data
- *EDS Taxonomic Code/Subspecies (code)
- *Sex (code)
- *Sample Condition (codes)
- Age
- *Wet/Dry[1] Weights
- Length/Width of Sample
- Displacement Volume

Record Type '6' - Profile Data
- *Oxygen
- pH and pH Scale (code)
- *Temperature and Salinity
- *Permafrost Depth
- *Secchi Depth
- *Grain Size (Phi unit levels)

Record Type '7' - Text
- *Text/Comments

[1] dry weights cannot be determined if specimens are to be archived.

DIGITAL DATA PRODUCTS SCHEDULE

a Type e. Intertidal, thic Organisms, .)	Media (Cards, cod- ing 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
intertidal and Benthic	tape	5 tapes is most likely. Impossible to estimate the number of bytes	030	yes	1977 Samples	6/79
"	"	"	"	"	1978 other data	12/79

MILESTONE CHART

0 – Planned Completion Date

X – Actual Completion Date

RU # 356 PI: A. Carter Broad

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

MAJOR MILESTONES	June	O	1978 N	D	J	F	M	1979 A	M	J	J	A	S	O	N	D	
Reporting 1976 data to NODC	X																
Laboratory Analysis of 1977 samples										0							
Reporting 1977 data to NODC										0							
1978 field data		0															
Laboratory analysis of 1978 data		←	—	—	—	—	—	—	—	—	—	—	—	—	—	→	
Laboratory Analysis of Boulder Patch Data (1978)							0										
Completion of marsh ecology		0										~~0~~					
Studies of food & feeding										/	←	→	/				
~~Boulder Patch follow up~~											~~0~~	~~0~~	~~?~~				
~~Laboratory Analysis of 1979 data~~													←	—	→		
Final report																~~0~~ →	

XVI. Outlook: At the end of the period covered by the current proposal, we should be finished with the work we originally set out to do except that there will be biological samples not yet analyzed. Over the years, we have collected considerably more material than was originally thought we would. The problems of picking out and identifying organisms have proved to be considerably more time-consuming than we had thought. ~~Finally, there will be some material collected in 1979 that will not reach our lab until near the end of fiscal 1979.~~

If we encounter no real surprises in the Boulder Patch (a difficult assumption to make before the first dive), we should have characterized it and plotted it with reasonable finality. Any continuation of the program beyond this period should be part of a new contract.

Similarly, any continuation of the feeding experiments beyond fiscal 1979 probably should involve another contract.

~~We do not recommend continuing the marsh perturbation study beyond 1979 unless this is done as a separate contract and unless the 1978 results yield some unanticipated information.~~

Therefore, we should like to continue this contract through fiscal 1981 on the following basis:

1. A. C. Broad to continue nominally as PI for administration and reporting.
2. Helmut Koch to assume additional responsibilities in laboratory and data management.
3. A budget of about 70K in 1980 for salaries and wages of personnel in Bellingham, minor supplies, and minimum travel. In 1981, the budget should be considerable smaller--perhaps 40K.

After 1979, we would do no field work and have no logistic requirements. We expect all lab work to be completed in mid 1981 with all reports completed that year.

On the other hand, if new lease areas--especially to the east of the Canning River, or if a winter exploration of Simpson or other lagoons or of the inshore Beaufort becomes a reality, we feel our group has expertise and experience that would be valuable, and might want to change the above. This, however, should be thought of as a new or separate venture.

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 informattion 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."

N. A. R. L.
Barrow, AK 99723

July 28, 1978

Dr. Gunter Weller
Dr. David Norton
O. C. S. E. A. P.
Arctic Project Office
University of Alaska
Fairbanks, AK 99701

Dear Gunter and Dave:

I offer the following changes in my proposal for RU 356 for fiscal 1979. I have been authorized by Western Washington University to negotiate these modifications.

1. Revised objectives: I propose the deletion from my original proposal of the second summer of investigation of the boulder patch located between Narwhal Island and the mouths of the Sagavanirktok River and of the final visits to the Beaufort and Chukchi Sea marsh sites where ecological investigations have been carried out in 1977 and 1978.

Our scientific objectives for 1979, therefore, are laboratory analysis of samples collected in 1978 (plus some remaining from 1977) and the continuation of experiments dealing with nutritive and energy sources for predominant, littoral and nearshore invertebrate species. The laboratory analysis is but the completion of field work done last year and work in progress now. Our experiments on feeding and energy sources are currently so promising that we feel continuation is essential to comprehension of the nearshore arctic ecosystem.

These two objectives are essentially unchanged from those in the proposal submitted on June 23. The deleted objectives are no longer pertinent.

2. Revised budget: The work I propose to do will cost an estimated $120,489, which breaks down as follows:

Salaries	$66,056
Fringe	14,603
Travel	1,500
Supplies	1,500
Overhead	36,530
Total	$120.489

In your guideline for RU 356 for 1979 the cost of our work was estimated at $105,500, and I understand that we are to function within that guideline. The difference between what I believe will be the cost of the work I propose and the Federal funds available for 1979 ($14,989) will be contributed by Western Washington University or may come in part from previously authorized funds if these are not fully expended this year.

I reiterate that I have been authorized by Western Washington University to make this commitment of University funds. The University will back me in this rather than further reduce these projects to a level I feel is not acceptable.

3. The deletions from my original proposal: Because this revised proposal does not include two field projects, the task of the P. I. will be simpler. So, I have reduced ny own commitment to the project from 7.5 months to 6 months. I see no need in this revised proposal for me to be involved in field operations in Alaska and currently plan to limit myself to supervision, report writing, and administration which will be done largely in Bellingham.

At this writing, our team of divers under the leadership of Ken Dunton has completed about one-third of their 1978 field work on the rocky bottom between Narwhal Island and Point Brower that Erk Reimnitz has called the Boulder Patch. It is, as had been anticipated, a unique habitat in the Beaufort coastal zone. The site on which we dived is slightly less than ~~three~~ five miles northeast of the Exxon artificial island in the Sagavanirktok delta. We now know it is different from any habitat we have encountered in the Beaufort Sea. We do not yet know the extent of the rocky area, although we expect to have data on this by the end of next month. We do not yet understand the ecological role of this Boulder Patch in the Beaufort lease zone. We do not yet know whether these rocks harbor species not found elsewhere in the American Arctic.

The work has gone well and looks very promising.

Deleting the continuation of the Boulder Patch investigation from our proposal was a difficult thing for me to do. I can not justify having done so on scientific grounds. The money simply is not there, and I have removed the Boulder Patch from our proposal reluctantly for that reason. I shall continue to look for ways of financing the continuation of this work, especially in view of the fact that most of the major expenses (boat, equipment) of doing so are behind us. A second season in the field will be relatively inexpensive. The work has proved to be feasible and the effort has been productive.

Finally, I have deleted a third season of visits to our marsh ecology sites. We have learned this year that the marshes have not recovered from ecological insults or perturbations done in 1977. Especially in view of the fact that new experiments were begun this year, it seems to me a shame not to spend the relatively minor amount that would be required to make a third season's observations when our original experiments will be two years old.

I enclose a revised proposal in which the corrections are made in ink and the significant ones initialed by me. These corrections are approved by Western Washington University. A retyped proposal can be submitted if you wish.

Sincerely yours,

A. C. Broad
Professor of Biology
Western Washington University

cc: Sam Kelly

1. COVER SHEET FORMAT

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

Proposal Date: October 1, 1978

Contract #: 03-5-022-81

Institution ID: 100-FCAD

FY 1979 Addendum for Winter Process Studies

Research Unit Number: 356-W

Title: Environmental Assessment of Selected Habitats in the Beaufort Sea Littoral System

Cost of Addendum: $125,000; Lease Area: Beaufort (100%)

Period of Addendum: October 1 - September 30, 1979

Agency signatures:

Principal Investigator	Officer authorized to sign for the University:	Financial Officer:
A. C. Broad Department of Biology Western Wash. University Bellingham, WA 98225 (206) 676-3632	Sam P. Kelly, Dean for Graduate Affairs and Research Western Wash. University Bellingham, WA 98225 (206) 676-3170	Harriet Axlund, Project Fiscal Officer Western Wash. University Bellingham, WA 98225 (206) 676-3200

3. Technical Proposal (Addendum)

I. Title: Environmental Assessment of Selected Habitats in the Beaufort Sea Littoral System

Research Unit: 356-W

Contract Number: 03-5-022-81

Proposed dates of addendum: October 1 - September 30, 1979

II. Principal Investigator: A. Carter Broad
Associate Investigator: David E. Schneider
Assistant Investigator: Ken Dunton

III. Cost of addendum: $125,000

IV. Background: Two specific projects are covered in this addendum. These have been developed by the Associate and Assistant Investigators in concert with the Principal and are treated below. The text of sections IV, V, and VI, except for this paragraph, is mostly that already submitted by Messrs. Schneider and Dunton. Sections IX (Logistic Requirements) and X (Cost Proposal) are new.

Physiological and Trophic Studies:

The trophic relationships of the shallow water Beaufort Sea community have been investigated by RU 356 during ice free periods in 1977 and currently in 1978. These studies initially focused upon the composition of fecal pellets and gut contents of freshly collected major species. These initial observations indicated that a number of the species were ingesting vascular plant detritus that presumably originates from erosion of tundra peat deposits. Experiments were then designed to further assess the role of peat in this food web. Major questions that are being considered are as follows:

1. Do animals that ingest detritus of terrestrial origin derive any nutrition from this material?

2. If these species derive nutrition from this detritus, are they able to utilize directly the material or are they digesting the microorganisms that may be the primary agents of decomposition?

3. Do the species that utilize detritus of the terrestrial origin prefer a particular size fraction? In other words, is there a hierarchy of species required to fully utilize this material, some dealing with fairly large particles and reducing them to smaller sizes while other species only operate on small particle sizes?

At present, answers to these questions are only being sought during ice free months. An obvious gap exists in our understanding of the functioning of this community during the period of ice cover. Before the impact of oil exploration and production can be fully assessed, we should have some knowledge of the physiological state, food habits and energetic requirements of the species during the winter months.

Specifically, we want to know:

4. Is the metabolism of key invertebrate species modified during winter in under-ice conditions?

5. What effect on basic physiological parameters is exerted by Arctic winter conditions of low temperature, increased salinity and prolonged darkness? Are key invertebrate species active and feeding year around?

6. Is there a winter conditioning of Beaufort Sea sublittoral invertebrates? Does this conditioning affect tolerances to various environmental insults?

The Stefansson Sound Boulder Patch:

A cobble and boulder patch which supports a diverse array of Arctic marine invertebrates and algae has now been shown to exist in the Beaufort Sea lease area. The kelp community is located in Stefansson Sound and was first surveyed by us in late July, 1978. The faunal and floral assemblage includes several species of macro algae, and numerous invertebrates, including seastars, fish, snails, chitons, mussels, hermit crabs, hydroids, anemones, nudibranchs, bryozoans, pycnogonids, tube worms, sponges, ascidians and spider crabs. Benthic samples taken from ALUMIAK in this area in August, 1978, are richer than other samples from comparable depths and may indicate a general enrichment by the kelp community.

It is suspected that some of these species may be new to the arctic and previously unreported.

The occurrence and health of this community is dependent upon two related factors: (1) the existence of boulders and cobbles suitable for attachment (i.e., exposed) and (2) siltation rate. It is thought that wind generated currents play an important role in keeping siltation rate to a minimum and in preventing excess accumulation of silt on rock surfaces as well as on sessile plant and animal species. Any activity which would disturb the homeostatic mechanisms which control siltation rate and sediment transport would probably affect the kelp community in some way. Information concerned with the age and health of these communities, i.e., the time it takes species to colonize and establish themselves on rock surfaces, algal growth rates, and their resilience to siltation are undoubtably important factors to be examined. Such information, along with a knowledge of sediment transport in Foggy Bay would be extremely valuable in decisions made regarding the management of the shelf and in establishing guidelines for oil development.

V. Objectives of Physiological Studies

1. To investigate the metabolic activity of selected major species of the shallow water community during the period of ice cover. Measurements of the rate of oxygen consumption under winter conditions of temperature, salinity, and photoperiod will enable estimates of the energetic requirements of these species during periods of ice cover. If species go into a dormant phase during the ice cover period this may be reflected by a depressed metabolic rate.

2. Other physiological responses of shallow water species to extreme winter conditions will be investigated if it is felt that an understanding of winter distribution patterns would benefit from such information. For instance, information on tolerance of selected species to extreme salinities and to freezing would be useful.

3. To initiate preliminary investigations of the effect of Alaskan North Slope crude oil on the trophic relationships of the shallow water community. Baseline information on assimilation of detrital components will be determined under Objective 4 and metabolic demands under Objective 1. Relatively straightforward laboratory experiments can be designed to determine if these processes are perturbed by exposure to crude oil.

4. To assess the importance of detritus derived from terrestrial sources by controlled laboratory feeding experiments using specimens freshly collected during periods of ice cover. The experiments will parallel those conducted during ice free periods and will be designed to attack the same basic questions posed in the previous section of this proposal. Laboratory conditions for the experiments will approximate field conditions of temperature, salinity and photoperiod at the season being studied.

5. To investigate the important food items of the major species of the shallow water Beaufort Sea community by analysis of fecal pellets and gut contents of specimens freshly collected during the period of ice cover.

Objectives of the continuing investigation of the Boulder Patch

The following objectives are based on a winter sampling effort in the 1978-1979 field season and a summer field season in 1979.

1. To continue the overall community survey.

2. Study the growth rates of *Laminaria* and of possibly other species through the winter.

3. Examine the rate and time of colonization, growth and establishment of algae on bare rock surfaces over a one year period.

4. Determine the rate of sedimentation on exposed rock substrata.

5. Exploration of the benthos for fossilized or remnant biota attached to buried rocks.

6. Observe and collect physical data on currents, turbidity, salinity, temperature, and ice conditions.

7. To observe additions or deletions of pelagic or demersal fauna between sampling periods.

VI. General Strategy and Approach to Physiological Studies:

Live animals for laboratory investigations will be obtained in conjunction with other coordinated sampling efforts during the early stable ice cover period in late October to mid-November during mid-winter in mid- to late February, during maximal ice cover in late March to early April, and during early spring as late as sampling through ice is possible. Coordination with our own divers, Carey (RU 6), and LGL (RU 467) will be necessary. Animals will be obtained by amphipod traps or by an epibenthic sled towed between two ice holes or by divers using appropriate collecting gear. Upon retrieval of the collecting gear the animals will immediately be sorted in a heated hut to prevent freezing and packed in suitably insulated shipping containers for immediate transportation to laboratory facilities at the Naval Arctic Research Laboratory in Barrow.

Oxygen consumption (metabolic activity) of animals will be determined either with a Gilson Differential Respirometer or by closed vessel respirometry using Winkler titrations for oxygen. Freshly collected animals will be used as much as possible for the measurements to avoid complications from laboratory storage.

Preliminary oil perturbation studies will be conducted in small volume static systems using seawater extracts of crude oil extracted under winter conditions of temperature and salinity, or using direct applications of crude oil to experimental containers.

Detrital feeding experiments will be carried out in small static volumes of seawater using known quantities of detrital material. Fecal pellets will in some cases be quantitatively collected. Changes in total organic matter, nitrogen content, and microbial activity will be determined either by ashing in a muffle furnace or by a wet oxidation procedure. Nitrogen content will be measured by micro-kjeldahl digestion. Microbial activity will be estimated by ATP analysis using firefly luciferin-luciferase assay with a liquid scintillation counter as the photodetection system. Living and nonliving carbon and nitrogen will be estimated using published ranges of values for C:ATP ratios. Assimilation efficiencies for detrital components will be calculated from the above information.

Fecal pellet and gut analysis will be accomplished by teasing apart single pellets or gut contents on a microscope slide and enumeration of items using a standardized procedure. In some cases fecal pellets and guts may be preserved for later analysis.

General Strategy and Approach to be Followed in Stefansson Sound

The proposed sampling periods needed to accomplish the above objectives are in November, 1978, March and July-August, 1979. Since several of the experiments are long term, a summer sampling period is required to complete the continuum and to provide a basis for comparison between winter and summer in regard to the objectives listed above.

Experiments to satisfy the above objectives were initiated in mid-August, 1978 under the current 1977-1978 field contract for the boulder patch. No specific funds have yet been provided for a boulder patch follow-up for 1979 summer field season. We hope to find support for a full summer season but include here only the minimum follow-up.

Sampling Strategy and Approach:

Except for a few minor changes, the strategy will be that used in the 1978 summer field season. Suitable substrata in the boulder patch will be scraped *in situ* for recruitment and sedimentation data, and photography will be extensively used as an aid to data collection. For winter diving, divers will employ additional safety measures and will require logistic support from OCSEAP. This support includes (1) assistance in preparing an entrance hole through ice, (2) a large heated wannigan, (3) helicopter support, and (4) transportation to and from the winter dive site.

An underwater transponder, supplied by Brian Matthews, has been installed at the winter dive site. This will enable us to relocate our dive location in the winter and allow Matthews to conduct current studies as well. Coordination and use of this sample site with other investigators is expected.

VII. Logistics Requirements: For this addendum, the following logistic support is required:

A. Quarters and subsistence:

Location	Approximate Dates	No. of Personnel	Total Man-Days
NARL, Barrow	10/15 - 12/15	2	122
" "	12/16 - 1/15	1	31
" "	1/16 - 2/15	2	60
" "	2/16 - 6/15	3	315
		Total Man/Days NARL:	528
Deadhorse	11/1 - 11/30	4	120
"	2/21 - 3/21	4	120
"	7/25 - 8/7	4	56
		Total Man/Days Deadhorse:	296

B. Travel

Round trips Bellingham to Barrow or Deadhorse

6 round trips to Barrow
12 round trips to Deadhorse

C. Laboratory at NARL, Barrow

1 Double lab with hood from 10/15/78 to 6/15/79

D. Aircraft - fixed wing

Barrow to collecting areas (Simpson Lagoon, Stefansson Sound, Deadhorse) x 9 for an estimated 20 hours. Small aircraft (Cessna 180 acceptable).

E. Aircraft - helicopter

Daily transportation from Deadhorse to Stefansson Sound during diving operation for estimated total of 30 hours.

F. Surface vessel

Boston Whaler will be required for July sample period.

G. Field Station

Summer sampling will be done from Narwhal Island (will need NARL camp there).

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

Proposal Date: 15 June 1978

Contract #: 03-78-B01-6

Task Order #:

NOAA Project #:

Institution ID #: None

FY 1979 RENEWAL PROPOSAL

Research Unit Number: 359

Title: Beaufort Sea Plankton Studies

Cost of Proposal: $50,000 Lease Area: Beaufort Sea 100%

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

Principal Investigator: Rita A. Horner
4211 N.E. 88th St.
Seattle, Washington 98115

Required Signature: [signature]
Rita A. Horner (206) 523-2607
4211 N.E. 88th St. (206) 543-8599
Seattle, Washington 98115
15 June 1978

Qualifications

The proposer is qualified to carry out the suggested research. I have studied Arctic plankton, primarily phytoplankton, and ice algae in the Chukchi and Beaufort seas since 1964. I have supervised graduate students and technicians who have analyzed Arctic zooplankton samples and I am familiar with the major taxonomic groups that are present. Phytoplankton and ice algae studies have been in terms of species present, their abundance, chlorophyll *a* concentrations, and primary productivity on a seasonal basis. Factors affecting the production of these organisms, including inorganic nutrient concentrations, temperature, salinity, and light, have also been studied.

I was Co-Principal Investigator for RU 359 from 1975 to 1976 and have been Principal Investigator since 1977. My participation has included field collecting, sample and data analysis, supervision of technicians and students, and report writing.

Technical Proposal

I. Title: Beaufort Sea Plankton Studies
Research Unit Number: 359
Contract Number: 03-78-B01-6
Proposed Dates of Contract: 1 October 1978 through 30 September 1979

II. Principal Investigator: Rita A. Horner

III. Cost of Proposal for Federal Fiscal Year (October 1 1978 through September 30, 1979)

A.	Science	$ 50,000		
B.	P.I. provided logistics	0		
C.	Total	$ 50,000		
D.	Distribution of effort by lease area		Beaufort Sea	100%

IV. Background

Zooplankton, ichthyoplankton, and phytoplankton samples have been collected in areas of high use by marine birds and mammals, such as ice edges. These samples have been analyzed to provide information on the distribution and abundance of zooplankton and ichthyoplankton, especially those species that are major food organisms for birds and mammals. The phytoplankton samples have been analyzed for distribution and abundance of species, chlorophyll *a* and phaeopigment concentrations, and primary productivity. All of these samples have been collected in summer, *i.e.*, August and early September during icebreaker cruises in 1976 and 1977. This time frame will be extended somewhat during the 1978 icebreaker cruise to include late September, which can probably be called the fall season for plankton.

Extensive literature searches have pointed out the lack of winter information for the plankton. The FY 79 work will try to provide some information for the nearshore area within the lease area. This work will coordinate with other studies, especially in Simpson Lagoon. The area of study will overlap that included during the summer icebreaker cruises and will provide additional life history information for some zooplankton and ichthyoplankton.

V. Objectives

The primary objective of the FY 79 project will be to assess the winter (November and February) density distribution and environmental requirements of zooplankton and phytoplankton in the nearshore areas of the Beaufort Sea, including Simpson Lagoon.

A secondary objective will be to analyze zooplankton and phytoplankton samples collected during the FY 78 icebreaker cruise in the Beaufort Sea.

Assessment of winter biological activity is particularly important in light of suggestions that oil exploration and drilling be done only in winter. The Beaufort Sea Synthesis Report (June 1977), investigators, and OCSEAP reviewers have pointed out the lack of fall, winter, and spring plankton data and the need to fill these data gaps.

VI. General Strategy and Approach

Winter sampling for zooplankton, phytoplankton, and ice algae will be done in November 1978 and February 1979 in the Simpson Lagoon and Prudhoe Bay areas. Sampling will be done in shallow water inside Simpson Lagoon and in deeper water, > 20 m, outside the Lagoon, and off Prudhoe Bay (Fig. 1). These sites are within the lease area and intensive summer sampling is being done in or near these areas.

Zooplankton samples will be analyzed for species present, abundance, distribution, and life cycle stages. Species of major interest will include larval and juvenile stages of fishes, especially arctic cod, euphausids, amphipods, and mysids. Attempts will be made to determine food preferences of some of the most abundant amphipod species.

Phytoplankton and ice algae samples will be analyzed for species present, abundance, distribution, chlorophyll *a* and phaeopigment concentrations. Phytoplankton, but not ice algae, primary productivity will be measured if an adequate incubation technique can be devised, even though light will be minimal and productivity low. Productivity of the ice algae will not be done because previous experience at Barrow (Horner and Alexander 1972, Alexander *et al.* 1974) has shown that few cells are present in the ice at these times and the only suitable incubation technique is an *in situ* one requiring divers.

Temperature and salinity measurements will also be made.

VII. Sampling Methods

Sampling will be done in approximately two two-week periods. Suggested sampling periods are 25 October to 7 November (before 15 November) and 5-16 February. These time periods are in early winter before the sun goes down and in mid-winter just after the sun is back. The February time was chosen especially to look for arctic cod eggs. This species is reported to spawn in shallow areas under ice in January and February in northern Russia

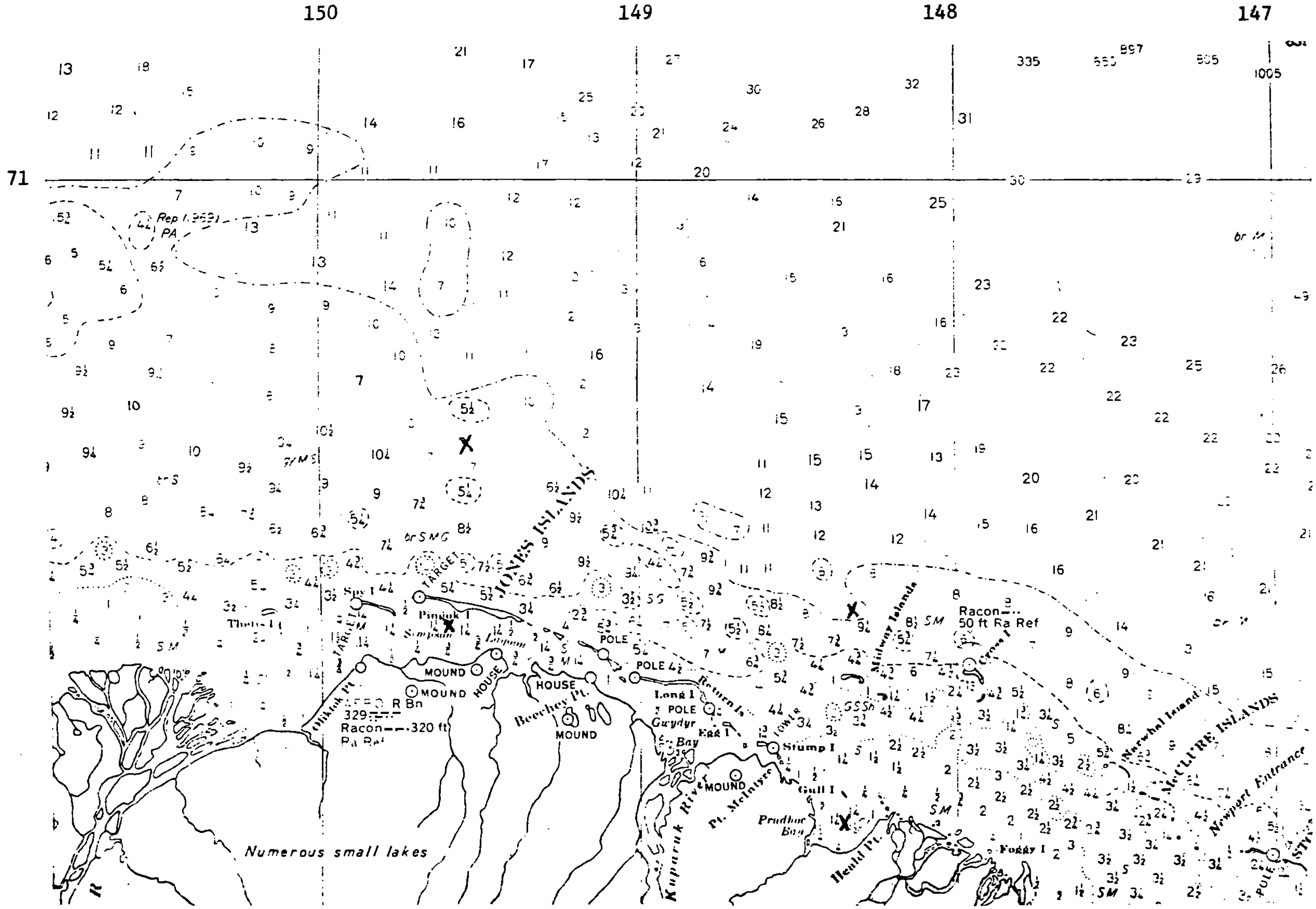


Fig. 1. Suggested station locations for November 1978 and February 1979 sampling. Except for the station in Prudhoe Bay, which must be in the deepest part of the bay, locations are approximate.

(Rass 1968), but we do not know when and where it spawns in northern Alaska. Depending on weather conditions and logistics, at least two or three sets of samples will be collected from each area in each two-week period. No statistical measure of sampling adequacy will be used. We will sample what we can, given the environmental and logistical conditions during the sampling periods.

Zooplankton will be sampled with 0.75 m ring nets with 308 μm mesh size. Smaller nets, 0.25 m with 64 μm mesh, will also be available and could be used inside Simpson Lagoon where there is little water under the ice. Traps will be used to collect amphipods. Other sampling gear will be used when possible and as necessary.

Phytoplankton will be sampled with water bottles. Samples will be transferred from the sampling bottle to 4-liter polyethylene bottles for transportation back to the laboratory. Portions of the samples will be taken for phytoplankton standing stock and preserved with 4% formalin buffered with sodium acetate, and for salinity determinations. The rest of the sample, about 3 liters, will be filtered through 47 mm HA (0.45 μm) Millipore filters for chlorophyll *a* and phaeopigment determinations. The filters will be frozen and returned to Seattle for analysis.

If a suitable *in situ* incubation technique can be worked out, some of the water sample will be put in 60-ml reagent bottles, inoculated with $NaH^{14}CO_3$ solution, and incubated at the sampling sites. Following a 2 to 4 hr incubation period, the samples will be preserved with $HgCl_2$ or H_3PO_4 and transported to the laboratory at Prudhoe Bay for filtration onto 25 mm HA (0.45 μm) Millipore filters. The filters will be placed in liquid scintillation vials and returned to Seattle for analysis.

One possible sampling - *in situ* incubation scheme would be to arrive at the first sampling station, cut two 20 cm auger holes, collect water samples (number and depths will depend on the amount of water under the ice), set up primary productivity experiments which would be left to incubate *in situ*, set out amphipod traps (one or two close to the underside of the ice and one or two on the bottom and baited with different baits). Fly to the second sampling station, repeat. Also do zooplankton tows and cut ice cores for ice algae. Return to station one, retrieve experiments and traps, do zooplankton tows and cut ice cores. Return to station two, retrieve experiments and traps, return to Prudhoe Bay. Flying distances between stations and the base camp at Prudhoe Bay are short enough that this possibility would allow a two to three hr incubation period and not increase the flying time too much.

Amphipod traps could be rebaited and left for retrieval the next day. Productivity experiments should not be left for more than about 6 hr (Strickland and Parsons 1968).

Ice algae will be sampled with a SIPRE corer, with two cores collected per station. Sections will be taken from the top, middle, and bottom of the cores, placed in covered plastic containers, and returned to the laboratory. Sections from one core per pair will be preserved with 4% formalin buffered with sodium acetate for standing stock samples. Sections from the second core will be broken up into small pieces and allowed to melt in the dark. The melt water will be filtered through 47 mm, 0.45 μm, Millipore filters for chlorophyll *a* and phaeopigment determinations. No primary productivity experiments will be run on ice samples.

VIII. Analytical Methods

A. Samples collected during winter

Zooplankton samples will be sorted first for fish eggs and larvae, euphausids, amphipods, and mysids. Other large or rare organisms will also be removed. The remaining sample will be split in a Folsom plankton splitter until a subsample containing approximately 100 specimens of the most abundant remaining species is obtained. The organisms in the subsample, along with the fish eggs and larvae, euphausids, amphipods, and mysids, will be identified and counted using dissecting microscopes. Copepods will be separated into adults and juveniles and counted, but will not be identified to genus or species. References used to identify zooplankton are listed in Table 1.

Amphipods collected in traps will be identified. These amphiphods, returned to the laboratory alive, will be sorted and individuals will be placed in jars of filtered seawater, and allowed to sit in a refrigerator to clear their guts. Individuals plus their fecal pellets will be preserved in individual vials. Fecal pellets will be examined with a microscope to try to determine food sources. There is no guarantee that any useful data will be obtained from these experiments.

Phytoplankton and ice algae standing stock samples will be analyzed following the inverted microscope method of Utermöhl (1931). Rare and large organisms (> 100 μm) will be counted at 125 X magnification in 50 ml chambers, while small (< 100 μm), abundant organisms will be counted at 312 X in 5 ml chambers. The portion of the chamber to be counted will be determined for each sample depending on the number of cells present, but usually 1/5 or 1/10 of the chamber will be counted. The principal references used to identify phytoplankton are Hustedt (1930, 1959) and Schiller (1933, 1937).

Primary productivity samples will be analyzed at the University of Washington using a Packard Tri-Carb Liquid Scintillation Spectrometer with Aquasol (New England Nuclear Co.) as the scintillation cocktail.

Chlorophyll *a* and phaeopigment determinations will be done using a Turner fluorometer (Strickland and Parsons 1968).

Salinity will be determined using an induction salinometer with "Copenhagen" water as a standard.

B. Samples collected during the 1978 icebreaker cruise

Several possibilities exist for analyzing these samples depending on the requirements of the Arctic Project Office.

1. Zooplankton samples

a. These will be analyzed as described for the winter samples with emphasis on fish eggs and larvae, amphipods, euphausids, and mysids. Copepods will be separated into adults and juveniles without identification

Table 1. References used to identify zooplankton.

Coelenterata	Euphausiacea
Naumov 1960 Shirley and Leung 1970	Leung 1970a
Ctenophora	Amphipoda
Leung 1970b	Sars 1895 Tencati 1970
Polychaeta	Decapoda
Pettibone 1954 Yingst 1972	Berkeley 1930 Hart 1971
Mollusca - Pteropoda	Appendicularia
Leung 1971	Leung 1972a
Ostracoda	Chaetognatha
Leung 1972c	Dawson 1971
Mysidacea	Pisces
Leung 1972b	Andriashev 1954 Musienko 1970

to genus or species as has been done with the 1977 icebreaker samples. The reason for not identifying copepods is that one person cannot sort, count, and identify all the non-copepod zooplankton, all the copepods, and participate in the winter sampling program.

b. If copepods are to be analyzed, I suggest hiring one full-time person to do this. This would add $10,000 to the budget. It is possible that Ms. Gayle Heron, a recognized authority on the taxonomy and biology of Arctic copepods, will be avilable for six months and she would be the logical choice to analyze the samples. If Ms. Heron is not available, someone else would be hired.

2. Phytoplankton samples

All primary productivity, chlorophyll *a* and phaeopigment samples will be analyzed. Standing stock samples would be analyzed depending on the requirements of the Arctic Project Office. Possible choices are:

a. No phytoplankton standing stock samples will be analyzed to allow the Principal Investigator time to do the large amount of library work that has been suggested (letter 16 February 1978, Frost to Weller, and included in Section 5, E, Other Information) and to participate in the winter sampling program. The library work will include:

1) a compilation of historical information on fluctuations in algal production and an analysis of determinants of annual algal production such as light, temperature, salinity, ice cover, and nutrients, insofar as this information is available for the Beaufort Sea. Depending on the data available, it may be possible to determine the magnitude and causes of natural variation and to compare relative rates of production in open water and under ice.

2) a compilation of historical data on the distribution and abundance of *Thysanoëssa inermis*, *T. longipes*, *T. raschii*, *Parathemisto abyssorum*, *P. libellula*, *Mysis litoralis*, *M. oculata*, and *M. relicta* in the Beaufort Sea along with available information on life cycles, food habits, and the effects of environmental parameters such as temperature and salinity.

3) Compilation of copepod distributions and abundances. This would be done in conjunction with the person analyzing the copepod samples and would be done only after we know what copepod species are being utilized by arctic cod and only for those species.

4) an attempt to determine food habits of some abundant species of amphipods from the literature.

b. Phytoplankton standing stock samples would be analyzed for all stations where primary productivity is available plus those stations where chlorophyll *a* is high. Two or three samples can be analyzed in an eight hour day; each station usually has six or eight samples, primary productivity will be done at about 45 to 50 stations during the cruise. The library work would be done only after the samples are analyzed and would be minimal depending on time available.

c. Phytoplankton standing stock samples would be analyzed only for stations where primary productivity and chlorophyll *a* are high. Library work would be done depending on time available.

IX. Deliverable Products

A. Digital Data

1. Possible Parameters (x indicates collected and submitted)

a. File Type 024, Zooplankton

Common to all records
x File Type
x File Identifier
x Record Type
x Station Number (except 1)

Record Type 1 - File Header
x Vessel
x Cruise/Cruise Dates
x Area/Project
x Investigator/Institution

Record Type 2 - Location
x Latitude/Longitude
x Date in GMT/Time in GMT
x Depth to Bottom
x Sample Interval (where applicable)
x Ship Speed
x Surface Water Temperature

Record Type 3 - Total Haul Data
x Gear Code/Mesh Size
x Duration/Haul Length
Total Settled Volume
Total Water Displaced
Total Dry Weight of Haul
x Volume of Water Filtered
x Duration of Tow
x Haul Type Code

Record Type 4 - Subsample Data
Sample Number/Taxonomic Code
Life History Code
Size of Subsample
Number in Subsample
Concentration
Dry/Wet Weight
Number of Adults
Number of Juveniles
Number of Eggs/Larvae

Record Type 5 - Text (when necessary)
x Sequence Number
x Text

Record Type 6 - Subsample Data 2

x Sample Number
x Taxonomic Code
x Life History Code
x Size of Subsample
x Number in Subsample
x Concentration
Dry/Wet Weight
x Number of Adults/Juveniles
x Number of Eggs/Larvae

b. File Type 028, Phytoplankton Species

Common to all records
x File Type
x File Identifier
x Record Type
x Station Number
x Sequence Number (Record Type 2 and 3 only)

Record Type 1 - Master
x Geographic Position
x Date/Time
x Water Depth

Record Type 2 - Text (when necessary)
x Text

Record Type 3 - Detail
x Sample Number
x Depth of Sample
x Taxonomic Code
x Count of Species
x Number of Cells/Liter
Wet and Dry Weights
Volume of Water Filtered

Record Type 4 - Detail II
x Sample Number
x Depth of Sample
x EDS Taxonomic Code
x Cells and Percent Cells per Liter
Carbon and Percent Carbon per Liter

c. File Type 029, Primary Productivity

Common to all records
x File Type
x File Identifier
x Record Types
x Station Number (Record Types 1, 3 and 4)

Record Type 0 - Header
x Vessel Name - Cruise Number
x Cruise Dates
x Senior Scientist/Investigator/Institution

Record Type 1 - Master
x Geographic Position
x Date/Time
x Water Depth
x Chlorophyll *a* - Integrated
x Phaeopigments - Integrated
x Carbon Assimilation - Integrated
x One Percent Light Depth
Phosphate PO_4-P Reactive Time
pH Scale & pH Corrections (Codes)
x Secchi Depth
Mixed Layer Depth
Light Level (Platform)

Record Type 3 - Detail
x Depth of Sample
x Chlorophyll *a* Concentration
x Phaeopigment Concentration
x Carbon Assimilation Concentration
x Elapsed Time of Incubation
Oxygen
Phosphate - PO_4-P
Ammonia - NH_3-N
Nitrate - NO_3-N
Nitrite - NO_2-N
Silicate - SiO_3-Si
pH
Total Alkalinity
x Temperature and Salinity
x Sequence Number

Record Type 4 - Text (when necessary)
x Text

2. Digital products and data submission schedule

a. Computer cards
b. Card listings

Processing and formatting will be done by the investigator. See p. 11 for data submission schedule.

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
Zooplankton	Cards	2000-3000	024	Yes	Aug 78 to Sep 78	Oct 79
		1000			Nov 78	Oct 79
		1000			Feb 79	Oct 79
Phytoplankton	Cards	0-3000	028	Yes	Aug 78 to Sep 78	Oct 79
		1000			Nov 78	Oct 79
		1000			Feb 79	Oct 79
Primary Productivity	Cards	1000	029	Yes	Aug 78 to Sep 78	Oct 79
		500			Nov 78	Oct 79
		500			Feb 79	Oct 79

B. Narrative Reports

Special reports that might be required by OCSEAP for synthesis or other meetings will be prepared as requested. It is likely that papers for publication in scientific journals will be written.

C. Visual data

All visual data will be included in required reports.

D. Other

No other data will be submitted.

X. Quality Assurance Plan

1. Instrument calibration

The fluorometer is calibrated using a known quantity of a chlorophyll extract as a standard. Acetone blanks are run with each batch of samples.

The Packard Tri-Carb Liquid Scintillation Spectrometer is calibrated by factory representatives twice yearly.

Standard seawater (Copenhagen water) is used to calibrate the salinometer at the beginning and end of a batch of samples and after each group of 30 samples when more than 30 are run at one time.

Flowmeters are calibrated periodically in the Department of Oceanography, University of Washington.

2. Field sampling

Zooplankton samples will be collected with 0.75 m ring nets, mesh size 308 μm, traps (amphipods) and any other gear that might be available and suitable for collecting animals under the ice. Phytoplankton will be collected with water bottles and 0.25 m ring nets with a mesh size of 64 μm. Ice algae will be collected with an ice corer (SIPRE) having a diameter of 7.5 cm.

Zooplankton will be preserved with about 50 ml concentrated formaldehyde and 20 ml saturated sodium borate solution per jar (approximately 5% formalin). More formaldehyde and buffer are added when large numbers of animals are present. Phytoplankton and ice algae standing stock samples will be preserved with 5 to 10 ml 4% formalin buffered with sodium acetate per 250 ml jar of sample.

3. Procedures for sample analysis

Zooplankton samples will be sorted first for fish eggs and larvae, euphausids, amphipods, and mysids. Other large or rare organisms will also be removed. The remaining sample will be split in a Folsom plankton splitter until a subsample containing approximately 100 specimens of the most abundant remaining species is obtained. The organisms in the subsample, along with the fish eggs and larvae, euphausids, amphipods, and mysids will be identified and counted using dissecting microscopes. Unless otherwise requested by the Arctic Project Office, copepods will be sorted and counted as adults and juveniles, but not identified to genus or species.

Phytoplankton and ice algae standing stock samples will be analyzed using the inverted microscope method of Utermöhl (1931). Rare and large organisms (> 100 μm) will be counted at 125 X in 50 ml counting chambers, while small (< 100 μm), abundant organisms will be counted at 312 X in 5 ml chambers. The portion of the chamber to be counted is determined for each sample depending on the number of cells in the chamber, but usually 1/5 or 1/10 of the chamber will be counted.

Primary productivity samples will be analyzed using a Packard Tri-Carb Liquid Scintillation Spectrometer with Aquasol as the scintillation cocktail.

Chlorophyll *a* and phaeopigments will be determined using a Turner fluorometer (Strickland and Parsons 1968).

Salinity will be determined using an induction salinometer with "Copenhagen" seawater as the standard.

4. Processing for output products

Data will be put on computer cards following OCSEAP data formats.

XI. Special Sample and Voucher Specimen Archival Plans

Zooplankton samples are being collected. Undoubtedly there will be some specimens that should be archived as reference or voucher specimens. As soon as preservation requirements and other details are received, we will follow those procedures.

XII. Logistics Requirements - see attached pages

XIII. Anticipated Problems

The only anticipated problem is that it will be impossible to submit data within 120 days of the completion of a cruise or three month collection period (XVII, 6). The Milestone Charts suggest a logical time frame for data submission.

If proposed field objectives cannot be accomplished, we will spend the time analyzing samples collected on the icebreaker cruise in Aug-Sep 1978 (objective two of this proposal).

XIV. Information Required from other Investigators

Dr. Don Schell and I will coordinate our winter sampling programs; we have already discussed this to some extent and will make more definite plans later. Dr. Alan Birdsall, LGL, has suggested coordination with LGL personnel. I have agreed with this, but no further contact has been made.

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 Fig. 1 for proposed station locations. Flights will be staged out of Deadhorse.

2. Describe types of observations to be made. Zooplankton collections, water samples, primary productivity experiments, ice cores.

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 Oct to 15 Nov. and 5-19 Feb 1979. After 15 Nov. and before 5 Feb. there is not enough light. Feb is when we might expect to find arctic cod eggs.

4. How many days of helicopter operations are required and how many flight hours per day? 4 - 6 days in a 2 week period; 3 - 4 (6) hr per day

   Total flight hours? 16 to 24 (24-36) total hr

5. How many people are required on board for each flight (exclusive of the pilot)? 2 (can be combined with other projects)

6. What are the weights and dimensions of equipment or supplies to be transported? Less than 300 lbs; all boxes less than 3 ft^3, net rings 0.75 m in diameter.

7. What type of helicopter do you reommend for your operations and why? NOAA

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? Deadhorse

11. Will special navigation and communications be required? Must be able to find stations a second time on any particular day to pick up experiments and on successive days if amphipod traps are left out.

XV. Management Plan

As soon after returning from the 1978 icebreaker cruise as possible, chlorophyll and phaeopigment samples and primary productivity samples will be analyzed and values calculated. Analysis of zooplankton samples will begin. Analysis of phytoplankton standing stock samples or library work will start.

Winter field sampling will occur in early November and February. Analysis of samples collected during these periods will begin as soon as possible after the field periods and continue until samples are completed, probably in June.

Analysis of the icebreaker zooplankton samples and phytoplankton standing stock or library work will continue into June.

Data analysis and formatting will begin when samples are finished and will end with a report to be submitted in early October 1979 (see Milestone Charts).

XVI. Outlook

Assuming that winter sampling is successful in FY 79, there will still be no information available for the ice algae in spring (April through June) when this community is most productive and may be quite important in the coastal ecosystem.

One proposal would be to have 5 people (3 divers, 2 support) at a field site, probably Prudhoe Bay because of water depth and logistics, for 3 to 3.5 months. Sampling would be done about 3 times per week with divers placing *in situ* primary productivity incubation corers in the underside of the ice and collecting cores for pigment and standing stock determinations. The support personnel would collect water samples and set up primary productivity experiments that would be incubated *in situ* at the same time as the ice algae experiments. Pigment and phytoplankton standing stock determinations would also be made on water samples. Additional studies that could be done at the same time using the divers could include primary productivity of benthic microalgae, meiofauna, and microbiology. Meiofauna and microbiological studies would require additional support personnel.

1. The final results would be an estimate of the significance of the ice algal community in the spring. Production of the ice algae could be compared with that of the water column. Final data products would include primary productivity rates, chlorophyll *a* and phaeopigment values, and standing stock of the ice algae and phytoplankton.

2. See chart (p. 23) for significant milestones.

3. Cost by fiscal year would be $60,000 to $70,000 depending on salaries and would include 5 people for the field season, 3 people to analyze the samples. This cost would not include meiofauna or microbiology.

4. Additional equipment would be diving gear only.

5. Location - off Prudhoe Bay where the water depth is about 7 to 10 m, perhaps near 70° 25'N, 148° 30'W. This area is suggested so there would be

enough water under the ice for the divers to work in and is close enough to Prudhoe Bay to minimize daily logistics problems and to provide adequate laboratory space.

6. Logistics requirements - a heated hut on the ice, crewcab truck, laboratory space, refrigerator, some freezer space, compressor to fill diver's tanks, adequate freshwater for diver's showers and cleaning diving gear.

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 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."

Other Information

A. Background of Proposer

The proposer is qualified to carry out the suggested research. I have studied Arctic plankton from the Chukchi and Beaufort seas since 1964. I have supervised graduate students and technicians who have collected and analyzed Arctic plankton samples. I am familiar with the techniques used and the organisms that are present. Studies have been in terms of species present, their abundance, distribution, pigment concentrations, and primary productivity. Studies have been done on a seasonal basis. Factors that affect planktonic organisms, including inorganic nutrients, temperature, salinity, and light, have also been studied.

I was Co-Principal Investigator for RU # 359 in 1975 and 1976 and have been Principal Investigator since 1977. My participation has included field collecting, sample and data analysis, supervision of technicians and students, and report writing.

B. I have no involvement with other OCSEAP or Federal projects.

C. The Principal Investigator will actively lead and supervise the proposed work, and will take full responsibility for timely completion of all objectives, independent of the percentage of the Principal Investigator's salary requested in the budget.

D. Personnel

R. Horner, Principal Investigator will participate in field work, analyze chlorophyll *a*-phaeopigment samples, phytoplankton standing stock samples, do library work, analyze data, write reports. She has done the same kinds of work on R.U. 359 since 1975. Resume attached.

T. Kaperak will participate in field work and analyze the zooplankton samples. He has done the same kinds of work on R.U. 359 in FY 78. Resume attached.

0 – Planned Completion Date

X – Actual Completion Date

RU # 359 PI: Rita A. Horner

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

MAJOR MILESTONES FY 79 winter sampling		O	N (1978)	D	J	F	M	A (1979)	M	J	J	A	S	O	N	D	
Field Effort		0	0			0											
Sample Analysis:	Pigments			0	0		0										
	Primary productivity			0	0		0										
	Phyto. standing stock			0	0	0	0	0	0	0							
	Zoo. standing stock			0	0	0	0	0	0	0							
Data Processing:	Pigments				0		0										
	Primary productivity				0			0									
	Phyto. standing stock									0	0	0					
	Zoo. standing stock									0	0	0					
Data Submission:	All data to be submitted													0			

0 - Planned Completion Date

X - Actual Completion Date

RU # 359　　　PI: Rita A. Horner

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

	1978			1979											
MAJOR MILESTONES 1978 icebreaker cruise	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Sample Analysis: Pigments	0														
Primary productivity	0	0	0												
Phytoplankton standing stock (if done)			0	0	0	0	0	0	0						
Zoo standing stock			0	0	0	0	0	0	0						
Data Processing: Pigments	0	0													
Primary productivity				0											
Phyto standing stock (if done)									0	0	0				
Zoo standing stock									0	0	0				
Data Submission: All data to be submitted													0		

0 - Planned Completion Date

X - Actual Completion Date

RU # 359 PI: Rita A. Horner

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

MAJOR MILESTONES	Overall Milestones	1978 O	N	D	1979 J	F	M	A	M	J	J	A	S	O	N	D	
Reports:	Quarterly				0						0						
	Annual							0									
	Final													0			
Field Effort		0	0			0											
Sample Analysis:	Pigments	0		0	0		0										
	Primary Productivity			0	0		0										
	Phyto standing stock			0	0	0	0	0	0	0							
	Zoo standing stock			0	0	0	0	0	0	0							
Data Processing:	Pigments	0	0		0		0										
	Primary Productivity				0			0									
	Phyto standing stock									0	0	0	0				
	Zoo standing stock									0	0	0	0				
Data Submission:	All data to be submitted													0			

58

22

O - Planned Completion Date

X - Actual Completion Date

RU # __________ PI: ______________________________

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	
Field Effort							0	0	0							
Sample Analysis							0	0	0	0	0	0				
Data Processing and Submission													0	0	0	

STATE OF ALASKA

JAY S. HAMMOND, GOVERNOR

DEPARTMENT OF FISH AND GAME

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 can 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. <u>Horner and Carey</u>

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. <u>Carey and Frost/Lowry</u>

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. <u>Frost/Mueller</u>

7) Food habits of key epifaunal invertebrate species, feeding type analysis of major benthic invertebrates, and predator/prey relationships within the benthos/epibenthos. <u>Carey</u>

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. <u>Fay/Shults</u>

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

PROPOSAL

To: National Oceanic & Atmospheric Administration
Outer Continental Shelf Environmental Assessment Program
Environmental Research Laboratories, Rx4
325 Broadway
Boulder, Colorado 80302

From: Division of Policy Development & Planning
Office of the Governor
Pouch AD
Juneau, Alaska 99811

Title: State of Alaska OCSEAP Coordination
Research Unit #372

Principal Investigator: Dr. Frederick F. Wright

Duration: 1 October 1978 to 30 September 1979

Total Cost: $113,308.00

Principal Investigator:

Frederick F. Wright, Ph.D.
OCS Research Management Officer
Division of Policy Development
& Planning
Office of the Governor
Pouch AD
Juneau, Alaska 99811
(907)465-3512

Organization Approval:

Frances A. Ulmer, Director
Division of Policy Development
& Planning
Office of the Governor
Pouch AD
Juneau, Alaska 99811
(907)465-3577

Finance Officer:

William C. Mullin, Director
Division of Finance
Alaska Department of Administration
Pouch C
Juneau, Alaska 99811
(907)465-2240

TECHNICAL PROPOSAL

I. State of Alaska/OCSEAP Coordination
Research Unit #372
1 October 1978 to 30 September 1979

II. Principal Investigator: Frederick F. Wright, Ph.D.
Co-Principal Investigator: David W. Norton, Ph.D.

III. Cost of proposal:

A.	Science	$113,308.00
B.	Logistics	.00
C.	Total	$113,308.00

IV. Background: This program was established in November, 1975 by contract 03-6-022-35161 between the State and NOAA. It has functioned since to facilitate communications between assorted State agencies and the BLM/NOAA OCSEAP. Two professional positions and one clerical position are involved, assigned to the appropriate NOAA offices:

1. OCSEAP Bering Sea - Gulf of Alaska Project Office, Juneau, Alaska - OCS Research Management Officer, Dr. Frederick F. Wright, and a State (temporary) clerical assistant.

2. OCSEAP Arctic Project Office, Fairbanks, Alaska - OCS Research Management Officer, Dr. David W. Norton.

This proposal covers only salary and staff benefits for the personnel involved. All other expenses (travel, clerical support, etc.) are covered by the Federal offices to which the State representatives are assigned.

V. Objectives: The specific objectives of the program are to:

1. support and maintain communication on all matters pertinent to OCSEAP between Federal and State agencies.

2. provide experienced technical and management assistance on the Alaskan OCS research situation to NOAA and BLM.

3. assist State agencies planning or managing OCS-related activities.

VI. to XV. Not Applicable

XVI. Outlook: It is anticipated that this project in some form will continue during the lifetime of the BLM/NOAA OCSEAP in Alaska.

XVII. Reporting: This program is so intimately involved in OCSEAP operations that routine reporting on its activities to NOAA has been judged unnecessary in the past. Bimonthly activity summaries and prognostications are submitted to the State and, as schedules permit, the Research Management Officers brief the Governor's Office quarterly on the OCS situation.

1. COVER PAGE

To: NATIONAL OCEANIC·ATMOSPHERIC ADMINSTRATION
OCSEAP Project Office
Post Office Box 1808
Juneau, Alaska 99802

Proposal Date: July 31, 1978
Contract #: 03-6-022-35232

FY 1979 RENEWAL PROPOSAL

Research Unit Number 417

TITLE: Ecological Studies of Intertidal and Shallow Subtidal Habitats in Lower Cook Inlet and the NEGOA Region.

Cost of Proposal: $120,000

Lease Areas: Lower Cook Inlet 75%
NEGOA 25%

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

PRINCIPAL INVESTIGATOR:

Name: Dennis C. Lees

Date: July 31, 1978

Signature: Dennis C. Lees / (dB)

Address: SRA Box 110, Homer, Alaska 99603

Telephone Number: (907) 235-8316

INSTITUTION: Dames & Moore

REQUIRED ORGANIZATION APPROVAL:

Name: R. H. Winn

Signature: R. H. Winn / (dB)

Position: Manager - Alaskan Operations

Address: Dames & Moore, 510 L Street, Suite 310, Anchorage, Alaska 99501

Telephone Number: (907) 279-0673

ORGANIZATION FINANCIAL OFFICER:

Name: Jon M. Benoist

Signature: Jon M. Benoist (dB)

Position: Administrative Manager

Address: Dames & Moore, 510 L Street, Suite 310, Anchorage, Alaska 99501

Telephone Number: (907) 279-0673

3. TECHNICAL PROPOSAL

I. ECOLOGICAL STUDIES OF INTERTIDAL AND SHALLOW SUBTIDAL HABITATS IN LOWER COOK INLET

Research Unit #417
Contract No. 03-6-022-35232
October 1, 1978 to September 30, 1979

II. PRINCIPAL INVESTIGATOR

Dennis C. Lees

III. PROGRAM COST

A. Science $120,000
B. Logistics -0-
C. Total $120,000
D. Distribution of effort
Lower Cook Inlet - 75%
NEGOA - 25%

IV. BACKGROUND

The intertidal and shallow subtidal portions of the Lower Cook Inlet and the NEGOA region are extremely important components of those systems, and are crucial to the well-being of many of their biological assemblages. The macrophytes in these regions produce large quantities of plant materials and are probably heavily utilized by detritivores that inhabit the coastal zone. Several species of commercial importance (e.g., shrimp and clams) at least partially depend upon the supply of such materials. Many other commercial species (e.g., salmonids, halibut, several crab species) feed heavily on various detritivores such as hermit crabs, worms, snails, small shrimps, and clams which depend largely on algal debris. In the past few years, information linking the macrophyte producers and commercial fisheries has begun to emerge but the full importance of this linkage has not yet been evaluated. Additionally, many important marine birds and mammals feed heavily on organisms which live in the inshore areas and probably depend heavily upon plant material produced by macrophytes. Furthermore, the littoral zone is important to many commercial species for spawning and rearing during their early life stages.

Biological studies of the Outer Continental Shelf (OCS) program in Lower Cook Inlet commenced in spring 1976, shortly before the Lower Cook Inlet Lease Sale. Initial biological studies were of a reconnaissance nature. Research units (RU's) were initiated to examine intertidal, benthic, and planktonic assemblages, marine fishes, birds, and mammals. These studies provided valuable information on the distribution of important areas of plant production and key areas for a number of commercial and non-commercial species. Furthermore, they provided hints about some of the important relationships between organisms and assemblages in Lower Cook Inlet.

Basically, the initial objective of this RU was to provide preliminary descriptions of the major intertidal habitats and assemblages in Lower Cook Inlet and determine their distributions. Attempts were made to develop qualitative assessments of their trophic structure and productivity. To a limited extent, this effort was extended into shallow subtidal habitats. Based on the results of that reconnaissance, site-specific studies of sandy intertidal and rocky intertidal and subtidal habitats were initiated in FY 77 on the east side of Lower Cook Inlet, and on a mudflat on the west side of the inlet. In these studies, the objectives were basically to examine zonation, seasonality, trophic structure, primary and secondary productivity and energy flow. Examination of primary production for macrophytes required examination of growth rates for several of the dominant species. In FY 78, the scope of this RU was expanded to include additional sites on rock, sand, and mud in Kamishak Bay, and rocky habitats in the NEGOA region. The approach to the field work was unchanged.

At the completion of FY 78, two years of observations will have been collected from the rocky intertidal and subtidal sites at Seldovia Point, rocky intertidal sites at Gull Island, from the sand beaches at Homer Spit and Deep Creek, and from the mudflat at Glacier Spit, Chinitna Bay; moreover, we will have collected one and a half years of plant growth data from subtidal macrophytes at Jakolof Bay. Additionally, we will have collected data from Kamishak Bay for a six-month period in FY 78 on:

1) a mudflat in Cottonwood Bay;

2) a sand beach near Iniskin Bay;

3) three additional rocky intertidal sites between Cottonwood Bay and Iniskin Bay in Kamishak Bay (Figure 1); and

4) from two sampling periods at several sites in the NEGOA region (Figure 2).

The data produced by this RU have great relevance for several reasons. It is clear from experience in other parts of the world that the greatest observable impacts from oil-related problems occur in the intertidal and nearshore zones. These studies are providing detailed descriptions of representative examples of major intertidal and shallow subtidal habitat types. They have also produced quantitative data with which to evaluate the relative importance and productivity of these habitats and their sensitivity to potential impacts from OCS oil and gas exploration, development and production. Furthermore, the studies relate strongly to other major OCSEAP funded biological studies in Lower Cook Inlet. Numerous marine bird and fish species feed in the intertidal and shallow water habitats which this RU is examining. For instance, our infaunal data indicates that mudflats provide large quantities of clams to shorebirds, sea ducks, and gulls. Furthermore, the production of juvenile clams on the intertidal flats may be crucial to the success of Western Sandpiper and several duck species migrating north during a

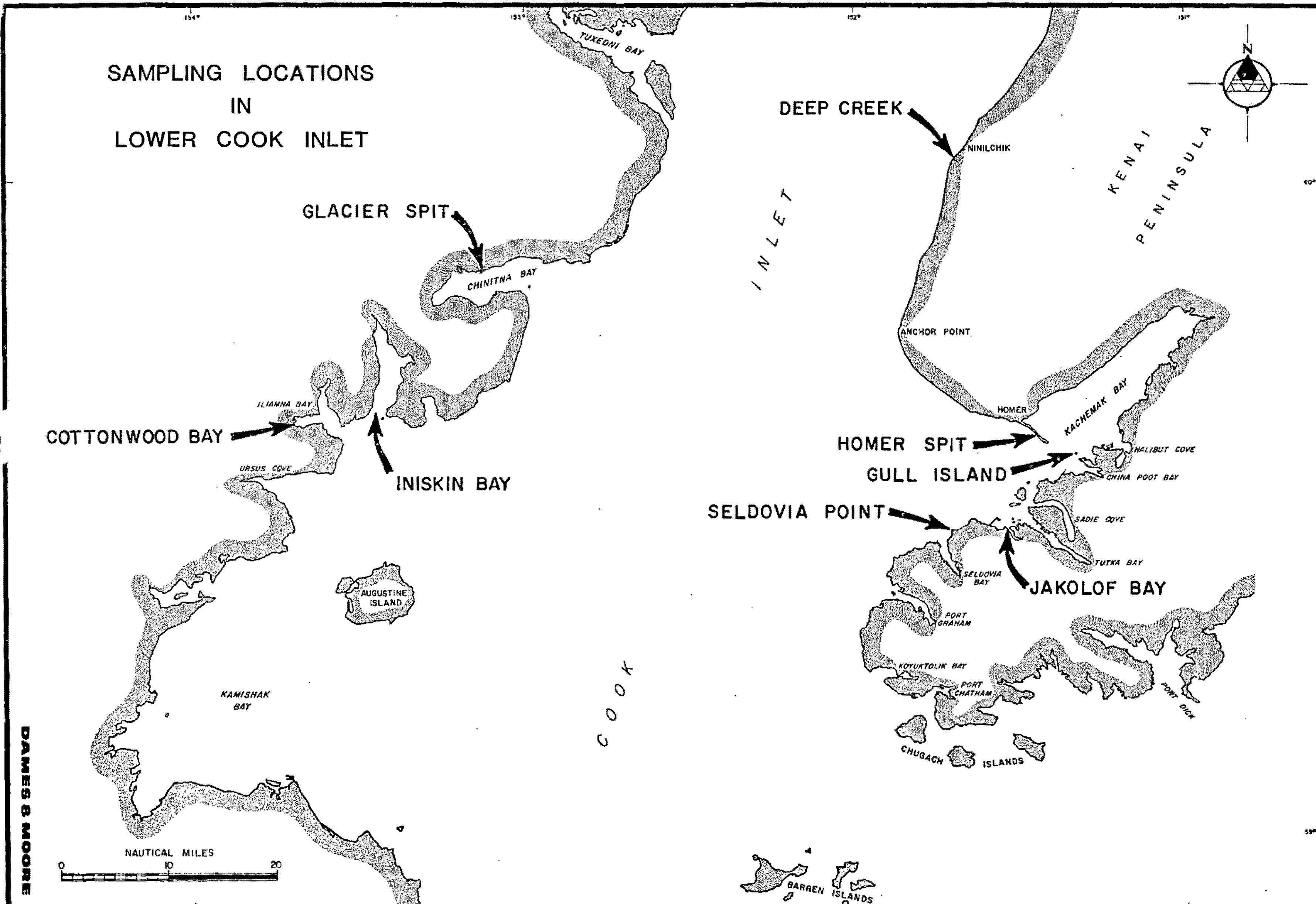

SAMPLING LOCATIONS
IN
LOWER COOK INLET
DEEP CREEK
NINILCHIK
KENAI
PENINSULA
GLACIER SPIT
CHINITNA BAY
TUXEDNI BAY
INLET
COOK
ANCHOR POINT
HOMER
KACHEMAK BAY
HOMER SPIT
GULL ISLAND
HALIBUT COVE
CHINA POOT BAY
SELDOVIA POINT
SADIE COVE
TUTKA BAY
JAKOLOF BAY
SELDOVIA BAY
PORT GRAHAM
KOYUKTOLIK BAY
PORT CHATHAM
PORT DICK
CHUGACH ISLANDS
BARREN ISLANDS
ILIAMNA BAY
COTTONWOOD BAY
URSUS COVE
INISKIN BAY
AUGUSTINE ISLAND
KAMISHAK BAY
NAUTICAL MILES
0
10
20
DAMES & MOORE

FIGURE 1

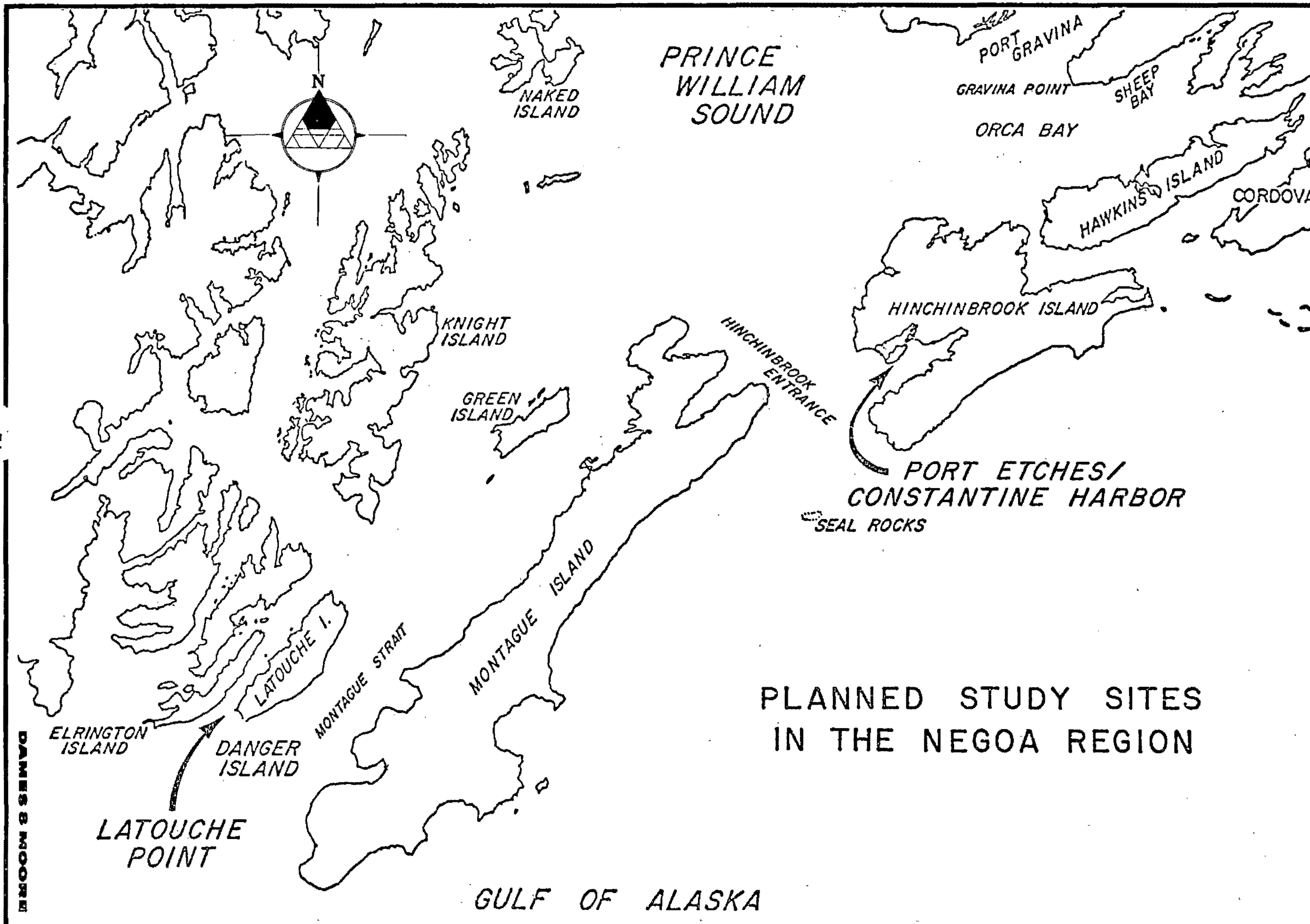

PRINCE WILLIAM SOUND
N
NAKED ISLAND
PORT GRAVINA
GRAVINA POINT
SHEEP BAY
ORCA BAY
HAWKINS ISLAND
CORDOVA
HINCHINBROOK ISLAND
HINCHINBROOK ENTRANCE
KNIGHT ISLAND
GREEN ISLAND
PORT ETCHES/ CONSTANTINE HARBOR
SEAL ROCKS
MONTAGUE ISLAND
MONTAGUE STRAIT
LATOUCHE I.
ELRINGTON ISLAND
DANGER ISLAND
LATOUCHE POINT
GULF OF ALASKA
PLANNED STUDY SITES IN THE NEGOA REGION
DAMES & MOORE

FIGURE 2

typical spring "breakup". These mudflats are also primary winter forage areas for several overwintering sea duck species. Moreover, large numbers of fish and crabs feed in the intertidal and shallow subtidal areas, and maximum utilization of these zones appears to occur in summer by juveniles. Synthesis of fish and bird food habit studies with the food availability data provided by this RU should provide valuable information on the relative contribution of the intertidal habitats to the Cook Inlet system. This RU also relates strongly with the benthic studies of Dr. Howard Feder. Both studies are examining assemblages that support and include numerous commercial species. Based on these studies, it appears that detritus-based food webs are important to several commercially important species. In this regard, the combination of primary production estimates for phytoplankton and macrophytes will provide a "first approximation" of the quantity of plant material available to the Cook Inlet system.

The objective of the work proposed herein for Lower Cook Inlet is to analyze and interpret the data collected to date, and describe and evaluate the potential impact from OCS oil and gas exploration, etc. This approach will permit a deliberate assessment of the assemblages examined, the information available on them and on similar habitats, and consideration of scientific literature on impacts from oil and gas development.

We are proposing to continue a low intensity field program in the NEGOA region. The proposed sampling scheme would provide information for two additional seasons (late fall and early spring) at sites sampled previously in mid-spring and mid-summer.

V. OBJECTIVES

1. Assess seasonal changes in composition and define trophic relationships among dominant intertidal and subtidal organisms in representative habitats in Lower Cook Inlet.

2. Determine the seasonal patterns of primary production, growth, and standing crop for major macrophyte species.

3. Describe and evaluate the potential for impact by OCS oil and gas exploration, development, and production on those intertidal and shallow subtidal habitats studies from FY 76 through FY 78.

Objectives 1 and 2 relate directly to Objective 3 in that they provide the biological background necessary to accomplish Objective 3. The research dictated by the first two objectives should provide reasonable descriptions of major biological assemblages and relationships between different assemblages. These descriptions should permit identification of particularly important organisms, areas or relationships with potentially high susceptibility.

VI. STRATEGY AND APPROACH

The major goal of the proposed continuation is to complete analysis and interpretation of the data collected in FY 77 and FY 78 in Lower Cook Inlet, and the NEGOA region and to compare this information with data from previous studies where available. A smaller expenditure of time and money has been allocated for continued site-specific studies in the NEGOA nearshore region. The strategy employed in the major task is simply to:

1. process the data into tables, figures, and appendices that facilitate description and comparison and write a narrative report on those studies, and,

2. to transfer the basic data onto "floppy" disks in an NODC format (File Type 030).

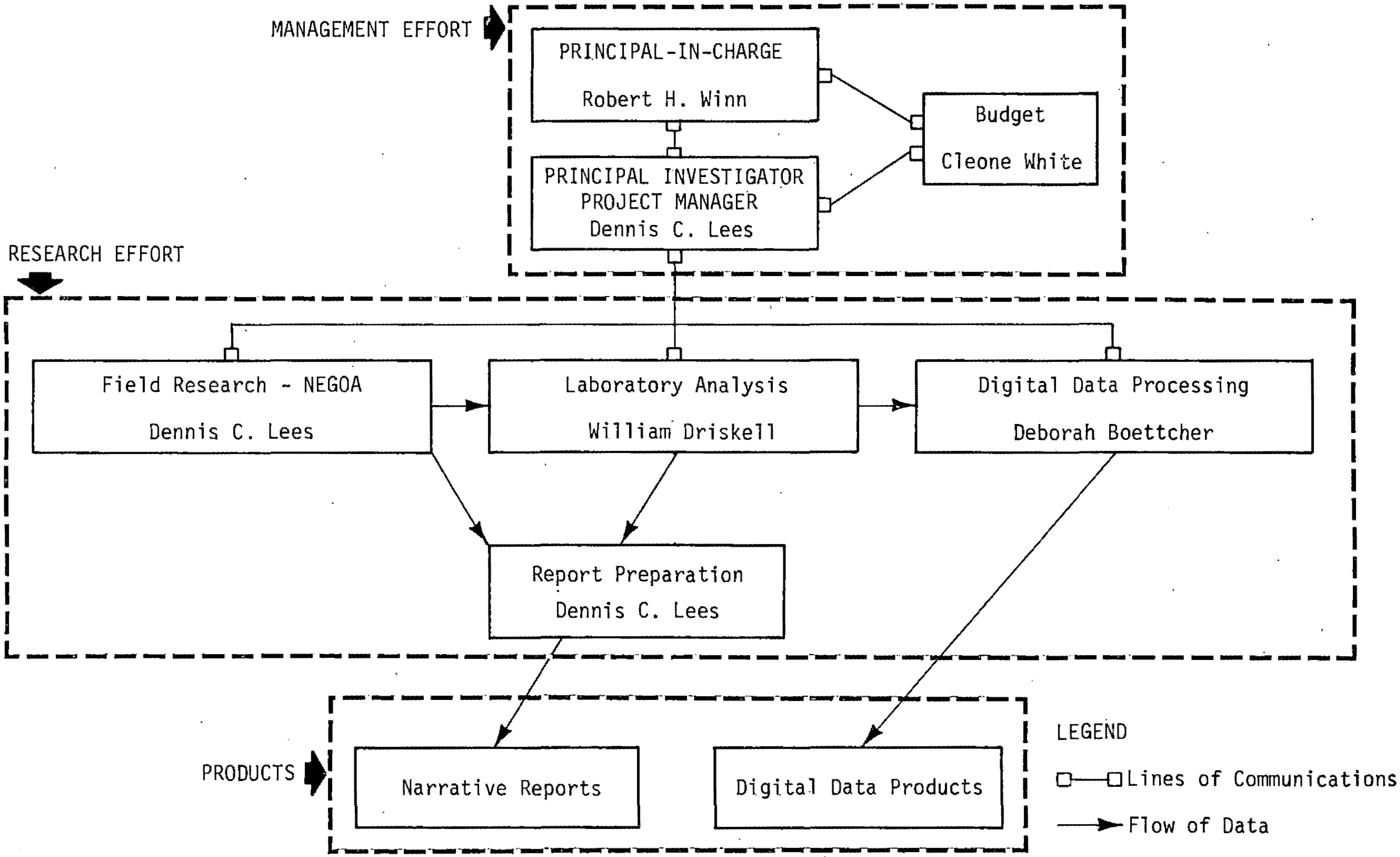
These activities will be conducted in the Homer office of Dames & Moore under the direct supervision of the Principal Investigator. Sample processing and data analysis are the immediate responsibility of Mr. William Driskell, the lab director (Figure 3). Digital data processing is handled by Ms. Deborah Boettcher. We are presently developing a capability to type the raw data into an in-house mini-computer and generate as output: 1) the NODC format digital data floppy disks, and 2) report-ready tables and appendices. In order to accomplish this, appropriate statistical tests will be programmed (see Analytical Methods). Report preparation will be the responsibility of the Principal Investigator. The substantial reduction in field activities will facilitate timely accomplishment of these tasks.

The strategy in the NEGOA region is to conduct a modest stratified random sampling program in two major ocean entrances into Prince William Sound, i.e., in Hinchinbrook Entrance and between Montague Strait and Latouche Passage, at Danger Island. During FY 78, sampling was conducted in late spring and mid-summer and Latouche Point. We now propose to sample in fall and early spring in order to provide seasonal perspectives on depth-related patterns in species composition, abundance, coverage, and biomass.

A. Sampling Methods:

On rocky substrates in two major ocean entrances to Prince William Sound, four sites will be examined in November (fall) and April (early spring). This timing provides sequential seasonal sampling for the surveys conducted in FY 78. A winter survey was not included because of monetary and logistical constraints.

We plan to examine intertidally in the *Fucus* and *Alaria* zones and subtidally, at three depths (15, 30, and 60 feet) in the laminarian zone. This permits examination of depth-related patterns in species



MANAGEMENT PLAN

FIGURE 3

DAMES & MOORE

composition, abundance, coverage, and biomass in the rocky substrate assemblages. Density, relative cover, plant biomass and size structure of selected species will be determined from replicate quadrat samples. Quadrat size will depend upon the size and density of the various target species; it may range from 0.1 to 25 m^2. Relative coverage will be determined by visual estimation of cover within quadrats by various organisms. This technique is a quick method for approximation of cover domainance, but the results are suitably repeatable. Density of selected species will be determined by counting individuals within the quadrats. Biomass of plants is determined by collecting all attached plants in the quadrats and determining wet weights of each species. We will examine ten 0.25 m^2 quadrats at each zone or level, in order to develop estimates of density, relative cover and biomass for the major species. The desire is to reduce variance to the lowest practical level. The number of replicates is strongly influenced by the constraints of water conditions, available time, and diving safety, however. In all cases, such estimates are based on replicate sampling. At all levels, the quadrats are placed along a 50 m measuring tape at points determined by random numbers. The tape is laid out along a specific depth (elevation) contour.

Trophic structure will be determined by a combination of on-site feeding observations and stomach analyses, and previously recorded in situ observations. This aspect of community structure is far too broad to be approached quantitatively, but some predictions about dietary trends are often justified.

Generally, sampling adequacy is examined by a comparison of the mean and variance of a parameter. Collection of replicate samples provides an estimate of the sampling distribution. Subsequent comparison or sampling distributions from two or more sampling periods by one of a number of statistical tests permits evaluation of the observed differences. We routinely use a significance level of $\alpha = 0.05$ to decide if a difference is real and due to natural changes or sampling variability. This is a relatively simple procedure in population studies, but is not really practical for broad, descriptive ecological assessments, where densities of important species range from less than $1/m^2$ to more than $1500/m^2$, and biomass of functionally important species range from 20 gm/m^2 to over 50 kg/m^2. Because of severe temporal and financial constraints, given the breath of the objectives the limited sampling requires only permit distinguishing between natural and sampling variability in the cases of large changes for abundant species. However, this limitation has generally permitted identification of seasonal and bathymetric patterns for dominant species for rock, mud, and sand habitats.

Consistency in species identification is assured by frequent intercomparison of organisms among the field investigators, and referral of questionable organisms to taxonomic specialists.

Size measurement techniques will be standardized among investigators. Estimation of coverage will be compared frequently among investigators to calibrate results.

B. Analytical Methods:

As indicated above, standard statistical techniques will be used to differentiate between sampling and natural differences in species composition, density, biomass, plant growth rates, etc., between sampling periods or sampling sites. Generally, confidence limits *per se* have not been calculated. Instead, we have routinely calculated standard deviation (not standard error) for all replicated data sets. In the final report, if confidence limits are deemed beneficial or can be applied to the analysis, we will use the 95% confidence limits to describe the variability (or precision) of the sample means. These are calculated as follows:

$$\text{Lower Limit} = \bar{x} - t\sqrt{\bar{x}/n}$$

$$\text{Upper Limit} = \bar{x} + t\sqrt{\bar{x}/n}$$

where

$\bar{x}$ = the arithmetic mean of a sample set,
n = the number of observations, and
t = is the Student's "t" value for n-1.

In our case, sample size is generally too small to permit calculation of confidence limits using the sample variance (s^2) and frequently, it is not advisable to assume a Poisson distribution. It frequently seems most expeditious to limit these calculations to "s" or the standard error ($\sqrt{s^2/n}$, the standard deviation of the mean).

Depending upon the type of data, we will employ Student's t-test, or one of a number of non-parametric tests, such as the Wilcoxin matched-pairs signed-ranks test, Kolmogorov-Smirnov two sample test, Mann-Whitney U test, χ^2 tests, or Kruskal-Wallis one-way analysis of variance (Siegel, S. 1956. Non-parametric Statistics, McGraw-Hill).

Size data for invertebrates will be used to develop life tables, including estimates of growth and mortality rates. This is done using a method developed from the Brody-Bertalanffy growth equations (Ebert, T. A., 1973, Oecologia 11:281-298).

Data for plant growth, density and biomass will be used to determine estimates for primary production for the macrophytes, according to the methods described by K. H. Mann (1972, Marine Biology 12:199-209; ibid, 14:1-10). This method uses growth rates, biomass estimates, size-frequency data, and length-weight regressions to determine annual primary production.

After tabulation of the field data, proper statistical tests are determined depending on the type of data under consideration, and parameters are compared between sampling levels within a survey, or between surveys at a specific level. The relationship between density, biomass, and size structure is examined to gain insight into the mechanics involved in observed changes. Frequently, where the data exhibit strong patterns, graphical presentations are more appropriate. This is definitely the case with the intertidal data, where strong seasonal and zonal (elevation) patterns are present. Also, the growth rate data and trophic structures are conducive to graphic presentation. However, in all cases, the complete data sets will be presented in appendix form to permit other investigators access to them. In this form, the data are somewhat easier to use than in the NODC digital data format.

VII. DELIVERABLE PRODUCTS

A. Digital Data - Table 1

1. Listing of types to be provided by research - those items noted with an 'x' will be provided. Additional digital data to be provided include size-frequency summaries, algal growth rates, and feeding data (on File Type 023 format).

2. Maximum/minimum values for applicable parameters:

Parameter	Unit	Minimum	Maximum
For Record Type '4'			
Percent Cover	Percent	0	100
Count of Species	Units	0	500
Wet and Dry Weights	Grams	0	10,000
Minimum/Maximum/Mean Length	Centimeters	0	2,000
Plant Weight	Centimeters	0	2,000
For Record Type '5'			
Wet/Dry Weights	Grams	0	10,000
Length/Width of Sample	Centimeters	0	2,000

3. Listings from programmed floppy disks are read by one

TABLE 1

FILE TYPE 030 - INTERTIDAL DATA

Common to all records
- xFile Type
- xFile Identifier
- xRecord Type
- xStation Number (Record Types 2,3 & 4)
- xSequence Number (Record Types 2,3 & 4)

Record Type '1' - File Header
- xVessel Name/Cruise Number
- xCruise Dates
- xSenior Scientist/Investigator/Institution

Record Type '2' - Station Header
- xGeographic Position
- xDate/Time
- Surface Water and Air Temperatures
- Salinity
- Secchi Depth
- Weather (codes)
- Wind/Sea State (codes)
- Beach Exposure Direction
- xSubstrata Type (code)
- xHabitat Description (codes)

Record Type '3' - Site Header
- Catalog/Photograph Numbers
- xGear Type (code)
- xTransect Number/Direction
- xMeter Number
- xSample/Zone/Arrow Number
- xQuadrat Size/Elevation/Slope
- xSubstrata and Surface Topography Types (codes)
- xCollection Time
- xSieve Size
- Dilution Volume
- xSediment Volume
- Grain Size
- xGrab Number
- Patch Grid Size
- xTotal Work Area
- Number of Grids Occupied
- Distance of Net Tow
- xWater Depth
- Large Sample Quadrat

Record Type '4' - Sample Data
- xNODC Taxonomic Code/Subspecies (code)
- Sex (code)
- xSample Condition (code)
- xPercent Coverage
- xCount of Species
- xWet and Dry Weights
- xMinimum/Maximum/Mean Lengths
- Minimum/Maximum/Mean Widths
- Minimum/Maximum/Mean Age
- Number of Grids Occupied
- Displacement Volume
- Dilution Volume
- xPlant Height
- xStarfish Code

Record Type '5' - Individual Sample Data
- xNODC Taxonomic Code/Subspecies (code)
- Sex (code)
- xSample Condition (codes)
- Age
- xWet/Dry Weights
- xLength/Width of Sample
- Displacement Volume
- xStarfish Code

Record Type '6' - Profile Data
- Oxygen
- pH and pH Scale (code)
- xTemperature and Salinity
- Permafrost Depth
- Secchi Depth
- Grain Size (Phi unit levels)

Record Type '7' - Text
- xText/Comments

technician for comparison by another technician to the original coded data forms. This procedure could be made much more efficient if the listing was translated back into a user product; i.e., species codes were translated into species names, etc.

B. Narrative Reports - No special reports at this time.

C. Visual Data - All location maps will be submitted as directed on Mylar overlays. Map scales will be appropriate to the level of discussion.

Location maps
Zonation diagrams for species and assemblages
Food web diagrams
Temporal abundance charts for seaweeds
Size/weight regressions for selected species
Plant growth rate figures
Size frequency histograms

D. Other Non-digital Data - none anticipated

E. Data Submission Schedule - Table 2

VIII. SPECIAL SAMPLE AND VOUCHER SPECIMEN ARCHIVAL PLANS

Voucher specimen collection will be retained in the Dames & Moore office in Homer during the study and transferred to the California Academy of Sciences at the request of the Project Office. We do request easy access to the specimens following transfer, however.

TABLE 2

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/Yea
Rocky Intertidal and Subtidal- Lower Cook Inlet	Disks	10,000 records	030 & 023	Yes	10/77 to 7/78	9/79
Sandy and muddy intertidal- Lower Cook Inlet	Disks	5,000 records	030 & 032	Yes	10/77 to 7/78	9/79
Rocky intertidal and subtidal- NEGOA region	Disks	10,000 records	030 & 023	Yes	10/77 to 7/78	9/79

IX. LOGISTICS REQUIREMENTS - NEGOA Region

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 Dames & Moore PRINCIPAL INVESTIGATOR Dennis C. Lees

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 Figure 2 for NEGOA area.

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. Vessel will be used as a diving platform, for transportation and for lodging in the NEGOA area.

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.) Vessel use must be scheduled between low tide series, and sampling period should be in November and April.

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.) Ten (10) days per survey.

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback? This survey could not 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. 12-16 hrs/day in daylight hours.

6. What equipment and personnel would you expect the ship to provide? Work and storage space, a suitable skiff and motor for diving and intertidal work; a boat operator.

7. What is the approximate weight and volume of equipment you will bring? 1,500 lbs., 150 cubic ft.

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

:ill you require any gases and/or chemicals? No If yes, they should be on ›oard the ship prior to departure from Seattle or time allowed for shipment by ›arge.

›o you have a ship preference, either NOAA or non-NOAA? If "yes", please name the ·essel and give the reason for so specifying. Yes. M/V Humdinger or M/V Searcher; local knowledge, operational convenience, availability, competitive charter rates.

:f you recommend the use of a non-NOAA vessel, what is the per sea day charter :ost and have you verified its availability? Yes. M/V Humdinger, $500/day, available, M/V Searcher, $750/day and fuel and food, available.

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low many people must you have on board for each leg? Include a list of partici- ›ants, specifically identifying any who are foreign nationals.
4 persons; myself, R. J. Rosenthal, William Driskell, and unidentified assistant.

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.)

Transportation flights from Homer to Port San Juan, in Prince William Sound, and back.

Describe types of observations to be made.

Transportation

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?

2 days, 3 hrs/day

Total flight hours? 6 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? Could carry bird or marine mammal observers, but the amount of equipment would preclude much more.

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.

What are the weights, dimensions and power requirements of carry-on equipment? N/A

What type of aircraft is best suited for the purpose? Deltavilland otter on floats

Do you recommend a source for the aircraft? Yes

If "yes", please name the source and the reason for your recommendation.

Kachemak Air Service - established knowledge, safety and reliability

What is the per hour charter cost of the aircraft? about $250/hour

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

Four

Where do you recommend that flights be staged from? Homer

X. ANTICIPATED PROBLEMS

The major problems concern boat charters in Prince William Sound and weather. We anticipate difficulty in finding a suitable boat for the proposed November sampling period in Prince William Sound. It is highly likely that both boats recommended in Section IX will be located in Kachemak Bay by November and, because of the season, will not be willing to travel to the Sound for a charter. The solution to this problem is to attack the problem at the earliest possible time.

The problem of weather can be resolved by using alternate study sites and planning for extra field time. We will attempt to establish sufficiently flexible field schedules and charters that they can be rescheduled to suit changing weather conditions.

XI. INFORMATION REQUIRED FROM OTHER INVESTIGATIONS

Arrangements are being made to acquire the following information:

A. NEGOA OCS reports (Dr. Steve Zimmerman)

B. Phytoplankton productivity reports (Jerry Larrance, PMEL)

C. Benthic reports from Cook Inlet (Dr. Howard Feder)

D. Bird feeding data from Lower Cook Inlet (Dr. Paul Arneson & Gerald Sanger)

E. Inshore fish data from Lower Cook Inlet (Dr. James Blackburn, ADF&G)

XII. OUTLOOK

Upon completion of the research proposed for FY 79, a major step will have been completed in the description of intertidal and shallow subtidal habitats -- basic descriptions of the most important intertidal and shallow subtidal habitats will have been developed. Generally, it appears that three additional aspects must be studied to complete the OCSEAP investigations. These include (1) descriptions of the nature and importance of the relationships between the components of the biological system in Lower Cook Inlet, as partitioned within the OCSEAP format, (2) experimental investigations into the ways that oil and gas exploration, development and production can potentially affect these components and relationships, and, based on the preceding studies, (3) an assessment of the sensitivity and susceptibility (risk analysis) of the various assemblages.

The intertidal and shallow subtidal zones of Lower Cook Inlet appear to be important to a number of valuable commercial and non-commercial species, such as king, tanner and dungeness crabs, several salmonids, sea ducks, shorebirds, shrimp, clams and sea otters. Their importance derives largely from the production of dense concentrations of plant and animal food materials, and the provisions of nursery areas for larvae and juveniles. As a consequence of the importance of a number of the species, detailed studies of specific relationships would appear valuable for a thorough understanding of the potential effects of petrochemical activities.

One of the most conspicuous categories of relationships involves marine birds and the intertidal and nearshore assemblages. Several species appear to be quite dependent on these habitats for food for varying periods of time; in several instances that dependence may be critical. For instance, we have conducted some preliminary research indicating that several species of shorebirds and sea ducks (particularly western sandpipers, scoters and scaup) exert tremendous predation pressure on the juvenile clam resource of the mudflats during spring migration. In another case, the rock sandpiper, a resident shorebird, feeds mainly in cobbly areas or boulder fields. A more difficult aspect to this study, but possibly as important, is the utilization of intertidal and nearshore habitats by demersal fishers and epifaunal invertebrates. These types of studies required would detail the specific points of utilization and their relative importance to the exploiting species and to the resource utilized.

We suggest that it would be most efficient to examine the interactions between the intertidal zone and associated bird and fish assemblages in one coordinated effort. The approach must include a program assessing resource (e.g., clam) stocks, while at the same time documenting exploitation pressures by the birds and fish. In addition, the experimental design must permit assessment of partitioning of exploitation effort among the potential predators such as shorebirds, sea ducks, flatfish, cottids and crabs. It appears that mudflats and rocky areas should receive the greatest effort and sand beaches the least, and efforts should be concentrated on birds and epifaunal invertebrates.

The final results should include detailed information on densities of specimens and size structure of the main species utilizing the major intertidal habitats in Lower Cook Inlet. Determination of 1) the relationships between the major component assemblages and 2) the relative importance of the various interactions would be "significant milestones", permitting strong predictions of the areas and assemblages susceptible to potential effects from petrochemical development and production. These predictions also would permit establishing sensitive and pertinent monitoring studies to provide early detection of environmental degradation. The study should be carried out intensively for at least two years, at an annual cost of about $250,000, and at a reduced level for another three

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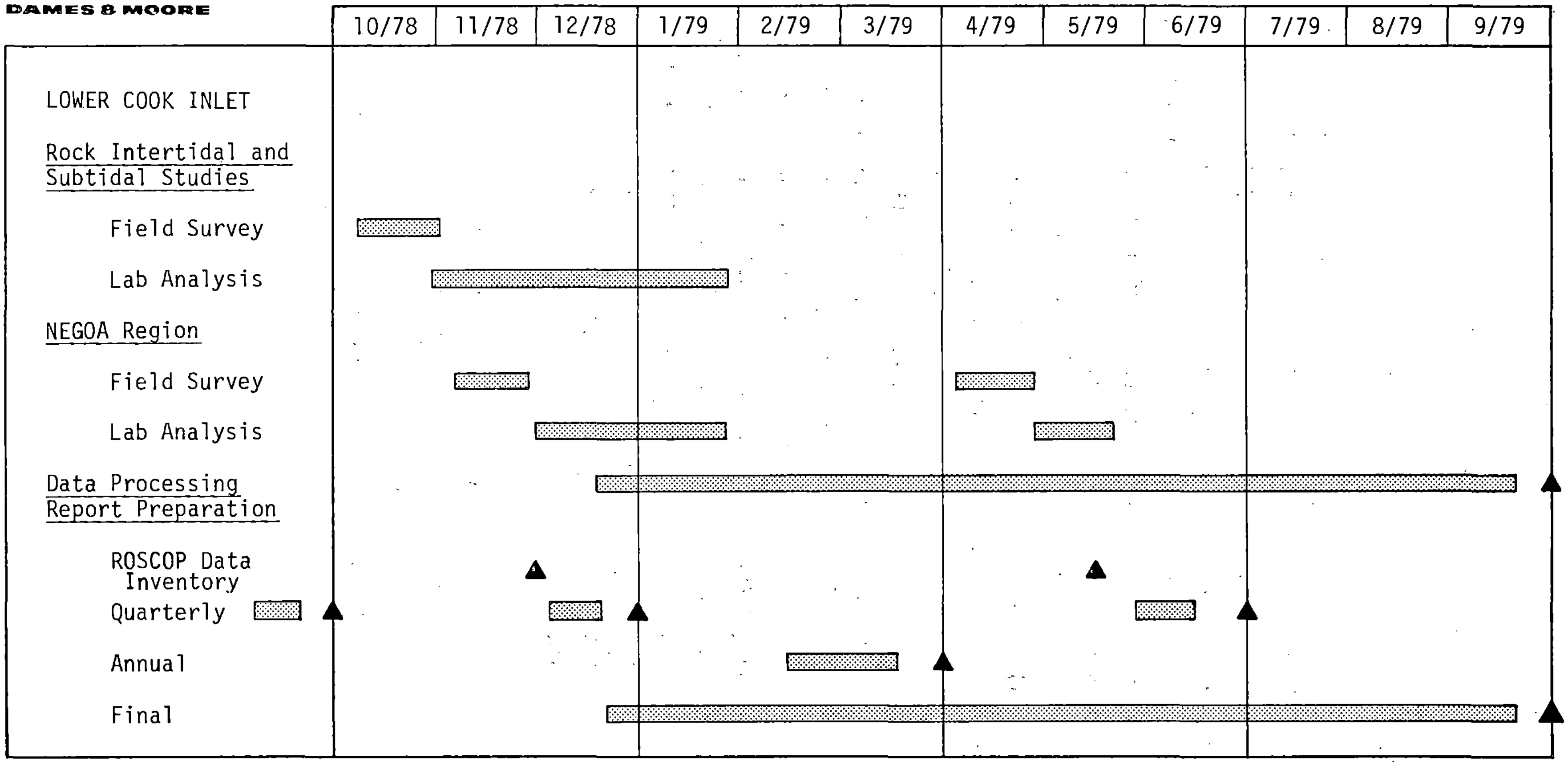

KEY:

IN PROGRESS

MILESTONES

XII. MILESTONE CHART

PI: Dennis C. Lees

R.U. #417

years, to acquire information on long term changes, at an annual cost of about $100,000.

We also suggest in situ studies to investigate the effects of petrochemical contamination on the intertidal assemblages in Lower Cook Inlet. Our studies indicate that many of the organisms grow slowly; some species exhibit low rates of recruitment. These characteristics would result in slow recovery from acute contamination. Effects studies should be conducted on all substrates possible and during all seasons. Even so, it appears that it will be very difficult to observe directly the effects on the interactions between the major components (e.g., birds and mudflats). These studies should include closely controlled treatment of experimental plots with various substances related to petrochemical exploration, development and production. Such treatments should include oiling, application of various dispersants, etc., combinations of oiling and dispersants, and controls. Such experiments would be extremely useful in judging how best to treat contamination should it occur. They would also provide useful information on detection of contamination, and on recovery patterns and rates. Cost by fiscal year is dependent upon the intensity and scope of the study. It appears that the results of the initial treatments should be monitored at least three years, based on our observations in rocky intertidal habitats. To conduct such experiments on at least four major substrates would cost at least $100,000 per year.

Finally, we suggest assessment of the wetland resources in Lower Cook Inlet. This valuable resource, very widespread on the west side of the Inlet, has been neglected in spite of world-wide evidence supporting its high productivity and great susceptibility to petrochemical contamination.

XIII. STANDARD STATEMENTS AND AGREEMENTS

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", (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."

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CONSULTANTS IN THE ENVIRONMENTAL AND APPLIED EARTH SCIENCES

ATHENS · CALGARY · JAKARTA · KUWAIT · LONDON · MADRID · MELBOURNE · VANCOUVER, B.C.
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SUITE 310, 510 L STREET · ANCHORAGE, ALASKA 99501 · TELEPHONE: (907) 279-0673
CABLE: DAMEMORE · TELEX: (090) 25227

September 13, 1978

National Oceanic and Atmospheric Administration
OCSEAP Office
P.O. Box 1808
Juneau, Alaska 99802

Attention: Dr. Herbert Bruce, Director

Gentlemen:

Modifications of a Proposal for Continuation of Ecological Studies of Intertidal and Shallow Subtidal Habitats in Lower Cook Inlet and the NEGOA Region

In response to your letter of 25 August 1978 specifying revisions to our proposal of 31 July 1978, I submit the following amendments and/or explanations.

1. File Type 023 will be used to report certain data; Table 1 (Cont.) indicates the variables to be submitted and should be inserted in Section 3, paragraph VII., as part of Table 1.

2. Section 3, paragraph VII.B. (page 18) should be amended to indicate that a final narrative report will be submitted as a deliverable product in partial fulfillment of the contract. One objective of this report will be to describe and evaluate potential oil and gas impacts on the intertidal and shallow subtidal habitats.

3. Regarding the "inordinate amount of time between data collection and data submission," I have the following comments and amendments. Since August 1977 we have been in the process of developing in-house capability for digital data processing at the Homer office. This task has been slow and painful, but is nearing completion. Because of the difficulties experienced so far, I feel more comfortable with the previously stated submission

TABLE 1 (Cont.)

FILE TYPE 023 - FISH RESOURCE ASSESSMENT

Common to all records
- xFile Type
- xFile Identifier
- xRecord Type
- Agency Code
- xVessel Code
- xCruise Number
- xHaul or Set Number
- Record Modifier
- xSequence Number

Record Type '1' - File Header
- Number of Hauls
- NPFC Area
- xLongtitude/Latitude
- xDate/Time
- xGear Code
- Duration of Fishing
- Distance Fished
- Direction of Tow
- Performance
- Surface Temperature/Gear Temperature
- xAverage Depth of Bottom During Tow
- xBottom Type Code
- Sounding Record
- Bottom Trawl Type/Accessories
- Bottom Trawl Warp or Scope Length
- Air Temperature
- Pres Weather
- Cloud Amount
- Sea State
- Wind Direction/Force
- xCurrent Direction/Force

Record Type '2' - Trawl Gear - Not Applicable

Record Type '3' - Miscellaneous Gear - Not Applicable

Record Type '4' - Species Catch - Not Applicable

Record Type '5' - Length-Frequency
- xTaxonomic Code
- xSex Code
- xLength of Class (mm)
- xLength Code
- xLength Frequency
- Length Sample

Record Type '6' - Individual-Biological
- xTaxonomic Code
- xSex Code
- xSex Maturity
- xLength of Individual (mm)
- xLength Code
- xWeight of Individual (gm)
- xWeight Code
- Age/Age Structure/Determination
- Sample/Data Type
- xStomach Examination
- xGut Collected
- Fin Clip

date. Next, the original Data Products Schedule (Table 2) should be replaced by the enclosed amended table. This table incorporates a corrected typographical error and corrections for the collection periods which reduce the length of time between collection of data and submission of records. Finally, I anticipate that the digitized data will be submitted well in advance of the stated date (9/79); however, I would prefer to be in the more flexible position of submitting the data early rather than having to slip the submittal data and write a justification for that. Therefore, unless there are overriding reasons, I prefer to leave the submission dates as they are.

4. Amend Section 3, paragraph IX. (page 20), Item A.3. to indicate that tentative dates for vessel charter are 10-20 November 1978 and 9-10 April 1979. However, dates cannot be finalized without further coordination with R. J. Rosenthal concerning field efforts on his nearshore fish study, and with several potential charter operators concerning charter dates.

5. Under Section 3, paragraph XI. (page 25), add:

   F. Meroplankton and zooplankton data from Lower Cook Inlet (Dr. Tom English).

   Assistance in obtaining these reports is not requested at this time.

6. The field sampling in October 1978 (as indicated on the milestone chart) was proposed under the FY78 contract to provide Fall information. It will involve final sample and data collection on intertidal and subtidal habitats in the east side of Cook Inlet. Logistics requirements are provided for in the budget for FY78.

7. The functions of the personnel listed in Section 4. Cost Proposal are indicated below:

   R. H. Winn - Principal-in-Charge, report review;
   D. C. Lees - Principal investigator, project manager, report preparation;
   J. P. Houghton - report preparation and review;
   W. B. Driskell, D. Boettcher and D. Erikson - sample and data analysis, data processing;
   C. White and L. Randall - bookkeeping;
   C. Manson and M. Stockdale - clerical;
   N. Savage - technical illustration.

   Be advised, however, that other persons may be involved in several aspects of the work, as required.

TABLE 2

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)
Rocky Intertidal and Subtidal- Lower Cook Inlet	Disks	10,000 records	030 & 023	Yes	10/77 to 10/78	9/79
Sandy and muddy intertidal- Lower Cook Inlet	Disks	5,000 records	030 & 023	Yes	10/77 to 10/78	9/79
Rocky intertidal and subtidal- NEGOA region	Disks	10,000 records	030 & 023	Yes	10/77 to 5/79	9/79

We hope that these revisions or explanations meet with your approval or resolve your concerns. If you have further questions, however, please contact me at the Homer office (235-8316).

Very truly yours,

DAMES & MOORE

Dennis C. Lees

Dennis C. Lees
Project Marine Biologist

DCL/ms

To: Bering Sea-Gulf of Alaska
Project Office
P.O. Box 1808
Juneau, Alaska 99802

Proposal Date: 23 June 1978
Contract #: NOAA 03-5-022-67T08
Institution ID #: P78-73

FY 1979 RENEWAL PROPOSAL
(Revised 30 August 1978)

Research Unit Number: 424

Title: Lower Cook Inlet Meroplankton

Cost of Proposal: $95,000 Lease Area: Lower Cook Inlet 100%

Period of Proposal: 1 October 1978 through 30 September 1979

Principal Investigator: T. Saunders English — 1 September 78
T. Saunders English — Date
Department of Oceanography, WB-10
College of Arts and Sciences
University of Washington
Seattle, Washington 98195

Required Organization Approval: G. C. Anderson — 9/6/78.
George C. Anderson — Date
Associate Chairman for Research
Department of Oceanography

Joe S. Creager — 9-11-78
Joe S. Creager, Associate Dean — Date
College of Arts and Sciences

Organization Official Officer: D. R. Oesterle, Acting for Donald R. Baldwin — 9-12-78
Donald R. Baldwin, Director — Date
Grant and Contract Services
1 Administration Building, AD-24

REF: P78-73

TECHNICAL PROPOSAL

I. Title: Lower Cook Inlet Meroplankton
Research Unit Number: RU(424)
Contract Number: 03-5-022-67-TA8
Proposed Dates of Contract: 1 October 1978 to 30 September 1979

II. Principal Investigator: T. Saunders English
Department of Oceanography
University of Washington

III. Cost of Proposal - Federal Fiscal Year 1979

A. Science $95,000

B. PI - provided logistics 0

C. Total $95,000

D. Distribution of Effort by Lease Area: 100% Lower Cook Inlet

IV. Background

This proposed research on early life history stages of fishes, shrimps, and crabs will contribute to knowledge of the quantitative temporal and spatial changes in composition and feeding habits for principal life stages of marine organisms in the Kamishak Bay area of Lower Cook Inlet. These data are needed for determining critical species or stages and will provide important information for use in evaluating the sensitivity of areas that may be impacted by petroleum development. This work will be based on earlier biological surveys which have provided species lists and general information on the relative abundance and distribution of important marine organisms. The field effort and analysis of past data will be coordinated with RU's 5, 138, 341, 417, 425, and 512 to provide a comprehensive understanding of the dynamics of these ecosystem components.

V. Objectives

The objectives of this study are to contribute to an understanding of the quantitative seasonal changes in composition and feeding habits of dominant marine organisms. Specific objectives are:

A. Identify early life history stages of important components of the food webs of Lower Cook Inlet, Kachemak and Kamishak Bays.

B. Describe temporal and spatial dynamics and distributions of these important ecosystem components, specifically ichthyoplankters and meroplanktonic stages of shrimp and crabs.

C. Evaluate timing and use of specific areas within Lower Cook Inlet and its bays by these early life history stages of fishes, shrimp and crabs.

D. Exchange data and information with RU's 5, 138, 341, 417, 425, and 512 to provide a comprehensive understanding of these ecosystem components.

These objectives are relevant to decision making during leasing and development because time periods and geographic areas will be identified as having greater abundance of early life history stages of fishes, crabs, and shrimps of substantial importance in sport and commercial harvests. This information will be useful in prediction and after-the-fact evaluation of environmental effects and hazards of oil and gas development in Lower Cook Inlet.

VI. Strategy and Approach

The general strategy of this contract year is to analyze FY 78 samples to present the results in the format desired by the Project Office. The experimental design was provided by the Project Office which specified times and locations for sampling and the field methods to be used. The narrative reports and visual data will meet the stated objectives by: 1) identifying important organisms, 2) describing temporal and spatial dynamics and distributions, 3) evaluating timing and use of specific areas, and 4) exchanging data and information.

This project will be managed by the Principal Investigator with the assistance of the Manager of Administrative Services, University of Washington, and the Office of Grant and Contract Services, University of Washington.

A. Sampling Method

There will be no field sampling in FY 79.

B. Analytical Methods

The methods of analysis to obtain densities of organisms per square meter and per cubic meter will be standard MARMAP methods (Smith, 1974). The theoretical model for estimating the abundance of organisms was described by English (1964). A partially hierarchical analysis of variance model with fixed and random factors will allow estimation of abundance in three dimensions with time, with confidence interval estimates about mean annual abundance and any other means of interest. The basic analysis of variance will provide a comparison between Inner Kachemak, Outer Kachemak, the Central Zone and Kamishak Bay. Basic time comparisons will be drawn between early summer, full summer, and early fall. Additional spatial comparison may be possible between bongo and neuston net samples.

References:

English, T. Saunders. 1964. A theoretical model for estimating the abundance of planktonic fish eggs. Rapports et Procès-Verbaux. Conseil Permanent International pour l'Exploration de la Mer. 155: 174-182.

Smith, Paul Edward. 1974. Manual of Methods for Fisheries Resource Survey and Appraisal, Part 4. Standard Techniques for Pelagic Fish Egg and Larva Surveys. Edited by Paul Edward Smith. Draft Copy, August 1974.

The bongo net samples taken with 0.505 mm mesh will be analyzed; The samples taken with 0.333 mm mesh will be stored. The samples taken with the neuston net will be analyzed.

The laboratory analysis proceeds under recommended MARMAP procedures. The volume is measured as a basis for considering splitting samples. The sorting by lesser skilled persons is checked in later sorting for other categories of organisms. Lower skilled persons can make preliminary identifications, but final identifications, sizing, enumeration, and staging are reserved for more skilled persons. Bottling, storing, curating, and voucher specimen selection are accomplished using MARMAP and OCSEAP procedures.

The computations, keypunching, and other manual aspects of data handling and analysis are all subject to independent proofreading.

The variable of interest is the number (concentration) of organisms beneath a unit sea surface of 10 square meters:

$$C = 10(a^{-1} b^{-1} cd)$$

where: a is the area of the bongo net in square meters,
b is the length of tow path in meters,
c is the number of organisms in the sample,
d is the maximum depth of the tow in meters.

The parameters a, b, c, and d are not considered to be variables; C is considered to be a variable. The sampling design of the Project Office implies areas and periods as first order effects with possible statistically significant interactions. Confidence limits can be computed about any means of interest and will be possible when the Project Office states the supporting rationale of the sampling scheme so that cells of area and time can be constructed.

The concentrations of organisms will be plotted on maps which emphasize the temporal and spatial distributions of these early life history stages.

The averaging may be arithmetic or geometric as appears appropriate, but will always be identified as to method.

VII. Deliverable Products

A. Digital Data

The list of parameters that will be submitted in File Type 024 - Zooplankton 02 and the minimum and maximum values applicable to this study are listed below:

Parameters	Limits of Values Min	Max
Common to all records		
File Type	024	024
File Identifier	alphanumeric	
Record Type	1	6
Station Number (Record Types 2-6 only)	alphanumeric	
Record Type '1' - Header		
Vessel Name	alphabetic	
Cruise Number	alphanumeric	
Cruise Dates	750101	991231
Area/Project	alphabetic	
Investigator/Institution	alphabetic	
Record Type '2' - Location		
Latitude	580000	620000
Longitude	1380000	1540000
Date (GMT)	750101	991231
Time (GMT)	0001	2400
Depth to Bottom (m)	0	1500
Sample Interval		
Upper	0	1500
Lower	0	1500
Ship Speed (knots to 1/10)	0	150
Surface Water Temperature (C° to 1/10)	-10	200
Record Type '3' - Total Haul		
Gear Characteristics (codes)	1	17
Mesh Size	333	2000
Haul Distance (m)	1	9999
Volume of Water Filtered (m^3)	1	999999
Duration of Tow (hr/min/sec)	1	20000
Haul Type (code)	alphabetic	

Parameters	Limits of Values Min	Max
Record Type '4' - Subsample Data 1		
Sample Number	1	9999
NODC Taxonomic Code	6175	8857041902
Life History (code)	alphanumeric	
Size of Subsample (% to 1/10)	1	1000
Number in Subsample	1	99999
Concentration of Sample ($/m^3$)	1	999999
Record Type '5' - Text		
Sequence Number	1	9999
Text	alphanumeric	
Record Type '6' - Subsample Data 2		
Same as Record Type '4'		
Concentration of Sample ($/m^3$)	1	999999

In processing digital data, original haul sheets and count sheet numbers are transferred to IBM 80-column entry sheets, keypunched and listed. These listings are proofread from the original haul and count sheets. Corrections are made, then new listings are made of the corrected deck. These corrections are then proofread again from the originals. Deck listings are checked two more times for correct spacing and field placement.

B. Narrative Reports

The narrative reports will describe methods, spatial and temporal intensity of sampling, techniques employed, current status of knowledge, description of statistical treatment, results, discussion and conclusions. Recommendations for further investigations will be defined. Our analysis and interpretation will include and discuss other significant reports dealing with the zooplankton of Cook Inlet. Appropriate reports include, but are not restricted to:

Damkaer, D.M. 1977. Initial zooplankton investigations in Prince William Sound, Gulf of Alaska, and Lower Cook Inlet, Research Unit 425, Annual Report. 138 pp.

Haynes, E. 1976. Summary status on the distribution of king crab and pandalid shrimp larvae, Kachemak Bay - Lower Cook Inlet, Alaska. Vol. IV. Environmental Studies of Kachemak Bay and Lower Cook Inlet, Alaska, Dept. of Fish and Game, Anchorage.

Sundberg, K. and D. Clausen. 1976. Post-larval king crab (*Paralithodes camtschatica*) distribution and abundance in Kachemak Bay, Lower Cook Inlet, Alaska. Vol. V. Environmental Studies of Kachemak Bay and Lower Cook Inlet. Alaska Dept. of Fish and Game, Anchorage.

We will provide special reports for synthesis meetings and other project purposes.

Visual Data

Information will be portrayed in maps, charts, figures and tables to support the narrative reports, similar to previous guidance. Specific items are:

a. Maps identifying sampling sites.

b. Charts illustrating:

   (1) Temporal quantitative distribution of principal planktonic life stages for each major species or species group by season.

   (2) Primary spawning areas for major species where applicable.

c. Figures and tables illustrating:

   (1) Temporal changes in species composition and density at each sampling site.

   (2) Temporal changes of relative abundance of principal life stages of major species of species groups at each sampling site.

The regular maps will be submitted. In addition, we will supply transparent, labeled Mylar film overlays on standard map formats for all map products desired by the Project Office. The blank Mylar maps will be supplied by the Project Office.

D. Other

None

E. List of Data Products and Data Submission Schedule

We intend to submit data by 3-month data collection periods as shown on the attached Data Products Schedule.

VIII. Special Sample and Voucher Specimen Archival Plans

Voucher specimens will be retained by the Principal Investigator throughout the period of this contract unless OCSEAP requests an early transfer to a permanent archive.

IX. Logistics Requirements

The attached forms reflect no logistics requirements in this contract year.

X. Anticipated Problems

The major difficulty that could be associated with this research is a hiatus in funding from NOAA, forcing layoffs and raising the uncertainty of rehiring qualified workers, as well as disrupting the scheduled milestones.

We have no field objectives in FY 79.

XI. Information Required from Other Investigators.

We will need data and information from RU's 5, 138, 341, 417, 425, and 512. The Lower Cook Inlet Lease Area Coordinator will hold meetings at which the necessary information will be available and can be exchanged.

XII. Activity/Milestone Chart

The Activity/Milestone Chart is attached.

XIII. Outlook

The outlook for this research unit will apparently be decided in a series of planning and synthesis meeting in October-December 1978. We do not know what the thrust of BLM desires will be and we do not know what paradigm OCSEAP will suggest. We feel that a detailed quantitative examination of the several shrimp populations of Inner and Outer Kachemak Bay might meet BLM needs. Those results would allow mass balance and population dynamics models that should have major impacts on decision making relative to environmental effects and hazards as they affect leasing and development. A major decision could be required if a population is asserted to be at risk or when a population yields a decreased harvest.

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 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 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 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."

OTHER INFORMATION

a. The general background of the proposer is in fisheries and biological oceanography. His work experience includes freshwater hatcheries, farm ponds, lakes and streams; he has done biological oceanographic research in the tropics, temperate waters, and in the North Polar Sea. The investigator has done similar work in OCSEAP in FY 1976, 1977 and 1978, and has done related work in Puget Sound since 1951.

b. There is only one contract.

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 his salary requested in the budget. The principal investigator's time commitment is 25% from OCSEAP funding. The principal investigator is not involved with other OCSEAP research units or Federal projects. The principal investigator expects to be supported for the 9 months of the academic year by the University of Washington, subject to dismissal upon 2 weeks notice. The academic time commitments are to teach a course in winter and in spring quarters, which greatly limits or eliminates travel from January into mid-June. The principal investigator will have no other sources of support or time commitments.

d. The personnel assigned for direct work on the project and their major supervisory assignments are:

   T. English - principal investigator
   K. Daly - crab identification
   L. Legacie - fish identification
   D. Roetcisoender - shrimp identification
   M. Weinstein - identification, data management, graphics
   D. Kisker - identification, data management, graphics

   This group has worked together in the OCSEAP program since 1975. Resumes are attached.

e. No other information is considered to be relevant.

f. Negotiations can be conducted by:

   Donald R. Baldwin, Director
   Grant and Contract Services
   University of Washington
   Phone: (206) 543-4043

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)		Submissio (Month/Year
Early Life History Stages of Fishes, Shrimps and Crabs	Cards	5,000	024	Yes	Apr 78	Jun 78	Dec 7
	Cards	30,000	024	Yes	Jul 78	Sep 78	Jun 79

MILESTONE CHART

O - Planned Completion Date

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

RU # 424 PI: T. Saunders English

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
Planning Workshops: LCI Synthesis	├──	──	──┤												
Data Processing	├──	──	──	──	──	──	──	──	──	──	──	──┤			
Quarterly Report				O											
Submit Spring 78 Data (55 bongo)			O												
Annual Report							O								
Quarterly Report										O					
Submit Summer 78 Data (173 bongo + 173 neuston)									O						
Final Quarterly Report													O		
Final Report															O

To: Department of Commerce, NOAA
OCSEA Program
Juneau Project Office
P. O. Box 1808
Juneau, Alaska 99802

Proposal Date: July 24, 1978

NOAA Project: R7120844

FY 1979 RENEWAL PROPOSAL

Research Unit: 425

TITLE: Composition and Source of Organic Detritus in Lower Cook Inlet

Cost of Proposal: $50,060 Lease Area: Cook Inlet (100%)

Period of Proposal: October 1, 1978 through April 30, 1978

PRINCIPAL INVESTIGATOR:

Jerry D. Larrance Date July 25, 1978

Jerry D. Larrance

Pacific Marine Environmental Laboratory
7600 Sand Point Way N.E.
Seattle, WA 98115
(206) 442-4900 FTS 399-4900

ORGANIZATIONAL APPROVAL:

Dr. John R. Apel Date 28 July 78
John R. Apel
Director
PMEL/NOAA
3711 15th Ave. N.E.
Seattle, WA 98105
(206) 442-4979 FTS 399-4079

Dr. Herbert Curl, Jr. Date 28 July 1978
Herbert Curl Jr.
Bio/Chem Group Leader
PMEL/NOAA
7600 Sand Point Way N.E.
Seattle, WA 98115
(206) 442-5436 FTS 399-5436

FINANCIAL OFFICER:

Ms. Cynthia L. Loitsch Date 28 July 1978
Cynthia L. Loitsch
Program Support Officer
PMEL/NOAA
7600 Sand Point Way N.E.
Seattle, WA 98115
(206) 442-4090 FTS 399-4090

TECHNICAL PROPOSAL

I. Title: Composition and Source of Organic Detritus in Lower Cook Inlet

Research Unit: #425

Proposed Dates of Contract: October 1, 1978 - May 30, 1979

II. Principal Investigator: Jerry D. Larrance

III. Cost of Proposal for FY 79:

A.	Science	$50,060
B.	PI-Provided Logistics	0
C.	Total	$50,060
D.	Cook Inlet	100%

IV. BACKGROUND

Offshore petroleum development in lower Cook Inlet will provide a potential source of contamination of the environment by accidental large spills and chronic low-level oil pollution. Such pollution would undoubtedly have a harmful effect on important commercial fisheries in lower Cook Inlet.

Benthic species harvested include snow, king, and Dungeness crab, shrimp, razor clams, and scallops. These are commercially harvested primarily within the rectangle bordered by Anchor Point, Kachemak Bay, the Barren Islands, and Kamishak Bay (Bureau of Land Management, Final Environmental Statement, 1976). Some primary king crab recruitment grounds are within this area in the Bluff Point-Kachemak Bay region. The adverse effects to these species from oil pollution are discussed in BLM (1976).

The larval stages of these and other benthic species are planktonic and rely on phytoplankton for food. Adults in the benthic community ultimately depend on organic production from phytoplankton and other plants. Phytoplankton grazed by zooplankton enters the detrital food web via fecal pellet deposition. Other cells enter the benthos by sinking directly. As small sinking particles, the cells and pellets may act to transport oil from the surface to the bottom. Studies have indicated rapid removal and dispersal of surface oil by suspended particles. When oil enters seawater, emulsions of very tiny droplets can form. Some of the droplets become bound to particles by absorbtion and adsorbtion; they subsequently sink directly or are sedimented in fecal pellets after being ingested by zooplankton. Thus, ingestion and sorbtion act as precipitation mechanisms to transfer otherwise buoyant oil particles to the detrital food web (NOAA Special Report, 1977; Forrester 1971 in NOAA; Conover, 1971).

Since lower Cook Inlet has a seasonally sustained high yield of phytoplankton, it can be assumed that their input of organic matter (fecal pellets and cells) to the benthos is considerable. The respective fraction of each is not known, but combined they can probably provide the means for transporting considerable amounts of oil to the bottom where it can impact the benthos.

In addition to the role of phytoplankton in transporting oil to the benthos, primary production can be affected by oil contamination and thus impact higher trophic levels. The impact on phytoplankton depends on oil and other contaminant concentrations, proximity of the cells to the contaminant, localized geography, species composition, and other variables. The species composition of a natural population can be significantly altered by oil contamination (Dunstan et al., 1975 and Lee et al., 1977). Other effects can include death, increased and decreased photosynthetic rates, decreased cell division rates, cell membrane damage, and other physiological abnormalities (Shiels et al., 1973; Gordon and Prouse, 1973; BLM, 1976; Hufford, 1971 in BLM, 1976). Surface oil can lower light levels to decrease photosynthesis and can interrupt gas exchange across the surface. Hufford (1971) in BLM (1976) states that photosynthesis can be decreased by 50 to 90% from lowered light levels and lowered cell division rates from phytoplankton under an oil spill. Drilling muds may contaminate phytoplankton and other biota due to the presence of toxic chromium and pipeline burial may resuspend contaminated sediments (BLM, 1976).

Phytoplankton standing stock and primary productivity are high in lower Cook Inlet. During our 1976 investigations, cell concentrations were greater than 10^6 cells/ℓ and primary production was as much as 7.7 gC/m^2 day in May in Kachemak Bay. Mean primary productivity in lower Cook Inlet reached a peak of about 4.9 gC/m^2 day in late May and decreased to about 0.7 gC/m^2 day by late August (Larrance et al., 1977). BLM (1976) reports that photosynthetic rates in lower Cook Inlet range between 0.25 and 0.50 gC/m^2 day. The latter figures are averages for an extensive region including the Aleutian Islands and may be annual estimates. They appear to be somewhat low for lower Cook Inlet in any case.

The extremely high productivity in Kachemak Bay is caused, in part, by relatively long residence time of water, and by a strong pycnocline development in that region. A gyre tends to constrain water in outer Kachemak Bay and a constriction (Homer Spit) prevents rapid turnover of inner Kachemak Bay waters (Larrance et al., 1977; Evans et al., 1972; Knull and Williamson, 1969). The local permanence and stability of the water column (i.e., water is not advected either laterally or vertically) enhances conditions for a bloom. Elsewhere in lower Cook Inlet, strong tidal currents cause pronounced mixing and prevent stabilization of the water.

Phytoplankton populations in such embayments where water is locally constrained are particularly vulnerable to toxic contamination since clean water dilution by mixing will not occur. The Kachemak Bay area is of particular importance, also, because king crab zoea in that recruitment area undoubtedly rely on the local phytoplankton community.

There is an east to west transition across lower Cook Inlet with respect to magnitude and timing of maximum phytoplankton standing stock and productivity. Organic production by phytoplankton in 1976 was 0.1 to 0.5 as great in Kamishak as in Kachemak Bay, and maximum productivity and standing stocks occurred about two months later in Kamishak Bay. Midchannel values were as high as in Kachemak Bay, but occurred about one month later when the water column became slightly stable. Thus, the organic input to the detrital food web from phytoplankton has distinctly variable components with respect to season, magnitude, and locale in lower Cook Inlet.

In the context of OCSEAP studies in lower Cook Inlet, a question was posed of the relative importance of phytoplankton and macroalgae as contributors to the total primary production of the Inlet. In a recent analysis using 1976 measurements of phytoplankton productivity (Larrance et al., 1977) and measurements of macroalgal growth (Dames and Moore, 1978), we estimated a maximum annual production of macroalgae to be about 7% of the phytoplankton production over the entire lower Cook Inlet. These estimates will be refined using our 1978 data and any additional information on macroalgae by Dames and Moore or other investigators. The significance of these comparisons to OCSEAP is in the estimation of the probable impact on the ecosystem by disturbance of either or both of these two plant communities.

Phytoplankton is abundant in lower Cook Inlet and its importance to the larval stages of commercial and other species is evident both in the transport of oil to the benthos and as sustenance for the benthos. It is of utmost importance to determine the fluxes of phytoplankton produced organic matter and total organic detritus; and to define the origin, composition and seasonal variation of organic detritus sinking to the bottom. Accordingly, this investigation will attempt to elucidate the fate of certain fractions of organic detritus in the lower Cook Inlet ecosystem.

V. OBJECTIVES

This is a study of the downward fluxes, distribution, and composition of the suspended organic particles which contribute to the benthic food web of lower Cook Inlet. The objectives are:

1. Define the seasonal composition and origin of the organic detrital material.

2. Determine the short- and long-term vertical fluxes of organic particles to the bottom.

3. Determine phytoplankton composition, standing stock, and productivity during the biologically active period of the year.

4. Test the feasibility for determination of sources of organic detritus by application of carbon and nitrogen isotopic composition.

The relevance of these objectives is included in the previous section.

The objective of the present proposal is to complete a final report addressing the objectives listed above.

VI. STRATEGY AND APPROACH

Field observations for this study will be complete by the beginning of the proposed contract period. The field program consisted of sediment trap deployment and recovery, intensive water column sampling, and primary productivity measurements. Five cruises were conducted in 1978 (March, May, June, July and August) to correspond to the period of highest biological production. The selection of sampling sites was influenced by studies conducted in 1976 (Larrance et al., 1977). The timing and degree of biological activity differed from east to west across lower Cook Inlet as a partial function of variable water column stability and light attenuation by suspended particulates. Therefore, a 7-station transect (Fig. 1) running east-west was chosen to study the variable input of pelagic material to the benthic communities of Cook Inlet.

Sediment traps, moored near the bottom at three sampling sites, were recovered after four or five days to provide minimum estimates of the input rate and composition of suspended particles reaching the sea floor. Aliquots were withdrawn from the sediment traps for the following analyses:

a. plant pigments - chlorophyll a and pheopigments

b. microscopic examination of major sedimented components including phytoplankton cells, zooplankton fecal pellets, macrophyte debris, etc.

c. ratios of stable carbon and nitrogen isotopes.

d. total particulate matter and total particulate carbon.

Chlorophyll Budget

A chlorophyll budget will be derived to examine the contribution of the algal biomass to benthic communities. Pigment concentrations in sediment traps provide useful measures of total plant matter lost from the water column while sediment traps were in place.

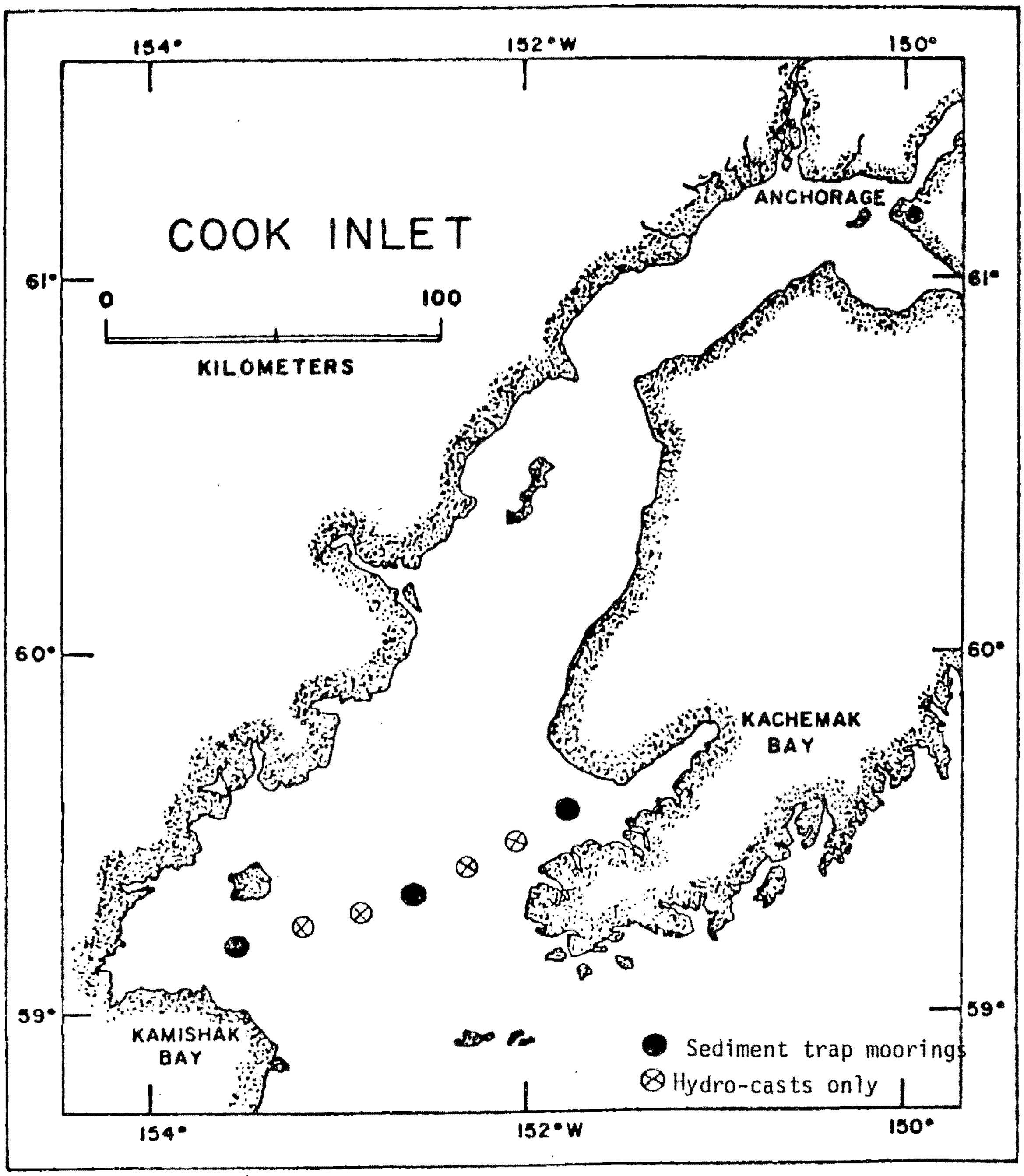


Figure 1. Station locations, Organic detritus studies,RU425, FY 1978.

Phytoplankton material can reach the sea floor in two important ways:

a. cells may sink directly

b. cells may be ingested by zooplankton, metabolically processed, repackaged, and eliminated as fecal material.

Smayda (1970) reviewed the literature and reported highly variable sinking rates for phytoplankton cells (0-30 m dy^{-1}) depending on cell buoyancy, cell shape, ability to swim in response to stimuli, and nutrient concentration. Fecal pellets sink at significantly faster rates ($\simeq$100-200 m dy^{-1}) and are, therefore, less apt to be advected from their area of production.

Recent work (Shuman and Lorenzen, 1975) demonstrated that planktonic herbivores degrade chlorophyll to pheopigments with a 100% molar efficiency. Therefore, the total chlorophyll lost to the water column due to zooplankton grazing and fecal pellet production can be calculated from the pheopigment content of a sediment trap. The chlorophyll concentration measured in the sediment traps is a measure of the chlorophyll deposited by direct sinking of phytoplankton cells or cell debris. The relative contribution of fecal pellet production (i.e., grazing) versus direct algal sinking can be quantified.

The average chlorophyll content of the ambient water column was determined concurrently. The absolute loss of chlorophyll from the water column (computed from sediment trap data) may then be expressed as the average daily percentage of the total phytoplankton standing stock that settles to the bottom. Chlorophyll synthesis may be calculated from carbon uptake experiments by applying a carbon/chlorophyll ratio interpreted from field data. It should be possible, then, to compare the amount of chlorophyll produced with that lost to the benthos to determine net loss or gain of chlorophyll to the system.

Coupled with the sediment trap technique, a field sampling program was conducted to gather information from the ambient water columns. Daily samples were taken at each sediment trap location for phytoplankton species, plant pigments, nutrients, solar insolation, primary productivity, total particulate matter, total particulate carbon, salinity, and temperature. These data will provide the necessary information for the chlorophyll budget and will enable us to determine phytoplankton composition, biomass, and productivity during the biologically active portion of the year.

The chlorophyll budget approach will be most useful in areas where residence time of the ambient water is long relative to the length of sediment trap emplacement. Work in 1976 (Larrance et al., 1977) suggested that Kachemak Bay may be a particularly fruitful area for such a technique because observed biological changes were mainly local rather than advective. Identical analyses will, of course, be conducted at midchannel and in Kamishak Bay. Comparisons of results from the three areas may provide insights about the validity of this approach in these distinct circulation regimes.

Isotopic Composition

In recent years, geochemists have used the distribution of stable isotopes of carbon and nitrogen to elucidate a range of geochemical and environmental questions. Parker (1963) identified the source of organic matter in estuarine sediments on the basis of isotopic composition, and Calder and Parker (1968) associated petrochemical contamination with carbon-12 and -13 composition. Abundances and distributions of carbon isotopes have also been applied to study the contribution of terrestrial organic matter in near-shore marine environments (Gearing, Plucker, and Parker, 1977). Although nitrogen isotopes have been used to a lesser extent to identify sources of organic matter, the relative composition of nitrogen-14 and -15 may be a more sensitive tracer than carbon as was found for sewage in a marine environment by Sweeney et al. (1976).

To evaluate the relative contribution of terrigenous and marine organic matter in detritus settling to the bottom, we have initiated a program for determination of the sources of organic matter on the basis of its isotopic composition of carbon and nitrogen. The isotopic composition of a small number of samples of riverine suspended matter, sediments, sediment-trap material, and plankton will be analyzed. By measurements of these materials, the sensitivity of the method will be assessed for distinguishing between marine and terrestrial sources of organic detritus in lower Cook Inlet.

Total Sedimentation

The experimental approach outlined above will identify the major components and sources of the organic detritus and quantify the short-term vertical inputs of organic material to the sea bottom. We are also concerned with total sedimentation over longer periods and plan to cooperate closely with Dr. Richard Feely of this research laboratory (OCSEAP Research Unit #152). He has deployed sediment traps for periods of 4-5 months each in lower Cook Inlet. We anticipate comparing these long-term results to data obtained from our short-term experiments to more completely document total detrital input. We will also employ results of the circulation studies obtained by Dr. Muench et al. of PMEL.

A. Sampling Methods

The sampling scheme was derived on the basis of findings from our 1976 studies, circulation, and available logistics and funding. A cross-inlet transect of seven stations was selected because it intersects the major water types (including turbidity and biological productivity) in lower Cook Inlet. In view of the large variability over 24-hour periods as measured in 1976, repeated daily observations at each station were made to obtain better estimates of mean values for the period sampled and to assess day-to-day variations.

We have assessed sampling and analytical variability for the measurement of chlorophyll and phaeophytin by our methods several times over past years. Similar estimates were occasionally made during the present study. These estimated variations are a function of the standing stock and will be applied accordingly.

The estimates include some "natural variation" which, for purposes of this study, can be considered as random error. Primary productivity experiments are routinely duplicated (light bottles) to obtain variability of that technique. On three cruises, a grid of closely spaced (1 mile) stations in Kachemak Bay was sampled for salinity, temperature, nutrient and chlorophyll measurements. The purpose was to ascertain spatial variability around a single station. In addition, each sediment trap mooring contained two traps side-by-side. Comparison of samples from the duplicate traps should permit calculation of sampling variance.

The sampling, therefore, was designed primarily to assess changes in the measured variables from month-to-month and station-to-station. Replication was applied insofar as practicable to estimate the variability necessary to determine whether observed changes were significant by appropriate statistical techniques.

B. Analytical Methods

Following deployment of sediment trap moorings, routine CTD-rosette casts were made to obtain temperature and salinity profiles. Water samples were collected from several depths for measurement of various biological and chemical parameters. Subsamples for phytoplankton species determination were preserved in acetate buffered formalin and returned to the laboratory for analysis by inverted microscope techniques (Lund, Kipling and LeCren, 1958). Plant pigments were analyzed aboard ship using fluorometric methods (Lorenzen, 1966). Seawater samples for determination of dissolved inorganic nutrients were frozen and returned to the University of Washington Department of Oceanography for analysis by Auto Analyzer methods (Strickland and Parsons, 1972). Half-day primary productivity experiments were conducted using standard carbon-14 methodology (Strickland and Parsons, 1972). Total particulate matter was measured by filtering subsamples through preweighed 47 mm 0.4 μm Nuclepore filters. The filters were washed with de-ionized water, dried in a dessicator, and reweighed in the laboratory. Total particulate carbon is being determined by filtering through precombusted silver filters. Filters are rinsed in de-ionized water, dessicated, frozen, and analyzed by the micro-Dumas combustion method, employing a Hewlett Packard C-H-N analyzer (Sharp, 1974). During each cruise, sunlight was continuously monitored with a Lamda Instruments quantum sensor sensitive to light in the photosynthetically active region (approx. 400-680 nm).

Material recovered from sediment traps was collected for analysis of plant pigment content, total particulates, carbon and nitrogen isotopes, total particulate carbon, organic carbon, and microscopic inspection using methods adapted from those described in this proposal.

Isotopic Analysis

Organic carbon and nitrogen (e.g., sediments and tissue) must be first converted to CO_2 and N_2 prior to isotopic analyses. This is accomplished in a high temperature combustion furnace in the presence of oxygen (Craig, 1953; Cline, 1973). Undesirable reaction products such as carbon monoxide (CO) and nitrous oxide (N_2O) are converted to CO_2 and N_2 in appropriate oxidizing and reducing furnaces. Carbon monoxide is readily converted to CO_2 at the surface of hot cupric oxide; nitrous oxide is readily reduced to N_2 at the surface of hot, clean copper. Since the combustion and conversion reactions may isotopically fractionate the product, care must be exercised that the original substrate carbon and nitrogen be converted to CO_2 and N_2.

After conversion to CO_2 and N_2, the samples are analyzed isotopically on an isotope-ratio mass spectrometer. Because the relative abundances of the isotopes of carbon and nitrogen are different (see above), the isotope mass spectrometer is usually designed for the specific analysis.

The mass spectrometer measures the C^{13}/C^{12} and N^{15}/N^{14} ratio directly and compares it to a standard reference material. The results are usually expressed in delta-notation:

$$\delta C^{13} = \left| \frac{(C^{13}/C^{12})_{sample} - (C^{13}/C^{12})_{std}}{(C^{13}/C^{12})_{std}} \right| \times 1000,$$

and

$$\delta N^{15} = \left| \frac{(N^{15}/N^{14})_{sample} - (N^{15}/N^{14})_{std}}{(N^{15}/N^{14})_{std}} \right| \times 1000.$$

The standard for carbon is usually prepared from a cretaceous belemnite (PDB) or a suitable working standard compared to it. The standard for nitrogen is atmospheric N_2, which has been shown to be globally uniform (Sweeney et al., 1976). The respective precisions for δC^{13} and δN^{15} are around ± 0.1 $^{o}/oo$; the precision being somewhat better for carbon.

Treatment of Data

As described in VI. A. above, replication was designed into the sampling scheme to provide data from which variances could be calculated within cruises (day-to-day variance) and surrounding stations (e.g., Kachemak Bay grid). These coupled with previous studies of the variability of methods and techniques used at PMEL should permit us to calculate the necessary standard deviations required to test for statistical significance from month-to-month at single stations and from station-to-station during a cruise. The precise forms of analysis of variance or other tests (e.g., chi-square) to be applied, or their necessary logarithmic or other data transformations will be determined when the complete data sets are in hand.

All data processing and subsequent statistical calculations and tests will be performed on the University of Washington's CDC-6600 using appropriate statistical software packages. The data will be displayed in tabular and graphical formats for understandable presentation. For example, single station and cross-sectional profiles of pigments, productivity, temperature, salinity, light, etc. will be prepared. No plan views or maps are anticipated. Confidence intervals will be amply stated.

VII. DELIVERABLE PRODUCTS

A. Digital Data

1. The minimal suite of data (with expected values) to be submitted is listed on the following two pages.

2. After being punched on data cards, the listing is proofread against original data. Data are thoroughly inspected for "outliers."

File Type 028
Phytoplankton Species

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

Record Type 1 - Master Record
- Latitude/Longitude 59-60°/151°-154°W
- Time
- Depth to Bottom 0-200 m.

Record Type 2 - Text
- Text
- Sequence Number

Record Type 3 - Detail Record
- Sample Number
- Sample Depth 0-100 m
- Taxonomic Code
- Count 0 - 2000
- Number of Cells/Liter 0 - 10^7
- Wet/Dry Weight
- Volume of Water Filtered 100 ml
- Sequence Number

Record Type 4 - Detail II Record
- Sample Number/Sample Depth
- Taxonomic Code
- Cells Per Liter/Carbon Per Liter
- Percent Cells/Percent Carbon Per Liter
- Sequence Number

File Type 029
Primary Productivity

Common to all records
- ✓ File Type
- ✓ File Identifier
- ✓ Record Type
- ✓ Station Number (except record 0)

Record Type 0 - File Header Record
- ✓ Vessel
- ✓ Cruise/Cruise Dates in GMT
- ✓ Senior Scientist
- ✓ Investigator/Institution

Record Type 1 - Master Record
- ✓ Latitude/Longitude 59-60°N/151°-154°W
- ✓ Year/Month/Day 78/3-8/
- ✓ Hour/Minutes
- ✓ Time Zone
- ✓ Depth to Bottom 0-200 m
- ✓ Chlorophyll/Phaeopigments/Carbon 0-300 mg m^{-2}
- ✓ One Percent Light Depth 0-70 m
- Phosphate/pH Scale
- In Situ Corrections for pH Measurements
- ✓ SECCHI Depth 0-50 m.
- ✓ Mixed Layer Depth 0-200 m.
- ✓ Light Level 0-700 ly.

Record Type 3 - Detail Record
- ✓ Depth of Sample 0-200 m
- ✓ Chlorophyll/Phaeopigment Concentration 0-30 mg m^{-3}
- ✓ Carbon Assimilation 0-2 g C m^{-3}
- ✓ Elapsed Time of Incubation 0-12 hrs.
- Oxygen
- ✓ Phosphate PO_4-P 0-4 µg at/l.
- Ammonia NH_3-N
- ✓ Nitrate NO_3-N/Nitrate NO_2-N 0-40/0-10 µg at/l
- ✓ Silicate SiO_3-Si 0-100 µg at/l.
- pH
- Alkalinity
- ✓ Temperature 0-20 C
- ✓ Salinity 20-35‰
- ✓ Sequence Number

Record Type 4 - Text Record
- ✓ Text
- ✓ Sequence Number

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)	Submissio (Month/Ye
PHYTOPLANKTON SPECIES	CARDS	5,000 CARDS	028	Yes	3/78 – 8/78	10/78-1/79
PRIMARY PRODUCTIVITY	CARDS	5,000	029	Yes	3/78 - 8/78	10/78-1/79

B. Reports

A final report will be prepared including display of pertinent data. Interpretation of data will be included with appropriate graphical presentation. The following items will be addressed which are consonant with the objectives of this research:

1. The composition of organic detritus and its seasonal changes will be described. Variables to be examined are organic carbon and nitrogen content, plant pigment content, and the physical appearance of particles (microscopically determined).

2. The origin of the organic particles will be inferred from microscopical examination, pigment content, and isotopic ratios of carbon and nitrogen. Visual identifications of particles from sediment traps can give an approximation of the proportion of particles which are phytoplankton cells, zooplankton fecal pellets, or other debris. The pigment content of sediment trap samples can provide some information as to whether the material is plant and whether it has been grazed by herbivores. The isotopic ratios (although samples are limited in number) may provide a clue about the proportion of terrestrial vs. marine produced organic matter.

3. Downward fluxes of organic detritus have been measured and their temporal (month-to-month) and spatial (cross-inlet) changes will be examined. The month-to-month information will be compared to the long-term fluxes concurrently obtained by Dr. Feely.

4. The phytoplankton composition, standing stock , and productivity will be described for 1978 and compared to the 1976 data. Seasonal and spatial variations will be examined to determine what differences are statistically significant. Correlations between primary production and environmental variables will be examined.

5. Carbon and nitrogen isotopic ratios in particles from oceanic, estuarine, and riverine sources will be compared to determine if their differences are large enough and the random variation small enough to warrant the use of these ratios for determining whether the material is of terrestrial or marine origin in the Cook Inlet region.

6. Calculations will be made to determine the proportion of the overlying phytoplankton populations which sinks to near bottom, either as intact cells or herbivore fecal matter.

7. The production of phytoplankton will be compared to that of macroalgae in the Cook Inlet area to determine their relative importance in the organic matter budget.

VIII. ARCHIVAL PLANS: None

IX. LOGISTICS: None required.

X. ANTICIPATED PROBLEMS: None.

XI. INFORMATION FROM OTHER INVESTIGATORS: None required other than that acquired through personal contact.

XII. MILESTONE SCHEDULE (page

XIII. OUTLOOK: Terminal.

XIV. Contract Terms.

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 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 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 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 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.

MILESTONE CHART

0 - Planned Completion Date

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

RU # 425 PI: LARRANCE

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
SUBMISSION OF DATA															
DATA ANALYSIS															
FIRST DRAFT REPORT															
FINAL REPORT															
REPORT SUBMITTED															

I. Title: Bottom and Near-Bottom Sediment Dynamics in Lower Cook Inlet

Research Unit Number: 430
Contract Number:
Proposed Dates of Contract: Oct 1978 - Sept 1979

II. Principal Investigators: David A. Cacchione
David E. Drake

III. Cost of Proposal:

A. Science $22,500
B. P.I. Provided Logistics
C. Total
D. Distribution of Effort:
50% in Lower Cook Inlet
50% other

IV. Background:

The energetic currents caused by tides, wind, and density gradients transport large amounts of materials as suspended and bed loads within Lower Cook Inlet. Previous and continuing work by Bouma and Hampton (RU 327) and by PMEL oceanographers have provided detailed morphologic charts and current measurements, respectively, within this dynamic environment. Our work compliments these data and is intended to provide quantitative information relating the tides and currents to the material transport. Our field efforts in F.Y. 78 during which we deployed two Geoprobe tripod systems will be completed in early F.Y. 79. Data analysis and reporting of results will follow the field program.

V. Objectives:

This study addresses the overall objective of evaluating geologic hazards associated with erosion and deposition on the seafloor and of characterizing bottom sediment dynamics. Specific objectives are:

1. To provide a spatial and temporal description of bottom sediment transport.

2. To develop estimates of bottom sediment flux related to high energy events such as storms and tides.

3. To relate the magnitude of bedshear to the initiation of bottom sediment movement for each sedimentary environment.

4. To provide detailed descriptions of seafloor physiography and surface sediment characteristics in selected areas of observation.

5. To describe changes in the surface character of the seafloor over relatively long duration (at least one month).

VI. General Strategy and Approach:

Our research focuses on the transport of bottom and near bottom materials in the sedimentary environments that have been previously described by Bouma and Hampton (RU 327). The field program was designed in consultation with Bouma and Hampton to provide detailed measurements of physical and sedimentological parameters in the area of large sand waves (about 5 m heights) for a short time period (several days).

Two Geoprobes, one of which was constructed under OCSEAP funding from F.Y. 78, were deployed in the large bed form area. This experiment was intended to gather data on the very near bottom transport during strong flood and ebb tides.

A second part of the experiment was to deploy one Geoprobe for a longer duration (about 2 months) in an area of lower bed forms (about 0.5 meter heights) to measure their response to storm conditions. Cacchione and Drake were to serve as Co-chief Scientists during the launch and recovery cruises, with Bouma and Hampton participating during each phase.

A. Sampling Methods:

The primary method in this work is the deployment of two Geoprobe tripods at sites shown in Figure 1 (area A) during the July 1978 cruise on R/V SEA SOUNDER. The plan for the July cruise was to deploy two tripods on a large sand wave (wave height about 5 m, wave length about 500 m) in central Lower Cook Inlet. These data will be used to assess the short term transport of bottom materials during several tidol cycle.

The redeployment of one Geoprobe (area B in Figure 1) at a shallower site that has smaller bed features (sand waves of about 1/2 m height) will provide longer term data on bed mobilization during spring and neap tidal cycles and possibly storm periods. This tripod will be recovered during F.Y. 79 (October) using R/V SEA SOUNDER.

At each Geoprobe site, we conducted a detailed geological and geophysical sampling program using equipment on R/V SEA SOUNDER. This site survey will be redone during the October recovery cruise. The site survey measurements will include 3.5 kHz and 12 kHz seismic profiling, side-scan sonar profiling, bottom photography with TV, light transmission - CTD - current meter profiling, and suspended and bottom sediment sampling.

B. Analytical Methods:

Geoprobe tripod data is available in two forms: digital data on a special cassette tape and 35 mm bottom photographs. The digital cassette tapes have been transcribed onto 7-inch computer tapes at PMEL with the assistance of D. Halpern and P. Freitag. The 7-track tapes were then rewritten on to 9-track tapes and stored at USGS, Menlo Park. In the near future, we hope to have our Sea Data cassette reader, procured under previous OCSEAP funding, installed and operational at our new Sediment Dynamics Laboratory, USGS, Menlo Park.

The digital data on the Sea Data cassette tapes includes measurements taken with the following sensors: 4 electromagnetic current meters, one rotor-vane current meter, 2 temperature probes, one pressure transducer, and a light transmissoneter and nephelometer. The following table outlines the calibration procedures for each of these:

Sensor (Vendor)	Method
E-M current meters (Marsh-McBirney, Inc.)	Calibrated over a range of 0 - 60 cm/sec in a recirculating water flume at Stanford University prior to and after each experiment. The reference speed is obtained by (1) laser - velocimeter, (2) pitot tube, (3) stop watch and neutrally buoyant floats. A short note is being prepared on this calibration procedure.
Nephelometer /transmissometer (Montedoro-Whitney Corp.)	Calibrated prior to and after each experiment in clear water and in water of carefully measured suspended sediment concentrations at constant temperature. Also checked for temperature dependence. Suspended sediment is usually material taken with cores at or near the experimental area.
Pressure transducer (Paroscientific)	Calibrated at the factory at 8 points. Checked at USGS at atmospheric and at 25 cm water pressures.
Temperature (thermistor) (Yellow Springs Inst. Co.)	Probes are calibrated at USGS using a controlled temperature bath, accurate to about $0.05^{\circ}C$, with a laboratory grade thermometer.
Rotor-vane (Bendix)	No dynamic calibration other than bench check-out of vane direction and rotor spin rate (compared to factory calibration). This check-out is done prior to each experiment.

A general estimate of the overall performance of each instrument will be given in the final report and in publications that result from this and previous work under RU 430.

Water samples are collected for suspended particulate matter analysis with 7-liter Van Dorn bottles. One liter aliquots are immediately drawn and filtered on board ship through preweighed 47 mm, 0.4 mm pore size Nuclepore polycarbonate filters. All samples are rinsed with 50 ml distilled water and placed in sealed plastic Petri dishes. The filters are weighed before and after collection on a Cahn model 4700 electrobalance.

The Martek transmissometer used on R/V SEA SOUNDER measures vertical profiles of light transmission (% transmission) and temperature.

The transmission measurements are converted to concentration of suspended materials by comparison with the suspended sediment concentration values obtained nearly concurrently with the profiling. This technique, although of low accuracy (about ±20% of measured values), gives good data on relative vertical changes.

VII. Deliverable Products:

A. Narrative reports will be completed that describe field methods and instrumentation, analytical methods, background information, and results based on work done under this research unit.

B. Visual data: We intend to submit maps and figures that show bottom sediment dynamics events, including sediment flux for preselected time periods and during high energy events.

VIII. Special Sample and Voucher Speciment Archival Plans: None

IX. Logistics Requirements: None

X. Anticipated Problems: None

XI. Information Required from Other Investigators:

A. Bouma/Hampton: We will utilize the data, as required, collected by Bouma and Hampton to aid our interpretation and analysis. We are working closely with them on this project.

B. PMEL (Charnell, Muench): We will need the current meter data taken by PMEL researchers at sites near our Geoprobe locations (Figure 1). We have already contacted the PMEL group (Muench) regarding this need; they are very cooperative.

XII. Activity/Milestone Chart: See attached.

XIII. Outlook:

This year is final close-out for our work in Lower Cook Inlet. A final report will be submitted within F.Y. 79. We propose in a companion proposal to initiate a small effort on the Kodiak shelf.

XIV. 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 be provided in the form and format specified by OCSEAP, accompanied by a data documentation form (NOAA 24-13).

6. Within 10 days of the completion of a cruise or data gathering effort, a ROSCOP data collection inventory form (NOAA24-23) will be submitted to the Project Data Manager.

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 for information and for forwarding to BLM. The release of such material within a period of less than sixty (6) 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 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."

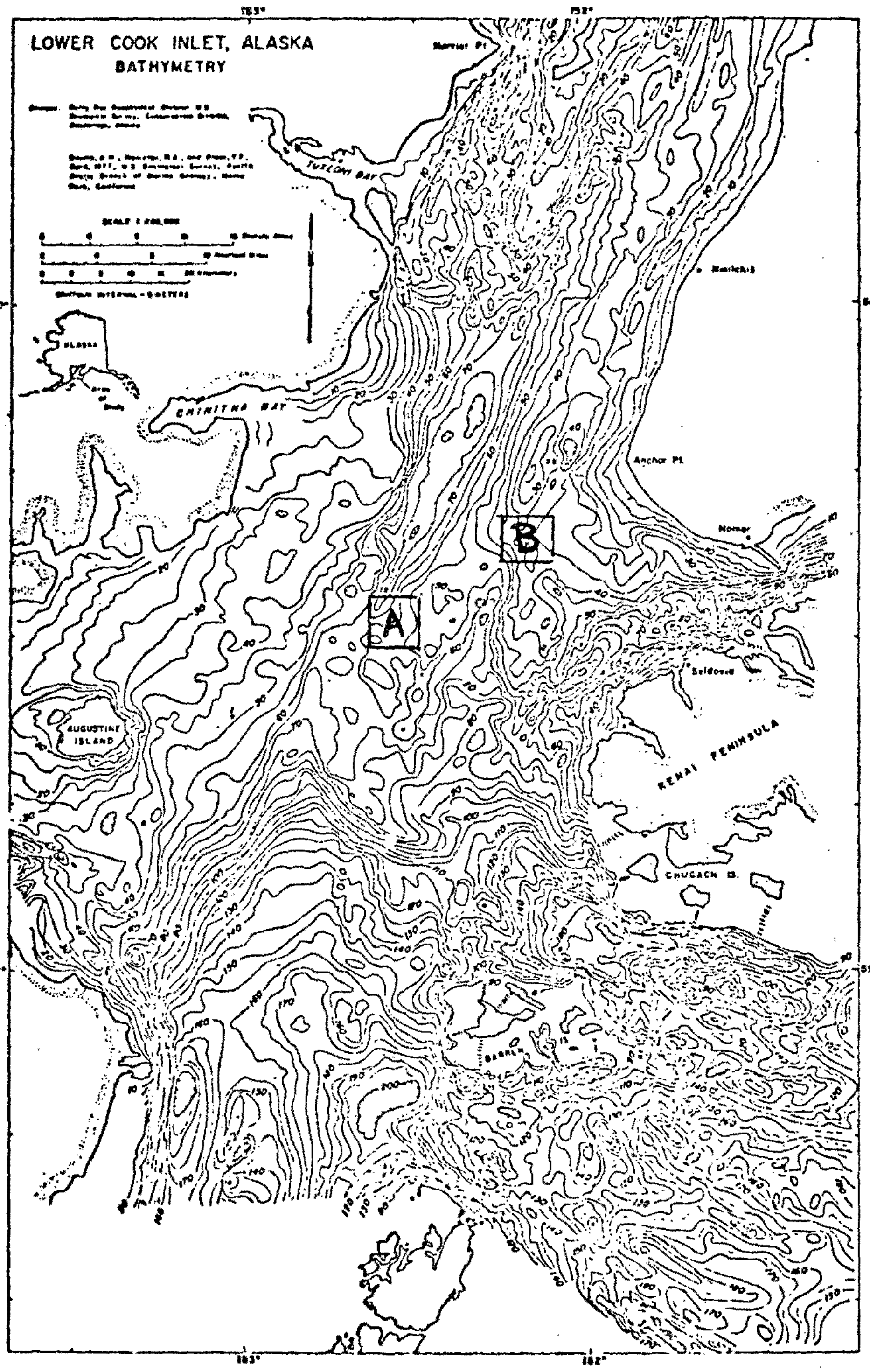


Figure 1.

A. Two GEOPROBE tripods

B. One GEOPROBE tripod

MILESTONE CHART

0 - Planned Completion Date

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

RU # 430 PI: Cacchione/Drake

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
Recovery - 1 Geoprobe (R/V SEA SOUNDER)	-0-														
Time series plots - Geoprobe data				-0-											
Time series analysis - Geoprobe data							-0-								
Bed shear profiles							-0-								
Grain size analysis							-0-								
Suspended sediment analysis							-0-								

Data Products Schedule

RU 430 - Cacchione/Drake, FY 79 (Cook Inlet)

Data Type (ie. 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 PI (Yes or No)	Collection Period (Month/Year to Month/Year)	Submission (Month/Year
Grain size analysis	Cards	10 spls	073	Yes*	Aug 1978	April 1979
GEOPROBE data	Tables & Graphic		--	Yes	Aug-Oct 1978	Jan 1979
Time series analysis of GEOPROBE data	Tables & graphic		--	Yes	Aug-Oct 1978	April 1979
Bed shear profiles	Graphic		--	Yes	Aug-Oct 1978	April 1979
Sediment flux values for GEOPROBE sites	Tables & graphic		--	Yes	Aug-Oct 1978	April 1979

*Graig McHendrie

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

RFx41-430-2556

FEB 27 1979

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

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

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

SUBJ : OCSEAP Research Unit 430.

REFS : (1) Juneau Project Office Ltr to Drs. Cacchione and Drake requesting renewal proposal dated May 22, 1978 (enclosed).
(2) Original Proposal dated June 27, 1978 (enclosed).
(3) Copy of project office internal comments on proposal (enclosed)
(4) Juneau Project Office Ltr to Drs. Cacchione and Drake, requesting revision to proposal dated October 26, 1978 (enclosed)
(5) Revised renewal proposal, dated February 2, 1979 (enclosed).

Required Acceptance Letter for RU 430
Drs. Cacchione and Drake

The enclosed revised FY 79 renewal proposal for RU 430, entitled "Bottom and Near-Bottom Sediment Dynamics in Lower Cook Inlet", has been reviewed by the Juneau Project Office and judged acceptable at the funding level of $24,750, (includes $2,250 for USGS overhead @ 10%. Please send an acceptance letter to Drs. Cacchione and Drake and initiate funding procedures for this amount.

Enclosures: refs 1 - 5 (above)

To: Outer Continental Shelf Environmental Assessment Program
Bering Sea - Gulf of Alaska Project Office
P.O. Box 1808
Juneau, Alaska 99802

Proposal Date: September 1978
Contract #: 03-6-022-35249
NOAA Project #:
Institution ID#: 95-1958142

FY 1979 RENEWAL PROPOSAL

Research Unit Number 435

TITLE: MODELING OF TIDES AND CIRCULATIONS OF THE BERING SEA (PHASE III)

Cost of Proposal:

Lease Areas: St. George-Bristol Bay 10%
Norton Sound 90%

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

PRINCIPAL INVESTIGATORS:

Name J. J. Leendertse Date Sept 11, 1978
Signature J Leendertse
Address 1700 Main St., Santa Monica 90406
Telephone (213) 393-0411, Ext. 523

Name S. K. Liu Date Sept 11 1978
Signature ShKiyLiu
Address 1700 Main St., Santa Monica 90406
Telephone (213) 393-0411, Ext. 7882

INSTITUTION:

The Rand Corporation

ORGANIZATION APPROVAL:

Name J. S. King, Jr. Date September 14, 1978
Signature [signature]
Position Treasurer
Address 1700 Main St., Santa Monica 90406
Telephone (213) 393-0411, Ext. 251

(3) TECHNICAL PROPOSAL

I. Title: MODELING OF TIDES AND CIRCULATIONS OF THE BERING SEA (PHASE III)
Research Unit Number: 435
Contract Number: 03-6-022-35249
Proposed Dates of Contract: October 1, 1978 through September 30, 1979

II. Principal Investigators

Jan J. Leendertse
Shiao-Kung Liu

III. Cost of Proposal

FY1979

A. Science

B. Logistics

C. Total

D. Distribution of Effort by Lease Area

10% St. George-Bristol Bay lease area

90% Norton Sound lease area

IV. Background

(a) Progress up to time of proposal submittal

In Phase I of the study, which was performed in the period of September 1, 1976 - September 30, 1977, two three-dimensional models were set up, a model of Bristol Bay and a Norton Sound model. These models are finite difference models based upon model developments sponsored by the Office of Water Research and Technology of the U.S. Department of the Interior.

The main fluid flow processes are computed on a three-dimensional grid system. On this grid system two momentum balance equations are computed, as well as balance equations for salinity and temperature, equations representing the conservation of the fluid mass and an equation of state. Since fluid motions occur in scales much smaller than the finite distances we are using in the grid representation, the model formulation contains subgridscale mass and momentum exchanges.

Because of the rather complicated open boundary conditions of the model, we needed to modify the available program to allow for interpolation of data between given boundary points. We also introduced a method for computing the vertical exchange coefficients based upon turbulence theory and we prepared programs for graphical representation of results. At the end of Phase I the models were becoming operational. The first experimental results are reported in WN-9987-NOAA, "The Bristol Bay and Norton Sound Models--A Progress Report."

In the second phase of the study, now underway, we started experiments based upon field data, and we extended the capabilities of graphical representation of results.

The field data of Bristol Bay, analyzed by PMEL, indicated interesting vertical salinity and density and current structures which were not completely understood.

In order to assist in the analysis, the vertical resolution of the model was increased to a maximum of 15 layers. Simultaneously, the alignment of the Bristol Bay model was changed to make better use of the available field data.

Since one of the main features of the model is that the turbulence intensity is modeled, we obtained considerable insight into the main processes. Turbulence generated at the bottom disperses upward; turbulence generated at the surface by wind disperses downward. The vertical momentum and mass exchanges are dependent on the turbulence intensity and the Richardson number. A description of the model giving its characteristics is presented in Appendix A.

Presently we are adjusting the parameters of the turbulence model, which naturally also have an effect upon computed tides. In Appendix B results of a simulation are presented and comparisons given between observed and computed tidal charts. The agreement is already good.

(b) Relation to other studies

In general, it can be said that the purpose of a model is its use as an aid in explaining or understanding a system and/or as a tool of prediction. In the present state of the research we are adjusting the model, and the research contributes considerably to explaining and understanding the fluid flow system in Bristol Bay. From the model results it is possible to determine exchanges, rates, etc. which cannot be measured directly, thus the project contributes considerably to the analysis of the physical processes in the considered areas. This contribution will likely increase during experimentation, for example, effects of winds can be separated from tidal effects.

The field investigations are the basis of our modeling work, as they provide boundary and initial values, and the data obtained from PMEL are highly valued. In addition, field data is used to adjust and verify the models.

As model data and field data are in many respects complementary, and this data is now becoming available for analysis, it is not surprising that PMEL oceanographic studies and Rand modeling work are becoming increasingly better coordinated.

(c) Relation of previous work to proposed work

The proposed work is a direct continuation of present ongoing modeling investigations. At the end of the present contract (September 1978) we expect that the Bristol Bay model will be adjusted and that some responses of currents and water levels to wind field will be determined.

In the proposed research effort the modeling work will be extended toward development and application of prediction techniques based upon model results, and the continuation of model experimentation in support of the analysis of the physical oceanography of the considered areas.

V. Objectives

(a) Long-range Objectives

The long-range objectives of the modeling studies are:

(1) To provide data for the Outer Continental Shelf Petroleum Development of the Bristol Bay area and the Norton Sound area from which the main physical processes can be determined which are important for determining impacts and risk of oil extracting and processing facilities.

(2) To provide a method for estimating the time-varying location of contaminants released in the Bristol Bay and Norton Sound areas. The data generated by this method are intended to be used for pollution event countermeasures.

(b) Objectives of the Proposed Study in the 1979 fiscal year (Phase III)

To accomplish the above-mentioned long-range objectives, the proposed study for FY1979 will have the following objectives for the Norton Sound area:

(1) Adjust and verify the three-dimensional simulation model for summer conditions on the basis of data collected in FY1978 (June-July 1978).

(2) Develop ice movement model and incorporate ice movement model and fixed icefield representation into three-dimensional simulation model and adjust and verify the combined model on available data.

(3) Develop current and water level responses to wind fields.

(4) Develop and verify trajectory prediction model.

The proposed study for FY1979 will have the following objectives for the Bristol Bay area:

(1) Determine additional current in water level responses to wind fields.

(2) Document and report on the experiments with the Bristol Bay area model. The report will include the verification of the model.

VI. Strategy and Approach

(a) Research and Development Work

1. Ice Model

The mathematical model the investigators intend to use to compute the response of the ice cover to driving forces is based upon consideration of the change in momentum in the horizontal plane by the wind stress at the upper surface, the stress at the ice-water interface, Coriolis force, internal ice stresses and the sea surface tilt.

Initially we intend to neglect the internal stresses on the basis that the ice contains fractures and cannot support stresses. The momentum equation for the ice can then be written in finite difference form.*

$$\overline{\delta_t(\overline{H}^x u)}^t = \underset{(1)}{-\delta_x\left(\overline{\overline{H}^x u}^x\,\overline{u}^x\right)} \underset{(2)}{-\delta_y\left(\overline{\overline{H}^y v}^x\,\overline{u}^y\right)} \underset{(3)}{+f\overline{H}^x\overline{v}^{xy}} \underset{(4)}{-\frac{1}{\overline{\rho}^x}\overline{H}^x\delta_x p}$$

$$+\frac{1}{\overline{\rho}^x}\left[\underset{(5)}{C^*\rho_a W_a^2\sin\psi} \underset{(6)}{-\left(E_x\delta_z\overline{u}^{2t}\right)_{k=3/2}} \underset{(7)}{+\delta_x\left\{HA_x\delta_x u\right\}_-} \underset{(8)}{+\delta_y\left\{\overline{\overline{H}^x\overline{A_y}^x}^y\,\delta_y u\right\}_-}\right]$$

at $i+\frac{1}{2}$, j, 1, n

$$\overline{\delta_t(\overline{H}^y v)}^t = \underset{(1)}{-\delta_x\left(\overline{\overline{H}^x u}^y\,\overline{v}^x\right)} \underset{(2)}{-\delta_y\left(\overline{\overline{H}^y v}^y\,\overline{v}^y\right)} \underset{(3)}{-f\overline{H}^y\overline{u}^{xy}} \underset{(4)}{-\frac{1}{\overline{\rho}^y}\overline{H}^y\delta_x p}$$

$$+\frac{1}{\overline{\rho}^y}\left[\underset{(5)}{C^*\rho_a W_a^2\cos\psi} \underset{(6)}{-\left(E_y\delta_z\overline{v}^{2t}\right)_{k=3/2}} \underset{(7)}{+\delta_x\left\{\overline{\overline{H}^y\overline{A_x}^y}^x\,\delta_x v\right\}_-} \underset{(8)}{+\delta_y\left(HA_y\delta_y v\right)_-}\right]$$

at i, $j+\frac{1}{2}$, 1, n

where
- H = local ice thickness
- u = ice velocity in x direction
- v = ice velocity in y direction
- C^* = wind stress coefficient
- ρ_a = density of air
- ρ = density of ice
- W_a = wind speed
- ψ = wind angle from the y coordinate
- f = Coriolis force term

*Our model formulation is based upon consideration of finite distances, consequently we are writing directly in the finite difference form.

In these momentum equations we have on the left side of the equal sign the change in momentum. The first two terms on the right are the advection terms, the third term is the Coriolis force term, the fourth term the pressure term, and the fifth the wind stress term.

The sixth term represents the momentum transfer to the flowing water underneath the ice, and the last two terms give a rough approximation of shear.

With the last two terms we are able to couple part of the ice field to land by use of very high horizontal momentum exchange terms or represent a certain area with unbroken thick ice coverage. In the latter case we have then assumed that in these areas the ice does not elastically or plastically reform.

Conform the bottom stress of a fluid flow model, and the momentum exchange coefficient at the bottom of the ice can be expressed:

$$E_x = \rho g\left(\overline{h}^z\right)^2 \left\{\left(\delta_z u\right)_-^2 + \left(\delta_z \overline{v}^{xy}\right)_-^2\right\}^{\frac{1}{2}} \Big/ \left(C_s\right)^2$$

at i+½, j, l, n

$$E_y = \rho g\left(\overline{h}^z\right)^2 \left\{\left(\delta_z \overline{u}^{xy}\right)_-^2 + \left(\delta_z v\right)_-^2\right\} \Big/ \left(C_s\right)^2$$

The formulation of the flow, as presented in Appendix A, has now to be changed if computations together with the ice are made. The changes are only in the top water layer, which now becomes layer 2. The wind stress at the top is now replaced by the stress of the ice moving relative to the water as described above. Also, the pressure gradient computation has now to account for the ice on the surface.

In the subgridscale energy equation, the generation of the energy in the upper water layer is now caused by the differential velocity of water and ice.

By constructing the ice model in much the same way as the representation of the fluid, we expect to reduce the programming effort considerably and also prevent many of the stability problems inherent in this type of numerical simulation.

During the development effort we intend to obtain estimates of the errors induced in the above-described model due to the omission of the internal deformations of the ice.

In our modeling effort we will direct our attention to modeling the fluid flow from which these transports of pollutants can be derived. This will be in contrast with modeling efforts in the AIDJEX project, which were directed toward behavior of the ice fields. From a cursory review of work performed in the above-mentioned scientific project, we have the impression that incorporation of deformation of the ice field due to stresses in the simulation would result in a more complete ice behavior model than was developed in AIDJEX.

2. Development of Trajectory Model

From model experiments with the Bristol Bay model with tides and with winds of certain directions and intensities, and from the same experiments without wind, it will be possible to find the time-varying responses due to wind alone for the top layer of the model. These responses are obtained by subtracting the time-varying velocities of the simulation without wind from the one with wind. We intend to use a constant wind field with a duration of 12 hours, running the simulations until the effect of wind has disappeared after the wind effect has been turned off.

Once we have determined the responses to wind fields of different intensities and directions, we are able to estimate the velocities of that layer for other directions at particular points in the field for winds of longer durations and other intensities by the use of convolution. We will be making the assumption that a linear relation exists between the square of the wind velocity and the speed of the current.

From the simulations with and without wind we will store on disk the hourly value of the current components at each point of the grid (or every other point in each direction). The estimate of a velocity caused by the square of the wind velocity component is then obtained by adding the individual responses for each 12-hour period, as shown in Fig. VI.1. Each wind component causes responses in the flow field in two directions (E-W and W-S). By combining the current components we are able to construct the velocity history at the point under consideration.

The computational procedures are simple and fast, as only additions and multiplications are involved.

Computation of the flow field under the influence of the tide alone will establish the tide-generated residual currents. These results, together with the results of convolution, permit computation of the movements in the top layer, which should be comparable with the movements of a drogue without the effect of the tidal excursions.

To compute the movement of a surface pollutant, we need to compute the surface speed in relation to the movement of the

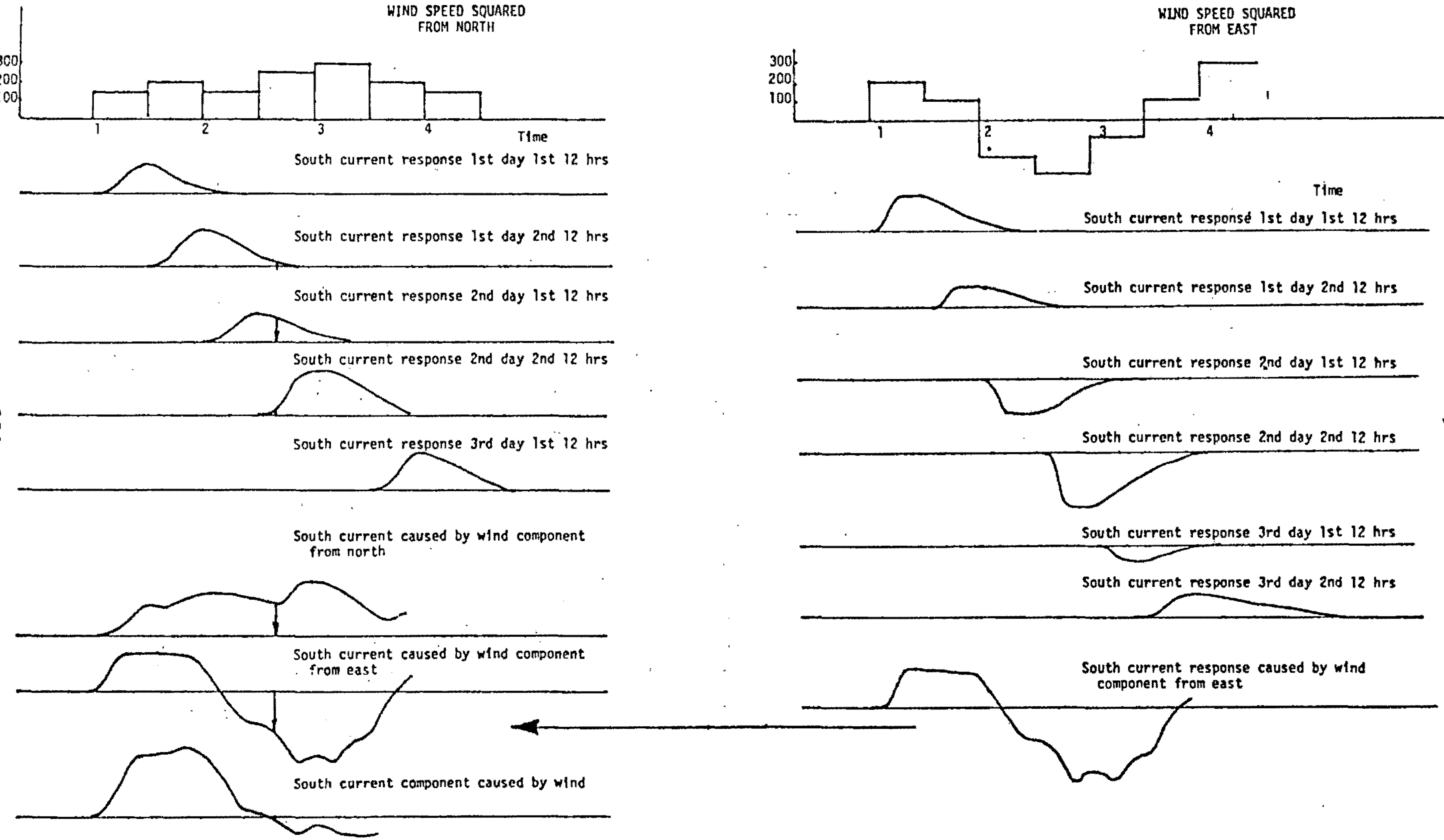


Fig. VI.1--Schematic of the computation of the south current component from the wind components by use of response functions top layers. We will investigate two approaches, namely, (1) using a response function approach as described above for the movement of the top layer, except that here the relative movement of the layer is computed by an exponential extrapolation of the response of the three top layers in the three-dimensional model; and (2) alternatively, a model based upon a simple analytical model relating wind speed and direction to the relative movement of water surface particles. During the investigation the choice of method will be made.

It is planned that at the end of FY79 a trajectory computation model for surface pollutants will be available of the Norton Sound area which can be used on a computer with limited capacity.

Based upon the same principle, a trajectory model can be developed for a suspended particle. This would be of particular interest in case of ice cover.

3. Adjustment and Verification of the Norton Sound Model

For the studies of the Norton Sound area, it is assumed that bottom pressure data will become available at the boundaries of the model in the beginning of 1979. These data will be collected this summer (1978).

These data will be the inputs for the model adjustment and verification experiments. It is planned that at the end of FY79 the Norton Sound model will be verified as to tide and wind and density effects.

As a result of the insight obtained into the physical processes by the modeling work for Bristol Bay and the field studies by PMEL, it is planned to modify the model in one particular aspect. As described in Appendix A, we have been using a functional relationship between the vertical exchange coefficients for mass, heat and momentum exchanges and the Richardson number according to the expressions introduced by Mamajev. It now appears that the simulations provide in principle sufficient information to also compute this relationship by considering the loss of turbulent energy (subgridscale energy) by the work done in mixing the heavier lower layers with the lighter upper layers. This modification is not very extensive.

(b) <u>Progress Control</u>

Every fourteen days the principal investigators receive extended budget information as to expenditures over the last fourteen days and on the project as a whole up to that date. Comparisons are also given with the planned expenditures. Very detailed information is also provided fortnightly on computer expenditures as to computation times, log-ons, and terminal times of all personnel involved. Generally speaking, very detailed budget control information is available to the principal investigators. We also graph the progress of expenditures.

VII. Deliverable Products

B. Narrative Reports

We intend to publish the results of the Bristol Bay study as a Rand Report entitled, *A Three-Dimensional Model for Estuaries and Coastal Seas: Vol. VI, Bristol Bay Simulation*. The report will be the sixth volume of a report series on the development of a three-dimensional model in which the authors intend to show the accuracy and capabilities of their model developments. The report will show the general circulation computed with the model, the computed vertical and horizontal water movements, and comparisons with field data.

Near the end of the project period we plan to report the research and development results of the Norton Sound studies in a Working Note to disseminate the study results in NOAA.

C. Visual Data

The computer programs which are used in this research are producing graphical representations of flow and density fields, etc. on microfilm. Enlargements of maps produced in this manner, such as shown in Appendix B, can be enlarged to appropriate scales on Mylar to conform with OCSEAP standardized reporting procedures. Before such maps are produced we will consult the Project Office.

VIII. Archival Plans: (None)

IX. Logistics Requirements: (None)

X. Anticipated Problems

The complexity of the coupled ice flow model will cause a major programming problem which will require considerable time for debugging. However, the complexity is not considered greater than the subgridscale energy model. In our budget estimates we have made considerable allocations for this phase of the development effort.

As presently conceived, the ice retains its thickness over the period of simulation. Since the ice is advected, with the formulation described earlier, we do not exactly maintain its mass. We will make an assessment of the errors caused by this, and if they appear of significance then we will consider introducing a variable thickness and use of a conservation equation for the ice mass.

A major problem we expect in the simulations of Norton Sound is instabilities in the computation near the boundary. These instabilities occur when the boundaries are ill-posed by our interpretation of the field data, or by the assumptions we make if such data is not available from the field data collection program.

If such conditions occur, the cause has to be analyzed and boundary modifications have to be made. This process can be time-consuming, costly and frustrating!

Of concern are boundary data for the adjustment and verification of the coupled ice-flow model of Norton Sound. Presently we do not have a good overview of data availability, but we intend to pursue that matter following the OCSEAP project meeting in mid-October.

The development of the coupled ice-flow model is considered by the investigators to be a research effort of considerable difficulty. We are far at the frontiers in simulating these complex geophysical fluid dynamics processes. The proposal is based upon our best estimates, extrapolated from similar efforts in preceding years in our long career of model building.

XI. Information Required from Other Investigators

For the Norton Sound model pressure data will be collected by PMEL for a period of not less than 14 days at the following stations:

Station Number	Latitude	Longitude
N1	62°30'N	166°07'W
N2	63°12'N	168°35'W
N3	64°00'N	168°00'W
N4	64°46'N	166°50'W

This field work and the analysis thereof has been coordinated with Dr. Charnell. Since we have used with success similar data from PMEL in the model investigations of Bristol Bay, we do not expect any difficulties in the use of this data.

In the model adjustment we expect also to use extensively current and density data already collected and readily available at PMEL.

We will require similar data for winter conditions. The data requirements will be discussed at the OCSEAP project meeting in October 1978.

XII. ACTIVITY MILESTONE CHART

RU#: 435

PI: J. J. Leendertse and S. K. Liu

MAJOR MILESTONES	1978 S	O	N	D	1979 J	F	M	A	M	J	J	A	S	O	N	D
System Development																
Improvement energy model	--	Δ														
Development ice-flow model	--	--	--	Δ												
Development supporting system for data input and representation	--	--	--	--	Δ											
Prepare trajectory drawing program			--	--	--	Δ										
Testing trajectory program						--	--	--	Δ							
Norton Sound																
Prepare tide boundary					--	Δ										
Adjust model for ice-free condition						--	--	Δ								
Determine wind responses								--	--	Δ						
Test trajectory program										--	--	Δ				
Adjust coupled ice-flow model											--	--	Δ			
Prepare Working Note												--	Δ			
Bristol Bay																
Drafting report	--	Δ														
Publication		--	--	--	Δ											

XIII. Outlook

At the end of the fourth phase of the study to be performed in FY1980 we plan to have developed, tested and evaluated an effective and rapid way to determine oil spill pathways in the Bristol Bay and Norton Sound areas. Reports describing the models, the experiments and comparisons with field data will be prepared. Documentation of the computer programs will be prepared.

In the fourth phase of the study we plan to finish the wind response with the model of Norton Sound under ice conditions. Subsequently we plan to compute general circulations in Norton Sound and Bristol Bay, around December 1979. In the beginning of 1980 we plan to make the trajectory program evaluations for both areas, with the trajectories to be computed on the basis of wind response, general circulation and spread of pollutants. This work should be finished mid-summer 1980, with the remainder of that project year to be used for documentation and report writing.

The cost of the fourth phase is estimated at $120,000. The total cost over FY1978, 1979 and 1980 would then be $454,770. This is $77,920 above our estimate in August due to the increased effort by incorporation of ice in the project in this proposal.

We do not yet know if additional field efforts will be required for the adjustment of the coupled ice-flow model. For the adjustment of the Norton Sound model without ice we expect that the data which are presently being collected will be sufficient. There are no logistics requirements.

XIV. Standard Statements

The following standard statements are included in this proposal:

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 are due by April 1. The Final Report will be submitted within 90 days after the expiration of the contract.

3. 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.

4. 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.

5. 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."

Appendix A

METHOD OF COMPUTATION OF THE THREE-DIMENSIONAL MODEL USED FOR THE BRISTOL BAY AND NORTON SOUND MODELS

The finite difference equations used in the models are very similar to those described in Refs. 1 and 2. In addition to salinity and temperature, constiuents and SGS energy are now also computed. If one constituent is computed, then the model simultaneously solves seven partial differential equations together with an equation of state for various complicated boundary conditions.

The expressions for the equations of momentum and mass balance have been changed from those described in Refs. 1 and 2, but their location on the grid is unchanged (Fig. 1). The terms with the vertical exchange coefficients are now computed implicitly rather than explicitly. Consequently, all concentrations, momentum components and SGS energy values are computed simultaneously for each series of points in a vertical. This computation method eliminated stability conditions related to the value of the exchange coefficients.

The continuity equation, the mass, momentum and SGS energy balance equations for the interior of the water body and the equation of state are:

$$\overline{\delta_t \zeta}^t = - \sum_k \left\{ \delta_x (\overline{h}^x u) + \delta_y (\overline{h}^y v) \right\} \qquad \text{at } i,\ j,\ n \qquad (1)$$

$$\overline{\delta_t (\overline{h}^x u)}^t = - \delta_x (\overline{\overline{h}^x u\ \overline{u}^x}^x) - \delta_y (\overline{\overline{h}^y v\ \overline{u}^y}^x) - \overline{h}^x \delta_z (\overline{\overline{u}^z w}^x) + f \overline{\overline{h}^x \overline{v}^x}^y - \frac{1}{\overline{\rho}^x} \overline{h}^x \delta_x p$$

$$+ \frac{1}{\overline{\rho}^x} \left[h \delta_z E_x \delta_z \overline{u}^{2t} + \delta_x \left\{ h A_x \delta_x u \right\}_- + \delta_y \left\{ \overline{\overline{h}^x \overline{A_y}^x}^y \delta_y u \right\}_- \right] \qquad \text{at } i + ½,\ j,\ k,\ n$$

(2)

$$\overline{\delta_t(\overline{h}^y v)}^t = -\delta_x(\overline{\overline{h}^x u}^y \overline{v}^x) - \delta_y(\overline{\overline{h}^y u}^y \overline{v}^y) - \overline{h}^y \delta_z(\overline{v}^z \overline{w}^y) - f\overline{h}^y \overline{u}^{xy} - \frac{1}{\overline{\rho}^y}\overline{h}^y \delta_y p$$

$$+\frac{1}{\overline{\rho}^y}\left[h\delta_z E_y \delta_z \overline{v}^{2t} + \delta_x\left\{\overline{\overline{h}^y A_x}^x \delta_x v\right\}_- + \delta_y\left\{hA_y \delta_y v\right\}_-\right] \quad \text{at } i,\ j+\tfrac{1}{2},\ k,\ n \qquad (3)$$

$$\overline{\delta_t(hs)}^t = -\delta_x(\overline{h}^x u \overline{s}^x) - \delta_y(\overline{h}^y v \overline{s}^y) - h\delta_z(w\overline{s}^z)$$

$$+\delta_x\left\{\overline{h}^x D_x \delta_x s\right\}_- + \delta_y\left\{\overline{h}^y D_y \delta_y s\right\}_- - h\delta_z\left\{\kappa\delta_z \overline{s}^{2t}\right\}$$

$$\text{at } i,\ j,\ k,\ n \qquad (4)$$

$$\overline{\delta_t(hT)}^t = -\delta_x(\overline{h}^x u \overline{T}^x) - \delta_y(\overline{h}^y v \overline{T}^y) - h\delta_z(w\overline{T}^z)$$

$$+\delta_x\left\{\overline{h}^x D_x \delta_x t\right\}_- + \delta_y\left\{\overline{h}^y D_y \delta_y T\right\}_- + h\delta_z\left\{\kappa' \delta_z \overline{T}^{2t}\right\}$$

$$\text{at } i,\ j,\ k,\ n \qquad (5)$$

$$\overline{\delta_t(he)}^t = -\delta_x(\overline{h}^x u \overline{e}^x) - \delta_y(\overline{h}^y v \overline{e}^y) - h\delta_z(w\overline{e}^z)$$

$$+\delta_x\left\{\overline{h}^x D_x \delta_x e\right\}_- + \delta_y\left\{\overline{h}^y D_y \delta_y e\right\}_- + h\delta_z\left\{E_e \delta_z \overline{e}^{2t}\right\}$$

$$+ S - Dh \qquad \text{at } i,\ j,\ K,\ n \qquad (6)$$

$$\overline{\delta_t(hP)}^t = -\delta_x(\overline{h}^x u \overline{P}^x) - \delta_y(\overline{h}^y v \overline{P}^y) - h\delta_z(w\overline{P}^z)$$

$$+\delta_x\left\{\overline{h}^x D_x \delta_x P\right\}_- + \delta_y\left\{\overline{h}^y D_y \delta_y P\right\}_- + h\delta_z\left\{\kappa\delta_z \overline{P}^{2t}\right\} + S_P$$

$$\text{at } i,\ j,\ K,\ n \qquad (7)$$

$$\rho = \left[5890 + 38T - 0.375T^2 + 3s\right] \Big/ \left[\left(1779.5 + 11.25T - 0.0745T^2\right) - \left(3.8 + 0.01T\right)s + 0.698\left(5890 + 38T - 0.375T^2 + 3s\right)\right] \quad \text{at } i, j, k, n+1 \tag{8}$$

The finite-difference equation used to compute the vertical velocities is

$$\delta_z w = -\,\delta_x\left(\overline{h}^x u\right) - \delta_y\left(\overline{h}^y v\right) \quad \text{at } i, j, k, n+1 \tag{9}$$

This equation gives directly the velocities by starting the computation at the bottom layer (K). At the bottom the velocity is zero, thus the velocity between the bottom layer and the layer above can be computed. This velocity (at K - ½) in turn can be used for the application of Eq. (9) and K - 1.

The horizontal pressure gradients in the top layer are:

$$\delta_x p = g\overline{\rho}^x \delta_x \zeta + \tfrac{1}{2}\,\overline{h}^x \delta_x \rho \quad \text{at } i+\tfrac{1}{2}, j, 1, n+1 \tag{10}$$

$$\delta_y p + g\overline{\rho}^y \delta_y \zeta + \tfrac{1}{2}\,\overline{h}^y \delta_y \rho \quad \text{at } i, j+\tfrac{1}{2}, 1, n+1 \tag{11}$$

Once these pressure gradients are known, then the gradients for the other layers are computed with increasing k by use of

$$\delta_z(\delta_x p) = g\delta_x \overline{\rho}^z \quad \text{at } i+\tfrac{1}{2}, j, k+\tfrac{1}{2}, n+1 \tag{12}$$

$$\delta_z(\delta_y p) = g\delta_y \overline{\rho}^z \quad \text{at } i, j+\tfrac{1}{2}, k+\tfrac{1}{2}, n+1 \tag{13}$$

THE EQUATIONS FOR THE TOP AND BOTTOM LAYERS

In the top layer, the momentum equations now contain the effect of the surface wind, and the equations are now written

$$\overline{\delta_t(\overline{h}^x u)}^t = -\delta_x(\overline{\overline{h}^x u}^x\,\overline{u}^x) - \delta_y(\overline{\overline{h}^y v}^x\,\overline{u}^y) - \overline{h}^x\delta_z(\overline{u}^z\overline{w}^x) + f\overline{h}^x\overline{v}^{xy} - \frac{1}{\overline{\rho}^x}\overline{h}^x\delta_x p$$

$$+\frac{1}{\overline{\rho}^x}\left[C^*\rho_a w_a^2 \sin\psi - \left(E_z\delta_z\overline{u}^{2t}\right)_{k=3/2} + \delta_x\left\{hA_x\delta_x u\right\}_- + \delta_y\left\{\overline{\overline{h}^x A_y}^{x\,y}\delta_y u\right\}_-\right]$$

at $i+\frac{1}{2}, j, 1, n$ (14)

$$\overline{\delta_t(\overline{h}^y v)}^t = -\delta_x(\overline{\overline{h}^x u}^y\,\overline{v}^x) - \delta_y(\overline{\overline{h}^y v}^y\,\overline{v}^y) - \overline{h}^y\delta_z(\overline{v}^z\overline{w}^y) - f\overline{h}^y\overline{u}^{xy} - \frac{1}{\overline{\rho}^y}\overline{h}^y\delta_y p$$

$$+\frac{1}{\overline{\rho}^y}\left[C^*\rho_a w_a^2 \sin\psi - \left(E_y\delta_z\overline{v}^{2t}\right)_{k=3/2} + \delta_x\left\{\overline{\overline{h}^y A_x}^{y\,x}\delta_x v\right\}_- + \delta_y\left\{hA_y\delta_y v\right\}_-\right]$$

at $i, j+\frac{1}{2}, 1, n$ (15)

where C^* = wind coefficient

ρ_a = density of air

w = wind speed

If it is assumed that no mass and temperature exchanges occur at the surface, then Eqs. (4), (5) and (8) are also applicable if the vertical exchange term is set to zero. Equation (6) is also valid for the subgridscale energy if no wind is present. If wind is present, then the subgridscale energy level is maintained by use of a special equation, which will be described later.

At the bottom layer, the momentum equations become:

$$\overline{\delta_t(\overline{h}^x u)}^t = -\delta_x(\overline{\overline{h}^x u}^x\,\overline{u}^x) - \delta_y(\overline{\overline{h}^y v}^x\,\overline{u}^y) - \overline{h}^x\delta_z(\overline{u}^z\overline{w}^x) + f\overline{h}^x\overline{v}^{xy} - \frac{1}{\overline{\rho}^x}\overline{h}^x\delta_x p$$

$$+\frac{1}{\overline{\rho}^x}\left[\left(E_z\delta_z\overline{u}^{2t}\right)_{k=K-\frac{1}{2}} - \overline{\rho}^x g u_-\left\{u_-^2 + (\overline{v}_-^{xy})^2\right\}^{\frac{1}{2}}\Big/\left(\overline{C}^x\right)^2 + \delta_x\left\{hA_x\delta_x u\right\}_- + \delta_y\left\{\overline{\overline{h}^x A_y}^{x\,y}\delta_y u\right\}_-\right]$$

at $i+\frac{1}{2}, j, K, n$ (16)

$$\overline{\delta_t(\overline{h}^y v)}^t = -\delta_x(\overline{\overline{h}^x u}^y \overline{v}^x) - \delta_y(\overline{\overline{h}^y v}^y \overline{v}^y) - \overline{h}^y \delta_z(\overline{v}^z \overline{w}^y) - f\overline{h}^y \overline{u}^{xy} - \frac{1}{\overline{\rho}^y} \overline{h}^y \delta_y p$$
$$+ \frac{1}{\overline{\rho}^x} \left[\left(E_y \delta_z \overline{v}^{2t} \right)_{k=K-\frac{1}{2}} - \overline{\rho}^y g v_- \left\{ (\overline{u}_-^{xy})^2 + v_-^2 \right\}^{\frac{1}{2}} \Big/ \left(\overline{C}^y\right)^2 + \delta_x \left\{ \overline{\overline{h}^y A_x}^x \delta_x v \right\}_- + \delta_y \left\{ h A_y \delta_y v \right\}_- \right]$$

at $i, j + \frac{1}{2}, K, n$ (17)

At the bottom no sources or sinks exist for constituents and temperature, thus Eqs. (4), (5) and (7) are valid, provided that the exchange terms at the bottom are set to zero. The subgridscale energy is not diffused out of the bottom layer, thus the vertical energy exchange coefficient can be set locally zero. However, SGS energy is generated at the bottom, as will be described later.

VERTICAL EXCHANGE COEFFICIENTS

For the vertical exchange coefficients in the model we make use of concepts independently introduced by Kolmogorov [3] and Prandtl [4]. According to these hypotheses, the turbulent eddy viscosity (ε) in a homogeneous fluid is directly related to the local energy:

$$\varepsilon = L\sqrt{e} \tag{18}$$

where e is the kinetic energy per unit mass associated with turbulent fluctuations and L is a length scale.

In the model, the turbulent energy, thus the energy which is not represented by the computed (mean) flows in the grid system, is computed as a constituent (SGS energy). Consequently, the eddy viscosity can be computed by use of Eq. (18), provided that we have values for the length scale.

If vertical density differences exist, the exchange terms also become a function of the turbulent Richardson number (Ri). Consequently, we can write for the vertical momentum exchange coefficient:

$$E = L\sqrt{e}\ f(Ri) \tag{19}$$

The turbulent Richardson number is expressed as

$$Ri = -\frac{g}{\rho}\frac{\partial\rho/\partial z}{e}L^2 \tag{20}$$

where ρ = density of the fluid.

In the finite difference model, the exchange coefficients can be expressed in many different ways. We are using a space staggered grid, with the pressure, salinity, temperature and SGS energy computed at integer values (i,j,k) of the orthogonal grid (Fig. 1). The momentum exchange coefficients are located at the interface of two layers between two horizontal velocities, as indicated in Fig. 2. As the locations at which the SGS energies are computed do not coincide with the location of the momentum exchange coefficients, averages of energy values at adjacent points have to be used. The expression for the vertical exchange coefficient in the momentum equation in X direction is:

$$E_x = \overline{\rho}^{xz}\,\overline{L\sqrt{e_-}}^{xz}\ \exp\left[m\,\frac{g}{\overline{\rho}^{xz}}\,\frac{(\overline{L}^z)^2\delta_z(\overline{\rho}^x)}{\overline{e_-}^{xz}}\right] \tag{21}$$

The exponential term in this equation describes the Richardson number dependency. It will be noted that the energy and the length scale are introduced in order to avoid the use of mean velocity data. The latter would not reflect the intensity of turbulence, as we are dealing with nonsteady flow.

No negative sign appears in the experimental terms as the Z axis is taken positive upward. The SGS energy is used at a lower time level than the other terms in the equation. This appeared to be necessary for stability. Similarly, the expression for the vertical exchange in the momentum equation in the Y direction is:

$$E_y = \overline{\rho}^{yz}\,\overline{L\sqrt{e_-}}^{yz}\ \exp\left[m\,\frac{g}{\overline{\rho}^{yz}}\,\frac{(\overline{L}^z)^2\delta_z(\overline{\rho}^y)}{\overline{e_-}^{yz}}\right] \tag{22}$$

where m = a constant.

The mass exchange coefficients are computed at a different location, namely, at the layer interface between the points where the concentrations are computed, as shown in Fig. 3.

Consequently, the expression for the mass-exchange coefficient is somewhat different than the momentum exchange coefficients. In the model we are using:

$$\kappa = a_4 \overline{L\sqrt{e_-}}^z \exp\left[r \frac{g}{\overline{\rho}^z} (\overline{L}^z)^2 \frac{\delta_z \rho}{\overline{e}_-^z} \right] \tag{23}$$

where r = a constant.

A factor a_4 appears in this formula, as the mass exchange is not the same as the momentum exchange.

The subgridscale energy is transported in a similar manner as the transport of constituents, thus the energy exchange coefficient can be written in the same form as the mass exchange.

$$E_e = a_1 \overline{L\sqrt{e_-}}^z \exp\left[m \frac{g}{\overline{\rho}^z} (\overline{L}^z)^2 \frac{\delta_z \rho}{\overline{e}_-^z} \right] \tag{24}$$

For the length scale L which appears in all the exchange coefficients, half the layer thickness is taken, on the assumption that motions larger than the layer thickness would be computed as the mean flow. At the bottom and the top layer we use the usual expression for the mixing length:

$$L = k' z(1 - z/d)^{\frac{1}{2}} \tag{25}$$

The application of this expression to the other layers appears to give much too large vertical momentum transports.

In the model this length scale is determined at the pressure points, namely, at i, j, k.

GENERATION AND DISSIPATION OF SUBGRIDSCALE ENERGY

In the interior of the fluid in our model, it is assumed that the interlayer shear generates the subgridscale energy. This source can be expressed as:

$$S = \varepsilon\left(\frac{\delta\bar{u}}{\partial z}\right)^2 \tag{26}$$

where $\bar{u}$ = mean velocity

$\varepsilon = L\sqrt{e}$.

In the model this source is determined at the interface between the layers at i, j, k + ½.

$$S = a_3\overline{L\sqrt{e}_-}^z\left\{\left(\delta_z\overline{u}^x\right)^2 + \left(\delta_z\overline{v}^y\right)^2\right\}^{\frac{1}{2}} \quad \text{at } i, j, k + 1/2, n \tag{27}$$

It will be noted that only the energy is computed at the lower time level. This was necessary for stability of the computation.

The energy generated at this location is assumed to be distributed equally into the adjacent layers.

In the bottom layer another source exists. It is assumed that energy which is taken out of the mean flow through the bottom stress immediately enters the subgridscale energy system.

The stress term in the momentum equation in the direction of the mean flow is

$$\frac{\tau}{\rho} = gU^2/C^2 \tag{28}$$

where U = velocity in bottom layer in the direction of flow.

If this term is multiplied by U, we obtain the energy which is taken out of the mean flow system and the local source (S) for the subgridscale energy.

$$S = gU^3/C^2 \tag{29}$$

In the model, the subgridscale energy generation is computed at the layer interfaces and the local finite difference source term becomes

$$S = g\left[(\overline{u}^x)^2 + (\overline{v}^y)^2\right]^{3/2} \Big/ C^2 \quad \text{at } i,\ j,\ K + \tfrac{1}{2},\ n \qquad (30)$$

The energy is completely introduced in the layer K.

At the water surface the generation of the subgridscale energy is different. Here the energy source is the wind which generates surface waves, and through these waves, turbulence. Wave and swell conditions depend on wind intensity, duration of the wind and the fetch. In the test cases a fully-developed sea under moderate wind speed was used as inputs. Under these conditions the waves are so-called deep water waves, and the total wave energy can be found from the Pierson-Moskowitz spectral sets (Neumann and Pierson [5]). Per unit area, the total wave energy is

$$E_t = 5.6 \times 10^{-9} u_w^4 \qquad (31)$$

where u_w = wind speed in cm/sec at 19.5 m above mean sea surface

E = wave energy

Half of this energy is kinetic energy. If we assume that all this kinetic energy is in the top layer (h_1) of the model, then the vertically-average subgridscale energy intensity in this layer is

$$e = 2.8 \times 10^{-9} u^4/h_1 \quad \text{at } i,\ j,\ 1,\ n \qquad (32)$$

As the wave theory presents an energy intensity for a given wind condition, we are not concerned with influx of the subgridscale energy into the system, but with maintaining this energy level during the duration of the wind condition in the simulation.

We have assumed that all the kinetic wave energy is in the top layer. From deep water wave theory it is known that the wave-induced water motions are effectively zero at a depth which is half the wave length.

BOTTOM AND LAYER THICKNESS APPROXIMATION

Since in the momentum equations product terms of velocity times the layer thickness (hu) are used, it appeared possible to give the bottom layer a thickness which is independent of the layer thickness in other areas of the model. This procedure permits a rather accurate description of the bottom.

In the field data for the Bristol Bay model, we noted sharp gradients in density. As our model is a finite difference model, the the resolution in this transition zone is relatively poor, and could lead to computational difficulties if long duration simulations were made.

For one or two experiments the investigators plan to run the model as a layer model, where the layer thickness is varied. In this mode the vertical advection is not computed, but is reflected in variations of layer thickness.

REFERENCES

1. Leendertse, Jan J., Richard C. Alexander, and Shiao-Kung Liu, *A Three-Dimensional Model for Estuaries and Coastal Seas: Volume I, Principles of Computation*, The Rand Corporation, R-1417-OWRR, December 1973.

2. Leendertse, Jan J., and Shiao-Kung Liu, *A Three-Dimensional Model for Estuaries and Coastal Seas: Volume II, Aspects of Computation*, The Rand Corporation, R-1764-OWRT, June 1975.

3. Kolmogoroff, A. N., *Compt. rend. acad. sci. USSR*, 30. 301 and 32. 16, 1941.

4. Prandtl, L., "Uber eln neues Formelsystem fur die ausgebildete Turbulenz," Nachr. Akad. Wliss., Gottingen, 6-19, 1945.

5. Neumann, G., and W. J. Pierson, *Principles of Physical Oceanography*, Prentice-Hall, New Jersey, 1966.

This puts an upper limit upon the wind speed which we were able to allow in the simulation. This wind speed can be estimated from the average wave period belonging to the wind speed (Neumann and Pierson [5]).

$$\bar{\tilde{T}} = .81 \times 2\pi u_w/g \tag{33}$$

and from the wave-length-wave-period relation

$$\bar{\tilde{L}} = g\bar{\tilde{T}}^2 \; 2\pi \tag{34}$$

The maximum wind that is allowed in a model with an upper layer thickness h for use in Eq. (32) can then be found from Eqs. (33) and (34):

$$u_w = \left[\frac{2g\sqrt{\pi}}{.81\sqrt{g}\cdot 2\pi}\right]\sqrt{\tfrac{1}{2}\bar{\tilde{L}}} < 21.8\sqrt{h} \tag{35}$$

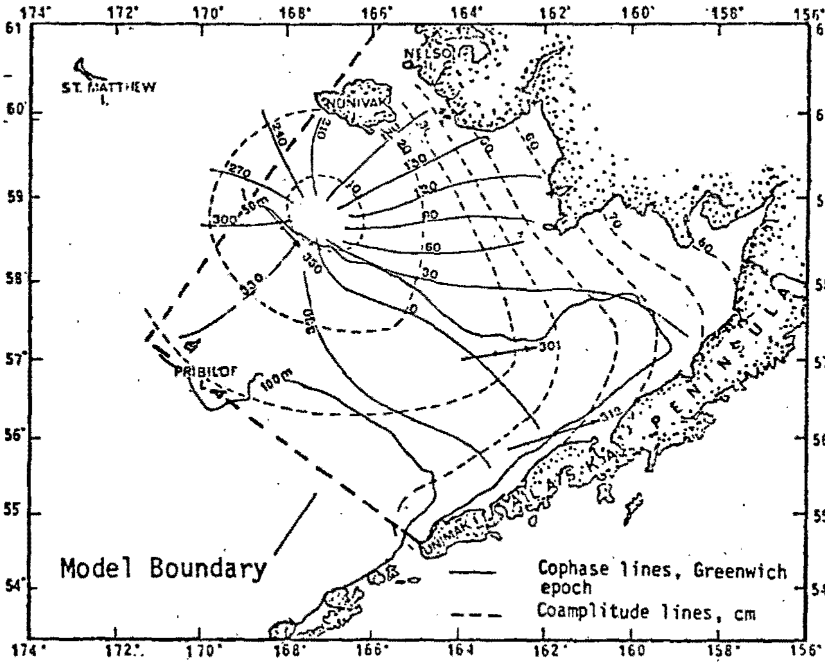
Higher wind velocities would also involve subgridscale energy inputs in lower layers. The model at present does not include inputs other than in the surface layer.

For the dissipation of energy, use is made of the now classical concepts developed by Kolmogorov [3] and Prandtl [4] that the dissipation rate depends on the transfer process from larger eddies to smaller eddies according to

$$D = a_2 \; \underline{e}^{3/2}/L \tag{36}$$

Appendix B

SOME GRAPHICAL SIMULATION RESULTS FROM THE THREE-DIMENSIONAL MODEL OF BRISTOL BAY AND COMPARISONS WITH FIELD DATA



Co-tide chart of K1 component in Bristol Bay
(compiled by PMEL)

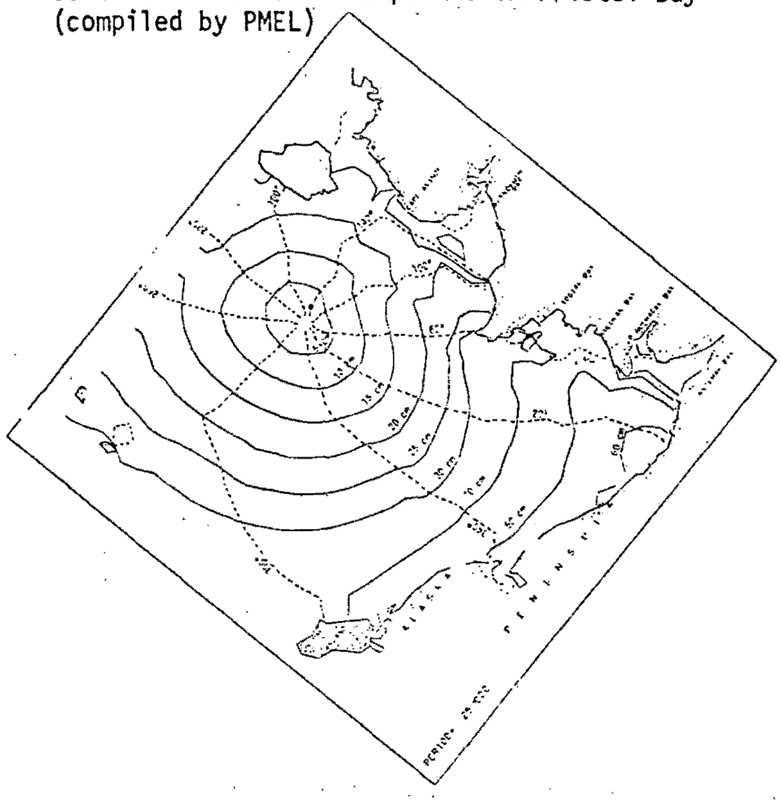
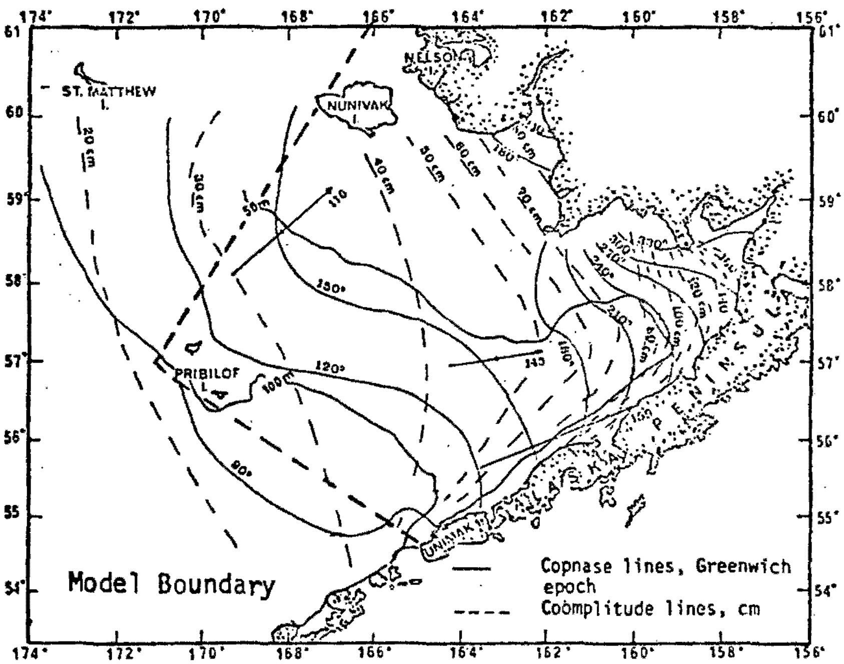


Fig. B-1--Observed and computed co-tide chart of the diurnal tide component in Bristol Bay



Co-tide chart of M2 component in Bristol Bay
(compiled by PMEL)

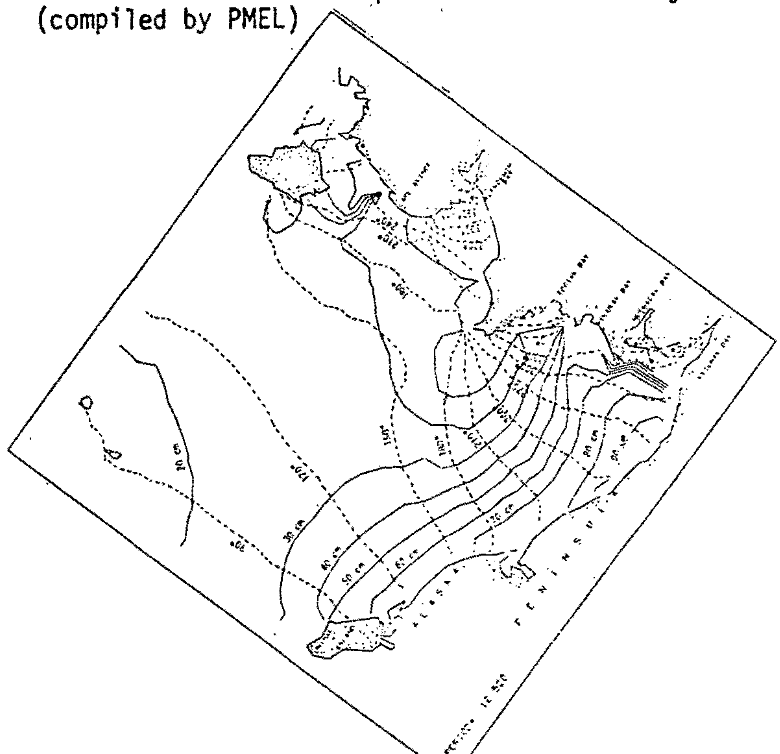


Fig. B-2--Observed and computed co-tide chart of Bristol Bay for the semidiurnal tide. (The amplitudes of the computed charts are lower because of lower input values at the boundary. The observed chart does not show an amphidromic point at the cape west of Togiak Bay as no data collection station was available.)

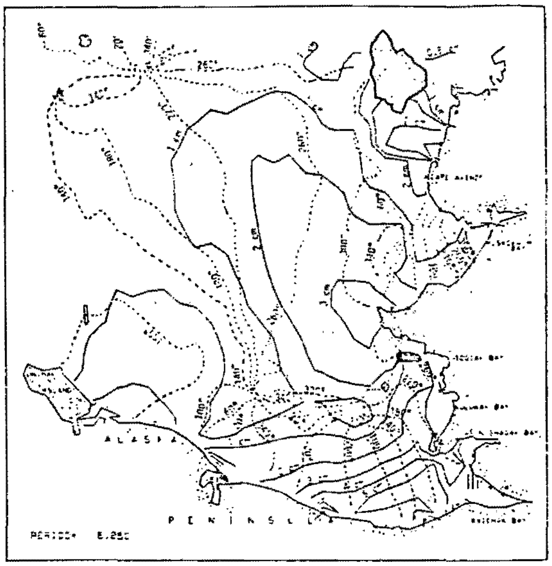


Fig. B-3--Computed co-tide chart for the quarter-diurnal tide. (This tide is generated by the nonlinear effects as in the tide inputs at the boundary no quarter-diurnal tide is introduced. Several amphidromic points are present. The amplitudes in this component are only a few centimeters.)

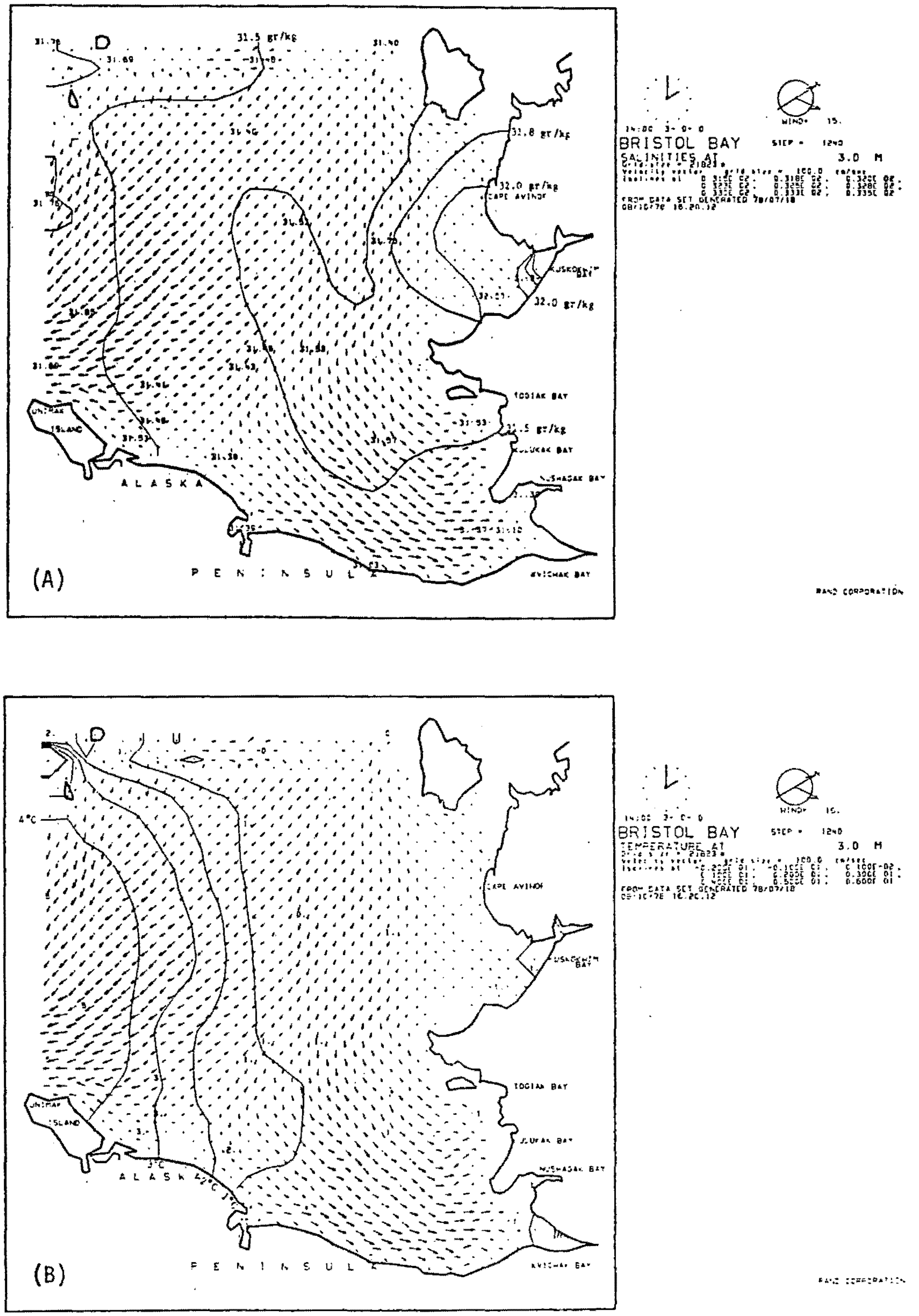
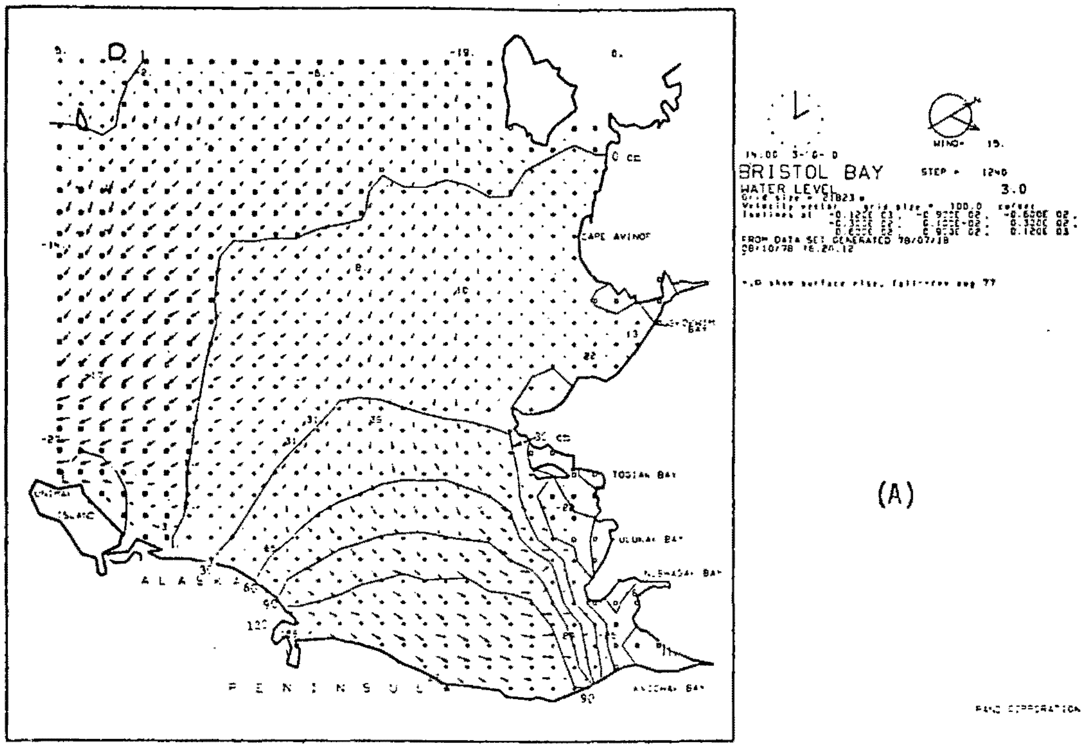
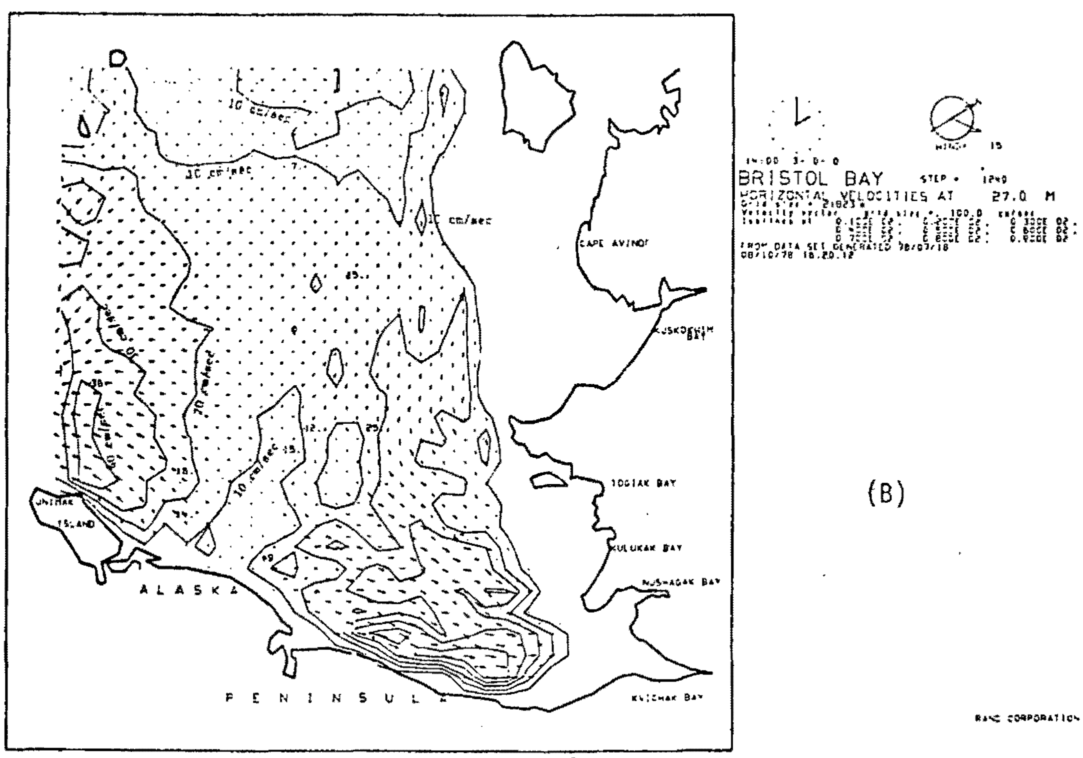


Fig. B-4-- Computed salinity (A) and temperature (B) distribution in the surface layer at 1400 pm 18 June 1976.

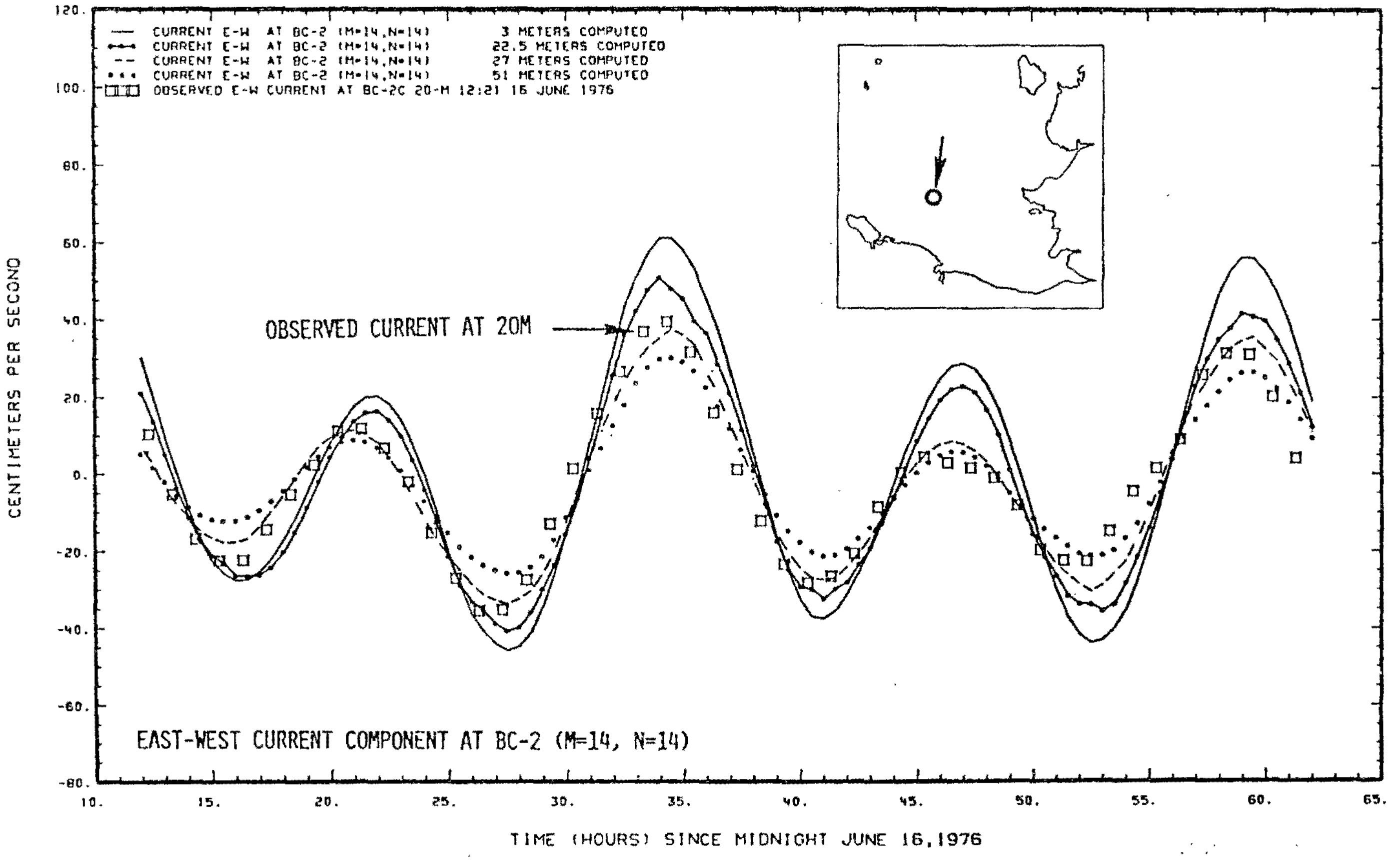


(A)



(B)

Fig. B-5-- (A) Computed water level, velocity distribution in the surface layer and the rise and fall of water surface. (B) Computed velocity distribution in the 8th layer (27m) at 1400 pm 18 June 1978.



BRISTOL BAY
CURRENT E-W AT STATION
OBSERVED VS. COMPUTED

Fig. B-6--Comparison between computed current components and observed components at station BC-2.

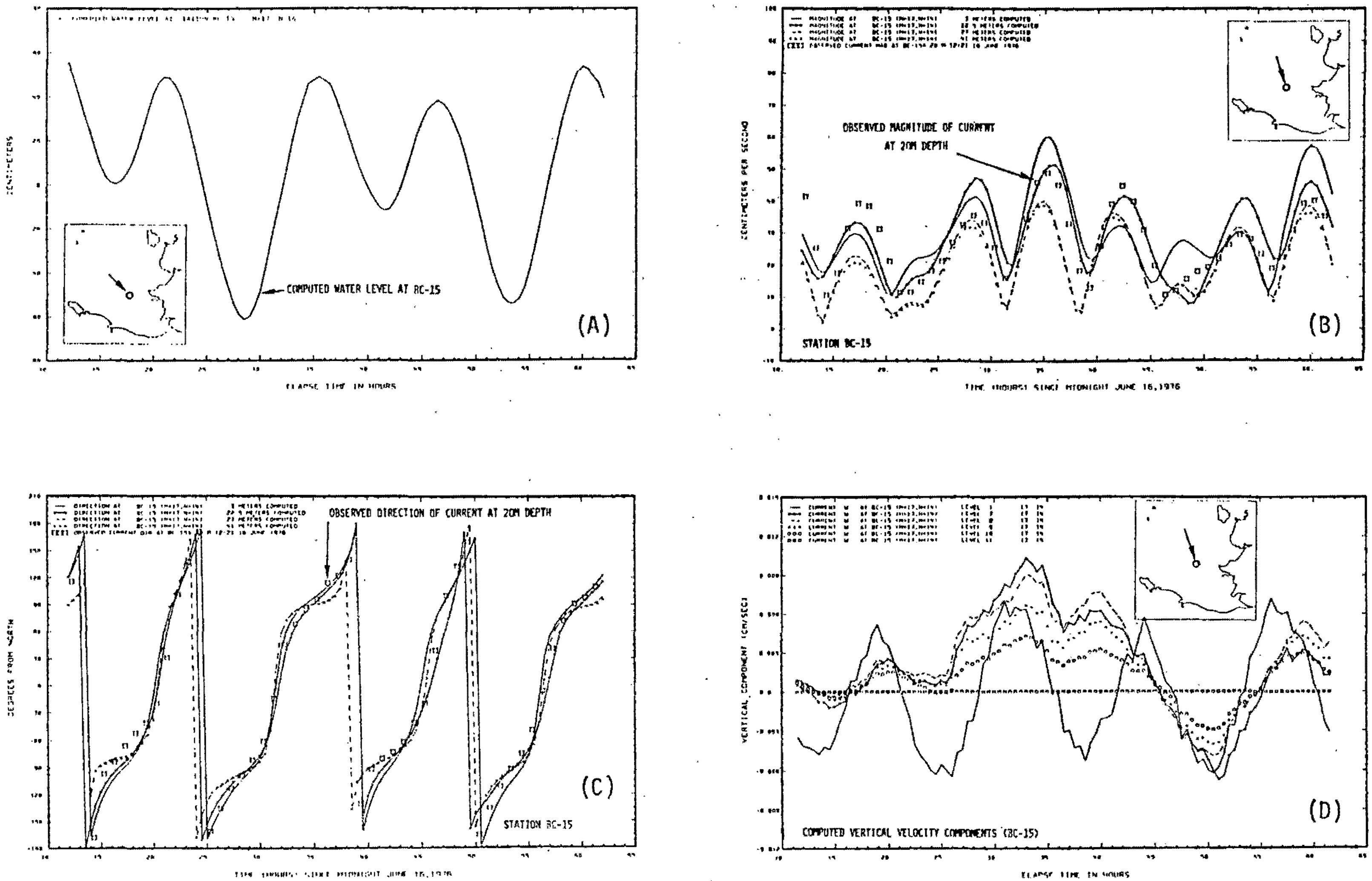
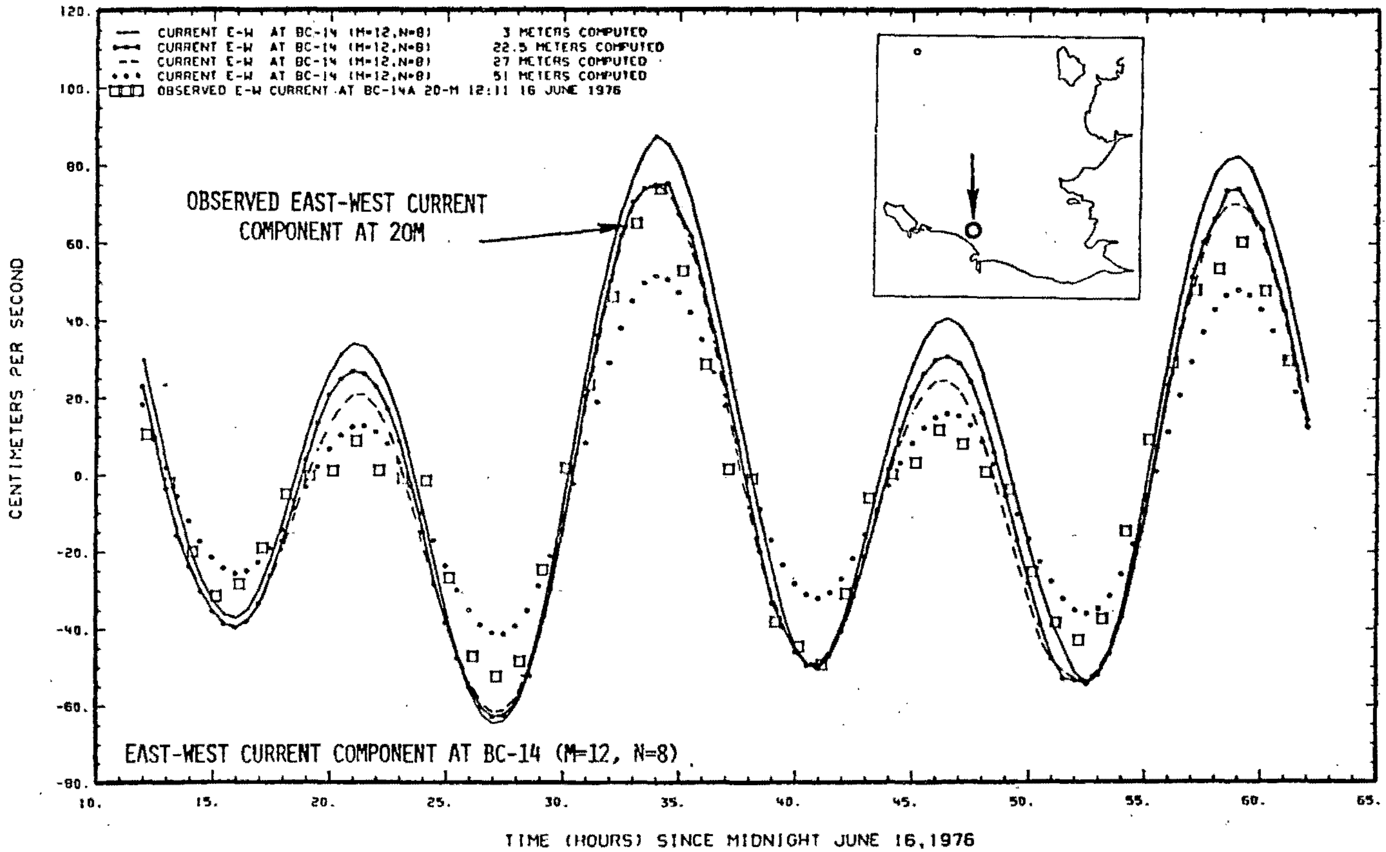


Fig. B-7--Comparison between the computed and the observed current speed and direction (B and C) together with the local water level (A) and vertical velocity component at six selected levels (D) during the period 0000 16 June through 1400 18 June 1976.



BRISTOL BAY
CURRENT E-W AT STATION
OBSERVED VS. COMPUTED

Fig. B-8--Comparison between computed and observed current components at station BC-14.

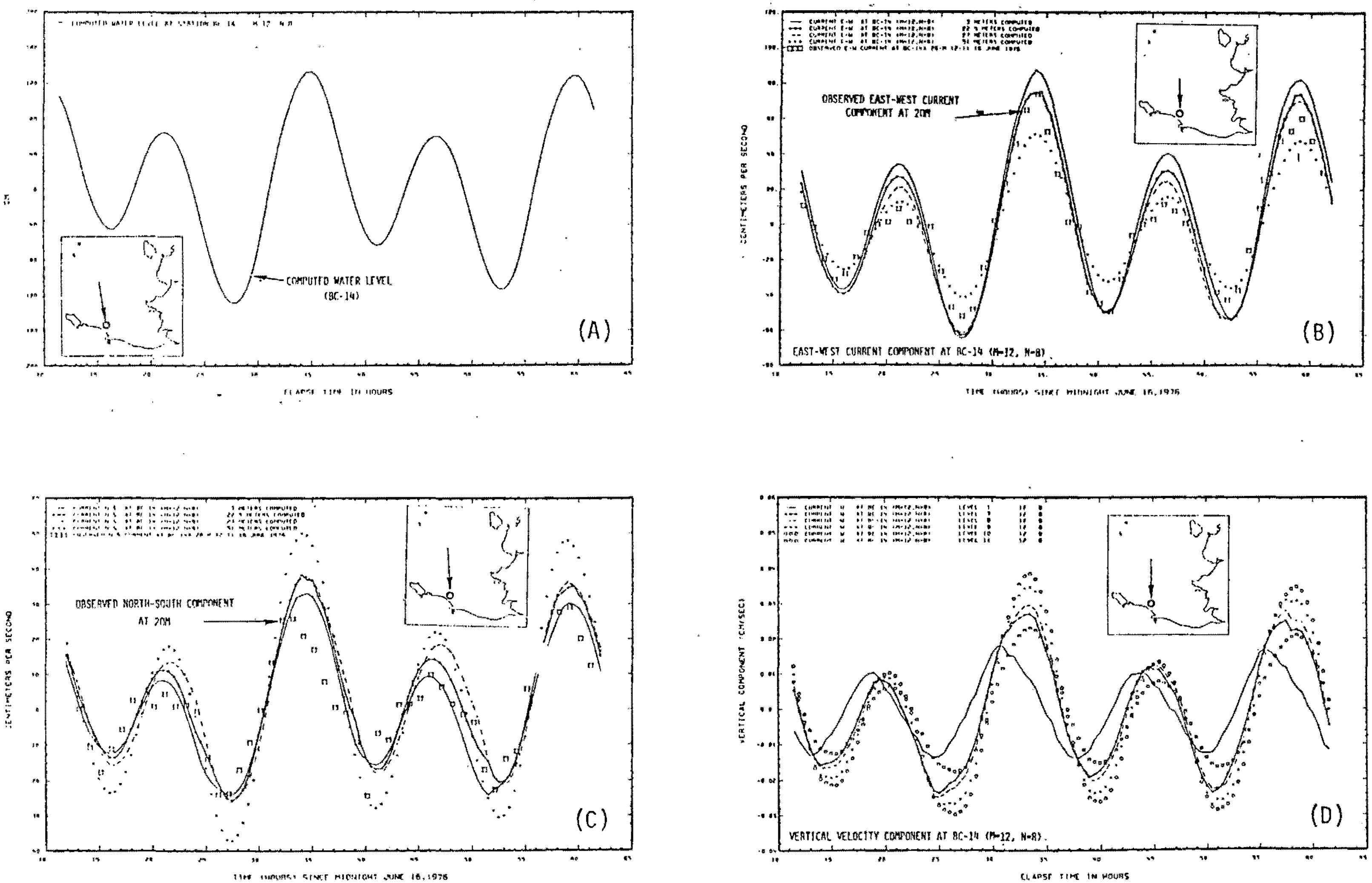


Fig. B-9--Comparison between the computed and the observed current components at a given location (B and C) together with the local water level (A) and vertical velocity component at six selected levels (D) during the period 0000 hr 16 June through 1400 18 June 1976.

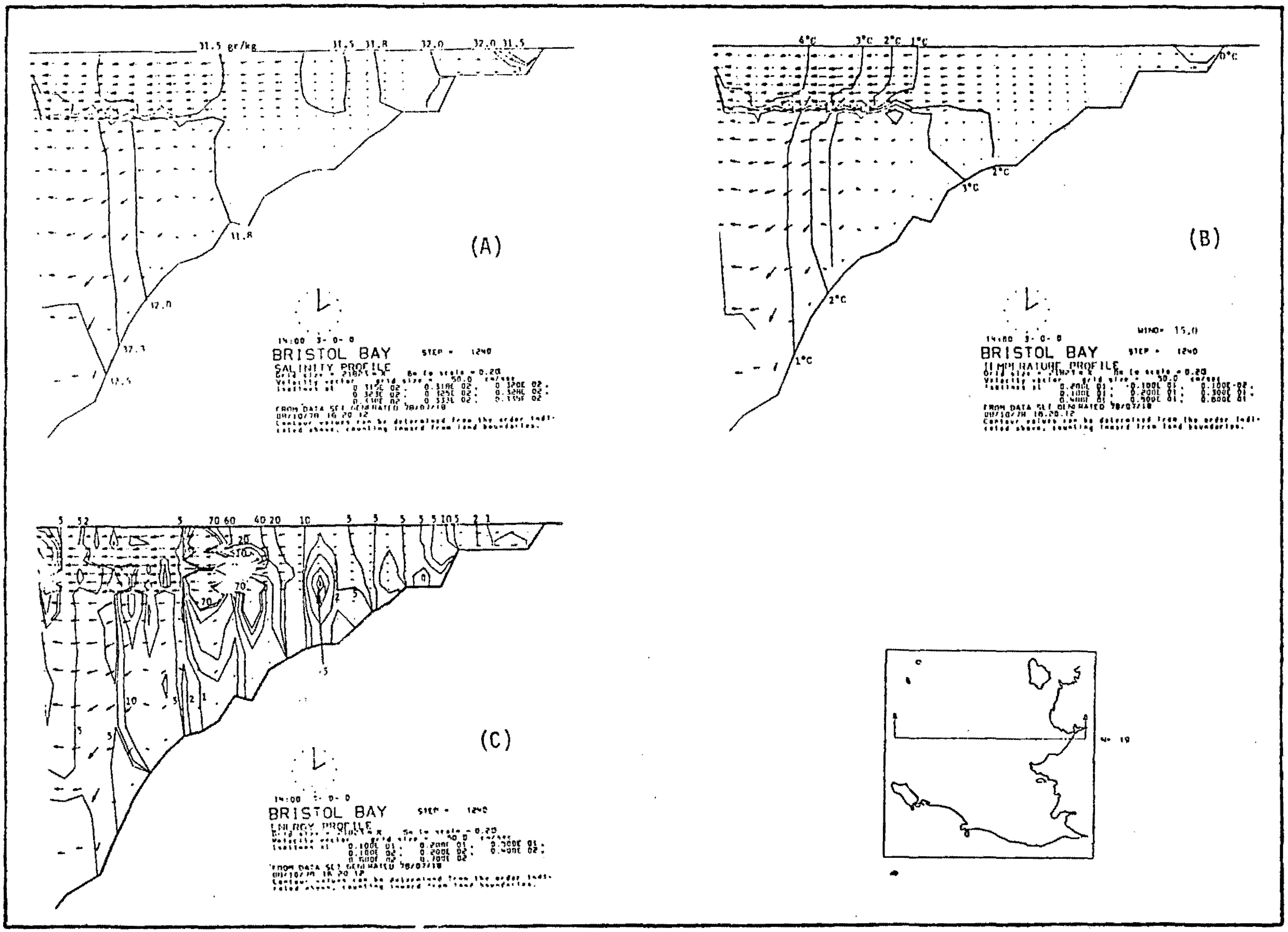


Fig. B-10-- Computed vertical distribution of salinity (A), temperature (B) and turbulent SGS energy (C) along a profile indicated in inset map at 1400 pm, 18 June 1976.

To: Outer Continental Shelf Environmental
Assessment Program
Bering Sea-Gulf of Alaska Project Office
PO Box 1808, Juneau, Alaska 99802

Proposal Date: June 1, 1978
Contract #: Not applicable
NOAA Project #: Not applicable
Institution ID#: 34633-02

FY 1978 ORIGINAL PROPOSAL

Research Unit 436

TITLE: Oil Spill Trajectory Analysis, Lower Cook Inlet, Alaska

Cost of Proposal: $ 25,500 (FPC) Lease Area: Cook Inlet 100 %

Period of Proposal: June 12 to August 30, 1978

. . . .

PRINCIPAL INVESTIGATOR(S):

Name . . . . . Roger S. Schlueter Date June 3, 1978

Signature. . . [signature]

Address. . . . 1100 Glendon Avenue, Suite 1000
Los Angeles, California 90024

Telephone No . (213) 879-9700

INSTITUTION. . . . . Dames & Moore
Advanced Technology Group

REQUIRED ORGANIZATION APPROVAL:

Name . . . . . Henry Klehn, Jr. Date June 2, 1978

Signature. . . Henry Klehn, Jr.

Position . . . Managing Partner, Los Angeles

Address. . . . 1100 Glendon Avenue,

Telephone No . (213) 879-9700

ORGANIZATION FINANCIAL OFFICER:

Name . . . . . Date 6/1/78

Signature. . . C. K. Ramsey

Position . . . C. K. Ramsey, Assistant Controller

Address. . . . 445 S. Figueroa Street
Los Angeles, California

Telephone No . (213) 683-1560

TECHNICAL PROPOSAL

I. Title: Oil Spill Trajectory Analysis, Lower Cook Inlet, Alaska
Contract Number: Not applicable
Proposed Dates of Contract: June 12-August 30, 1978

II. Principal Investigator: Dr. Roger S. Schlueter
Senior Engineer
Dames & Moore

III. Cost of Proposal for Federal Fiscal Year (10/1/78-9/30/79):
No cost impact

IV. Background:

Previous oil spill trajectory analyses completed in March 1976 yielded information on probable shoreline impact areas and associated time to impact. That study needs to be updated to reflect new current data and to investigate other spill sites. In addition, some questions have arisen regarding data preparation work that was performed on the previous project. Lastly, the issue of statistical and deterministic errors and their effects on the final conclusions has been raised. These areas will be addressed in the study proposed herein.

V. OBJECTIVES

An oil spill trajectory analysis can fill many objectives; through their involvement with similar analyses in Alaska and elsewhere, NOAA personnel are familiar with these objectives. As suggested in your letter dated March 24, 1978, the immediate purpose of this proposed project is to evaluate biological study sites.

VI. General Strategy and Approach

For purposes of this section, the proposed work can be divided into three distinct categories as follows:

A. Documentation

The report* describing the previous trajectory analysis was essentially a data report, containing only cursory descriptions of data preparation procedures and model algorithms. In response to requests for greater detail, in-depth discussions of both of these topics will be provided. Where applicable, this documentation will contain sample calculations (see Section VIII, Work Item 1).

B. Trajectory Simulation

The overall approach to the calculation of "base case" trajectories will, for the sake of consistency, conform to that employed in the previous work. That is, a basic set of wind and current conditions will be established. Unless new data dictate otherwise, the eight predominant wind patterns from those defined by Putnins (1996) used in the previous work will also be used here. In contrast, new current data are known to be available and will be used to supplement the previously used data bases (see Section VIII for details).

Using this environmental data, spill trajectories from OCSEAP specified spill sites will be simulated using the spill model. The result for each "environmental scenario" is the point at which the trajectory intersects the shoreline and the time to impact. When combined with the probability distribution of the winds and currents, this data permits probability of exposure maps to be generated for each site and for all sites taken together.

*Final report, Oil Spill Trajectory Analysis, Lower Cook Inlet, Alaska, For National Oceanic and Atmospheric Admministration, March 8, 1976.

C. Error Analysis

The overall strategy outlined in Section B above is a deterministic one in that all quantities are uniquely specified. Both systematic and random fluctuations affect the base case shoreline impact distributions, however. Hence, it is proposed to investigate to what extent these processes "smear" the distribution of impact points.

In order to limit the number of runs to be made, one or possibly two base scenarios will be selected in conjunction with OCSEAP personnel; all error analyses will relate to these base cases.

Several methods are available for simulating the error processes as discussed in Section VIII. In general, some measure of the error--such as percent deviation from the base case for systematic errors and standard deviation for random fluctuations--will be varied and the resultant changes on the shoreline impact distribution observed. While certain quantitative measures exist, i.e., range of extremal impact points, the final assessment of the shoreline impact distribution will be a qualitative one. For example, one might conclude that a 25 percent systematic error in net currents has no significant effect on the base cases considered.

VII. Sampling Methods

This section not applicable.

VIII. Analytical Methods

In this section, details of the overall methodology described in Sectin VI will be given. However, this discussion will be organized to follow Work Items 1-5 of your letter dated March 29, 1978.

Work Item 1. Model Documentation

This work item is a straightforward task involving documentation of the model and data manipulation procedures. Only two points need be discussed here.

Recently, an improved spreading algorithm was incorporated in the model. Of course, this necessitated that the "trajectory only" option be revalidated to ensure that it was not adversely affected. These validation runs consist of running various wind and current fields through the data preprocessor and spill model and comparing the results with those calculated by hand. These comparison runs will be provided with the documentation as "proof" of the interpolation and computational schemes used in both codes.

The second issue concerns the means by which the wind and current data are input to and manipulated by the preprocessor program which prepares these data for direct input to the oil spill model. This program serve two purposes: 1) the volume of input is reduced by interpolating sparse data onto the required grid, and 2) the costs of analysis are reduced by permitting each environmental scenario to be prepared once for use with as many spill sites as necessary.

Data preparation for input to the preprocessor begins with the establishment of a grid over the area of interest. This grid is then superimposed over a synoptic map of the wind or current field to be input. Starting at the upper left corner of the grid, the values of the vector speed and direction are read at every nth grid intersection in both the horizontal and vertical directions. The value of n depends directly on the spatial variability of the input data. In the previous project, n was chosen to be four for the wind data and two for current data; the grid size was three nautical miles.

The preprocessor program performs a double linear interpolation in the x and y directions on the current and wind data sets. At this point in the program, then, values of speed and direction are known for the wind and current data at each grid point. Using an efficient encoding scheme, these data are passed to the spill trajectory program via intermediate data files.

This process is best illustrated by the simple example where a vector field is input at every other (n=2) grid intersection. Letting subscripts i,j denote a grid intersection point, this means that values for V_{ij} and θ_{ij} are known for i=1, 3, 5... and j=1, 3, 5... where V is speed and θ is direction. Now

$$V_{i+1,j} = \frac{V_{i,j} + V_{i+2,j}}{2} \quad V_{i+1,j+1} = \frac{V_{i+1,j} + V_{i+1,j+2}}{2}$$

where i,j = 1, 3, 5..., and similar equations apply for θ.

Weighting factors must be used when $n \neq 2$ but the concept is the same.

Mr. Pelto has requested that a copy of the preprocessor program be included with this proposal. I have not done that because, in spite of its apparent simplicity, there is some rather contorted logic in the code itself where internal variables assume more than one role as the program executes and a large number of transfers to subroutings occur. In short, it is not easy to "read." If a program listing is essential, we will be happy to quickly respond to your request.

Clearly, some interpretive judgment must be used when the synoptic charts of winds and currents are transferred to the input grid. We are presently in the process of implementing a purely objective capability that could alternatelively be used. The basic theory behind this approach is described by Lin and Goodin* and an operational code that embodies this concept is now being tested at Dames & Moore. While some tests have been completed, its applicability to this project is unknown. If successful, this concept may have very interesting implications beyond this particular project. Our proposed approach will be successful with or without this capability, but its possible applications should be discussed among OCSEAP and Dames & Moore personnel.

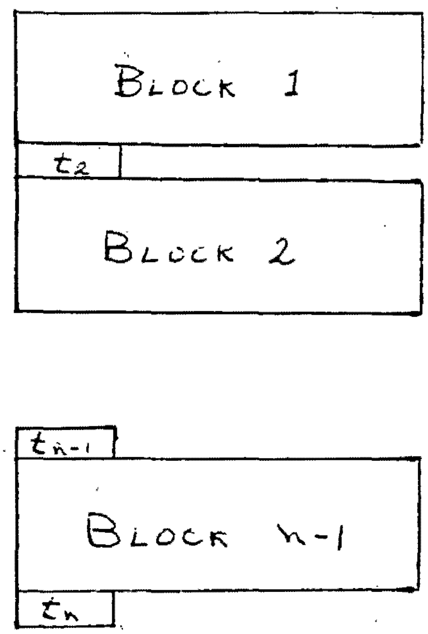
The question about double entry of net currents in the previous study remains and a very direct approach to resolving the issue will be used. The original data will be reworked by the Principal Investigators on that study. The process will be clearly documented and comparisons with previous results made. If errors are uncovered, we will recalculate selected case trajectories to assess the effect of double counting the net current. Considering the magnitude of the driving forces, the net current is the least significant and we believe that if a rerun is necessary major changes will not be found.

Work Item 2. Data Requirements

There are no analytic methods associated with this work item, however, the following discussion of environmental data formats used by the spill model should satisfy your request.

*Lin, C.Y., and Goodin, W.R., "An Iterative Algorithm for Objective Wind Field Analysis," Monthly Weather Review, Vol. 104, No. 6, June 1976 (see attached reprint).

Both wind and current data are input in the same format. For any given parameter, the total set of data can be schematically represented as follows:



Block 1 data describe the spatial dependence of the wind or current fields at time t=0, block 2 describe the fields at t_2, and so on. The last time, t_n, denotes the cycle time of that wind or current field. For times greater than t_n, the input file is rewound and reused with each time value increased by t_n.

Within each block, the wind or current fields are input at every nth grid intersection as discussed earlier. They are specified in the order (speed, direction) with FORMAT (16F5.0). The direction is relative to magnetic north (positive clockwise) and speed is in meters per second.

Two data decks showing a hypothetical and real wind field are listed on the next two pages to illustrate the data input scheme. Figure 1 shows a hypothetical wind field used for model validation runs. The wind was assumed to be spatially uniform over an entire square grid so that at each input time the wind need only be specified at the four corners of the grid. The wind speed is 0 m/s at t=0 hrs, rises to 20 m/s at t=1 hr, then falls back to 0 m/s at t=3 hrs, which is the period of the wind cycle. The wind direction is from 180 degrees at all times.

Figure 2 shows the wind input data for the 1976 oil spill study corresponding to wind pattern 1 (after Putnin). This wind field is graphically shown in Plate 4 taken from that study.

Clearly, the closer any new data are to this format, the easier it will be to incorporate into the proposed study. Any data that are spatially gridded in space and specified at various points in time should be relatively easy to modify into the desired format. Also, data specified as shown in Plate 4 or in a similar map format should be amenable to digitization and reformatting to the desired structure.

Usually, current meter data are given as velocity as a function of time at the current meter station locations. The principal problem in dealing with this type of data is how to define the current at all grid points, particularly if the stations are sparsely distributed over the area of interest. The most straightforward method to deal with this problem is to use manual interpretation between the stations, particularly if the individual has a working knowledge of hydrodynamics of Cook Inlet.

Of course, this introduces subjective judgments into otherwise objective data. This is why the divergence reduction procedure was suggested as an alternative in

```
0.0  180. 0.0  180.
0.0  180. 0.0  180.
1.0
20.0 180. 20.0 180.
20.0 180. 20.0 180.
3.0
```

FIGURE 1. Data File for Validation Test Case

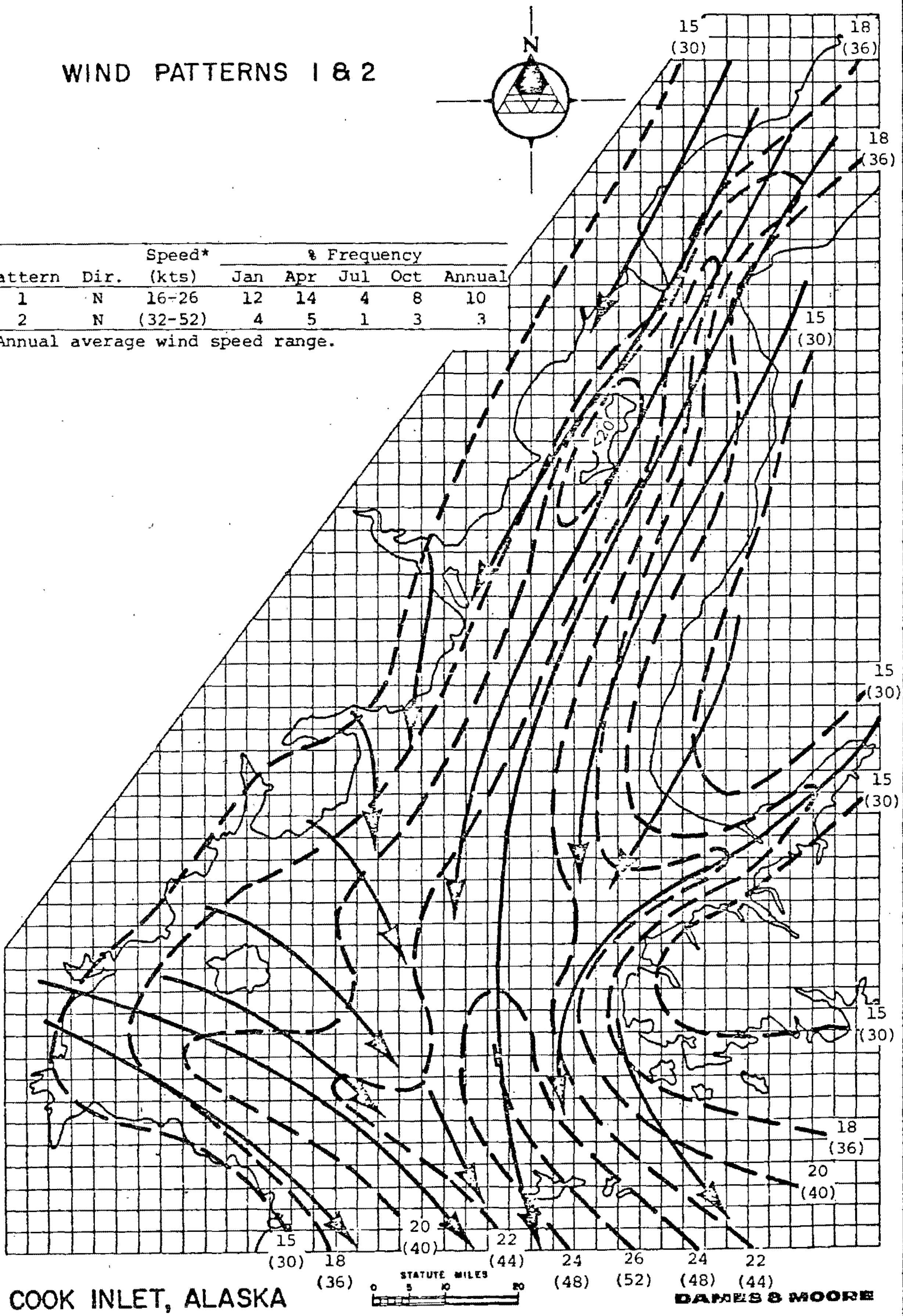
		16.	40.	16.	40.										
														16.	40.
16.	40.	16.	40.	20.	40.										
														16.	35.
18.	35.	21.	40.	16.	40.										
												16.	27.	16.	28.
22.	30.	16.	35.	16.	40.										
										16.	26.	16.	26.	20.	26.
22.	20.	16.	20.												
										16.	20.	16.	20.	21.	23.
21.	20.	16.	20.												
								16.	320.	16.	320.	20.	20.	22.	20.
18.	20.	16.	20.												
								16.	315.	16.	345.	21.	20.	22.	20.
16.	20.														
				16.	300.	16.	300.	16.	270.	19.	26.	22.	19.	19.	10.
15.	10.	16.	30.	16.	30.										
				16.	300.	16.	315.	16.	300.	21.	5.	22.	16.	18.	10.
16.	25.	16.	30.	16.	30.										
		16.	281.	17.	281.	19.	315.	20.	345.	22.	360.	22.	6.	21.	18.
18.	35.	16.	35.	16.	30.										
16.	281.	18.	281.	19.	281.	19.	310.	20.	328.	23.	358.	23.	5.	18.	2.
16.	10.	16.	290.	16.	290.										
16.	281.	18.	281.	20.	281.	21.	306.	22.	330.	23.	345.	24.	5.	19.	340.
17.	300.	17.	290.	18.	290.										
		16.	281.	16.	300.	16.	324.	20.	324.	22.	335.	24.	350.	24.	340.
20.	320.	19.	305.	19.	300.										
				16.	300.	17.	324.	19.	324.	21.	335.	24.	342.	24.	335.
24.	320.	22.	310.	22.	310.										
200.															

FIGURE 2. Data File Representing Wind Type 1 (following Putnin)

WIND PATTERNS 1 & 2

Pattern	Dir.	Speed* (kts)	% Frequency Jan	Apr	Jul	Oct	Annual
1	N	16-26	12	14	4	8	10
2	N	(32-52)	4	5	1	3	3

*Annual average wind speed range.



COOK INLET, ALASKA

DAMES & MOORE

PLATE 4

Section VI, and should be evaluated once the nature and distribution of the current data is known.

Lastly, a full hydrodynamical simulation of Cook Inlet could be undertaken but this appears to be beyond the scope of work contemplated by OCSEAP. The best procedure can only be selected after a careful review of all available data.

Probably the most difficult data to handle are drogue tracks; this is because the data are Lagrangia in nature while the model is fundamentally Eulerian. The best use of this type of data is qualitative verification of the interpolated current meter data. Drogue data are most useful in this regard if the winds are negligible during the drogue experiment or wind effects on the drogue are known. If the later is true, the oil spill model can be used to predict drogue movement and qualitative comparison of predicted and observed drogue tracks made.

Work Item 3. Model Simulation

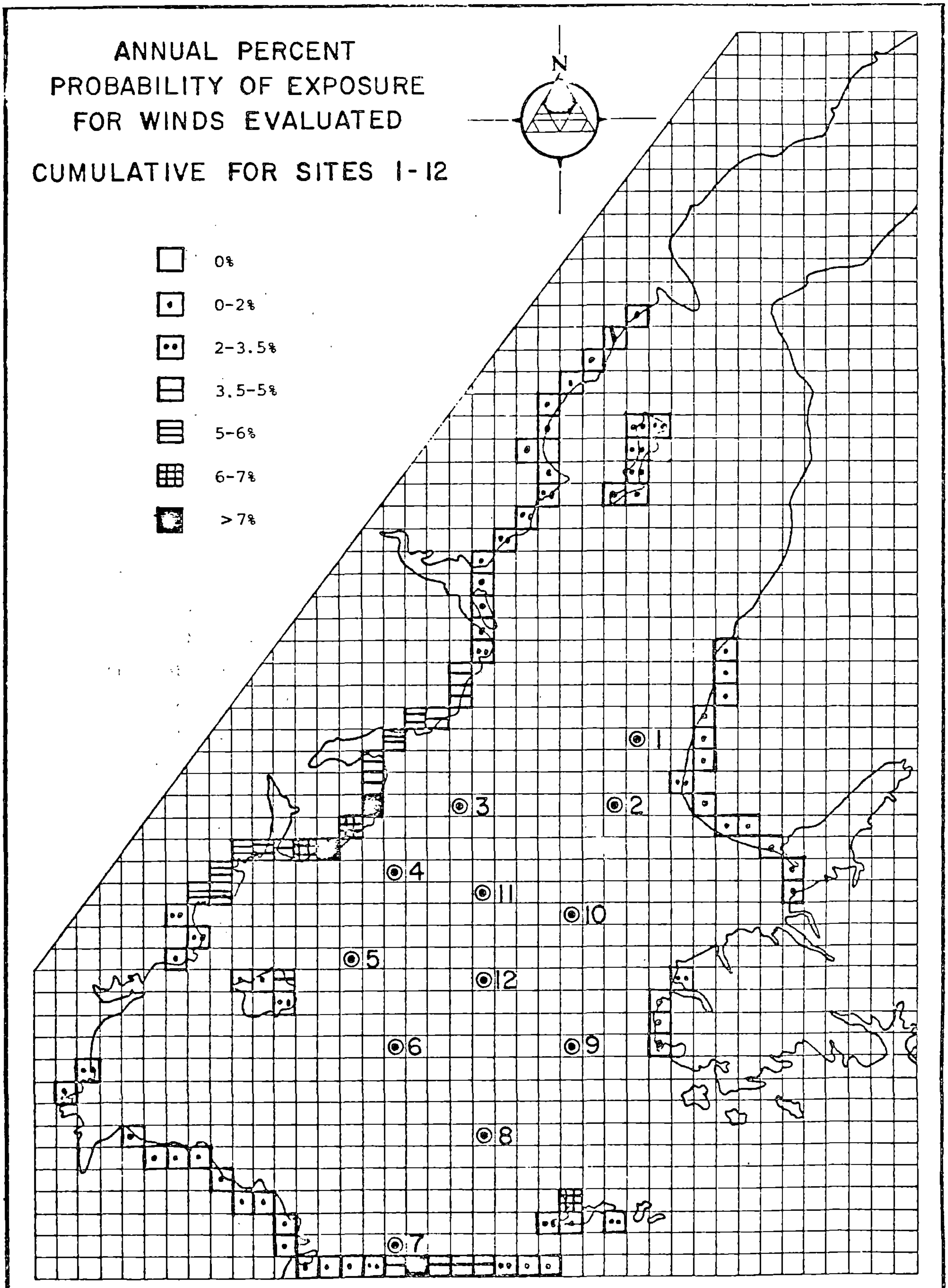
Once the environmental data sets are defined, actually exercising the model is straightforward. The basic algorithm and its numerical implementation remain as described in the 1976 study report. Other questions regarding use of the model have been raised, however, and they are addressed in the remainder of this section.

Based on results of the 1976 study and on location of the new postulated spill sites, it does appear to be prudent to shift the grid southward. There is nothing inherent in the model that limits the extent or location of the grid system. Rather, the extent of the grid will more likely be limited by the availability of reliable wind and current data.

Reviewing the cumulative distribution of shoreline impact points from Plate 34 of the 1976 study (reproduced on the next page) suggests that the northern edge of the grid be located at the Forelands. Also, as Mr. Pelto suggests, it would be advisable to move the southern edge of the grid to include Shelickof Strait and as much of Fognak and Kodiak Islands as desired by OCSEAP personnel. Note that our previous grid was chosen in conjunction with NOAA to coincide with the lease tract grid as a matter of convenience, not on the basis of any objective critreria. From the point of computational efficiency, the best grid would be one aligned with be the main axis of Cook Inlet. The final grid system will be chosen early in the project in consulatation with OCSEAP personnel.

Six hypothetical spill sites have been postulated. These sites will form the basic spill scenarios for this project. If, subsequently, more sites are deemed important these can be processed with relative ease. Once the grid system is established and appropriate environmental data digitized, the incremental cost of running trajectories from another site within that grid is small (see Part 4 for costs). Given that Dames & Moore personnel were available, merely running more spill site trajectories and providing the results to OCSEAP could be done in a matter of days.

The overall methodology described to this point yields the shoreline impact points under postulated conditions. While these conditions reflect representative surface wind patterns, other wind and current fields may occur. Moreover, the postulated winds and currents may not truely represent an average set cf base cases. Hence, as suggested by Mr. Pelto, it would be informative to determine the sensitivity of the shoreline distribution of spill points to perturbations in the standard cases.



COOK INLET, ALASKA

DAMES & MOORE

PLATE 34

These perturbations (errors) are systematic as opposed to random fluctuations present in all real wind and current fields (see Work Item 5 below). Moreover, these systematic errors will be assumed to apply to wind and current speeds, not directions. For example, a base case wind pattern could exist but be weaker (speeds less) or stronger (speeds greater) than the base case. Similarly, the tidal velocities are likely to exhibit the same directional distributions whether the maximum or minimum speeds differ from the base case.

Consequently we propose that the systematic error analysis proceed by first selecting a base scenario that yields as fairly "rich" distribution of shoreline impact points. Variation on the wind and current speeds will then be introduced and that base case rerun and the effects noted. We anticipated these variations be selected at, say ±10 percent and ±25 percent. Further variations can then be run if the results change too little or too much. "Too little" and "too much" necessarily remain ill-defined until the actual results are seen; OCSEAP personnel will be involved in these decisions.

Work Item 4. Model Documentation

The only additional documentation required beyond that provided in Work Item 1 will cover the error analyses. It is expected that the most expeditious means to do the sensitivity analyses will be to introduce the capability directly into the model under control of a limited number of new input parameters. These changes will be completely documented. In addition, all wind and current fields used in this study will be provided both in graphic and gridded (numerical) format. The latter will take the form of Figures 1 and 2, modified to make them more easily read.

Work Item 5. Presentation of Results

Following your request, results of the "base case" trajectory simulations will be derived and presented following the 1976 study. This has the advantage of permitting direct comparison with results from the previous effort. In addition, a discussion of the sensitivity analyses will be presented.

Details of the analysis of systematic errors was discussed under Work Item 3. Here, consideration of random errors will be discussed. A random error analysis recognizes that wind and current fields are not, in fact, smooth and deterministic but are affected by naturally occurring turbulent phenomenae. As in the previous error analysis, the purpose of the "random" error analysis is to measure the sensitivity of the final shoreline distribution of impact points as a result of these fluctuations.

We propose to approach the random error analysis by developing probabilistic distribution functions for wind and current fields. We expect to use normal distributions for both speed and direction components of each field with different parameters for each components. Knowing these distributions, a series of trajectories will be run from a selected base case with the wind and current fields subject to random distributions throughout the period of simulation. A statistically significant number of simulations will be run to enable the shoreline distribution of impact points to be defined.

It is clear that the success of this approach depends on our ability to define the distribution functions. Traditionally, this is extremely difficult due to the paucity of high resolution wind and current data over open water areas. We expect to encounter the same problem in Cook Inlet. Two approaches can be taken to solve this problem.

On one hand, the scientific literature contains information on non-site-specific turbulence measures. Where appropriate, these data can be used to guide the Cook Inlet analyses. On the other hand, a more pragmatic approach would involve the a priori specification of a selected distribution and its parameters. With this known, the sensitivity analysis can be performed and the results presented in the form, "If the distribution of wind velocities assumes a normal distirbution with variance less than ______, then these random fluctuations do not materially affect the stated results." The blank remains to be filled. The advantage of this approach is that later studies yielding the necessary distributional parameters would contribute to the conclusion of this study.

Again, the approach we will take can only be determined after all avialable data have been reviewed. The results of this review and our conclusions will be discussed with OCSEAP personnel before a final approach is selected.

Finally, the project report will discuss in detail, the usefulness of the various data sources to both the base case and error analyses. Our conclusionss should enable OCSEAP personnel to evaluate ongoing and proposed data collection programs with respect to oil spill trajectory analyses.

IX. DELIVERABLE PRODUCTS

A. Digital Data

Not applicable

B. Narative Reports

Considering the duration of this project, only one final report is planned. If desired, it will be complemented by an oral presentation of our results. This report will be delivered on August 30, 1978.

Quantitative results will take three forms. The primary results of this study are centroid trajectories as illustrated on the following page (this is a rerun of two of the 1976 cases; presumably, results of this form will meet your requirements as defined under Work Item 5 in your letter of 5/3/78). Two other maps will be patterned after the 1976 study and show shoreline impact distributions and minimum time to impact for the base case scenarios. Additional maps of a similar nature will illustrate the results of the error analyses.

C. Visual Data

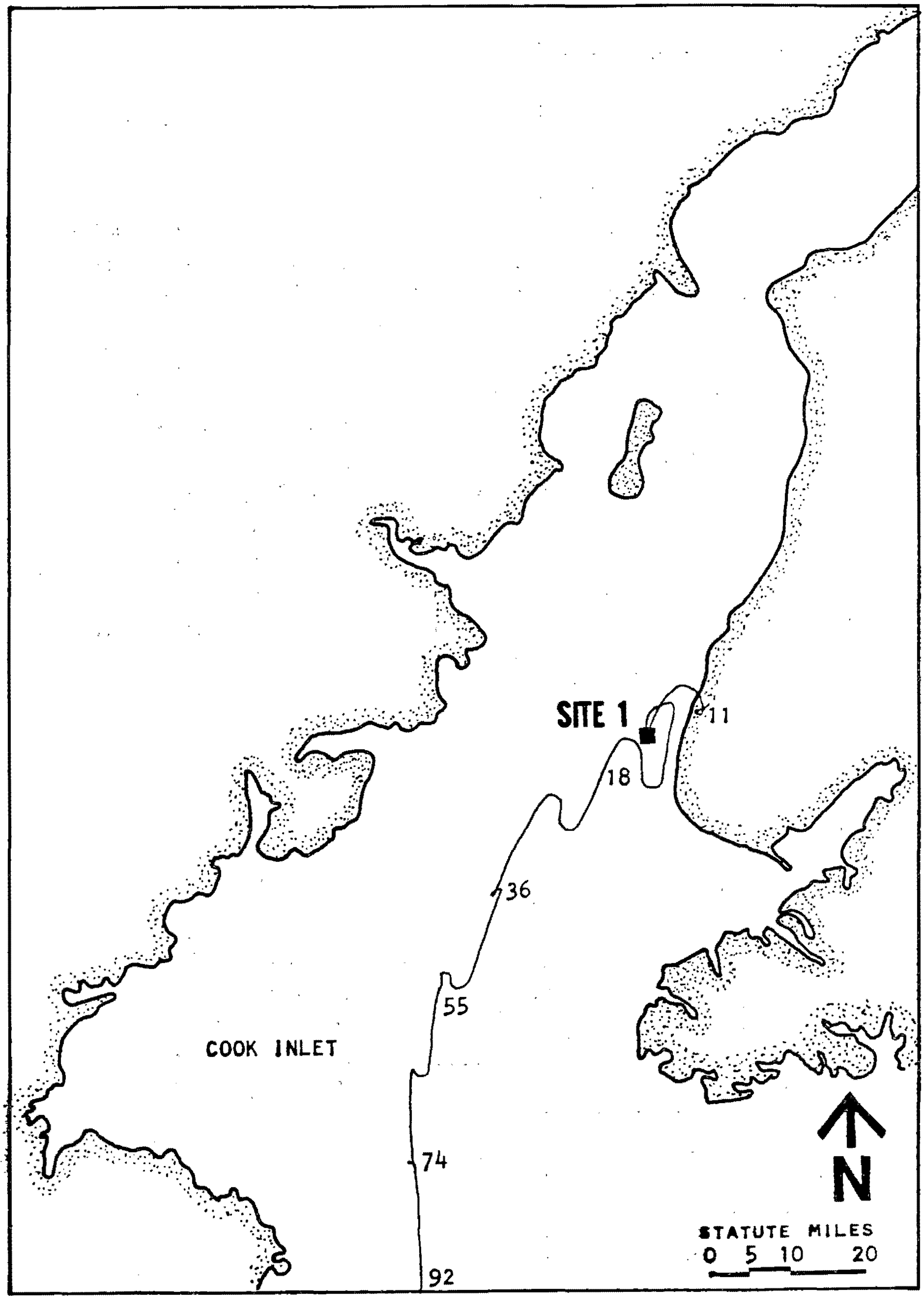
No other data maps will be provided beyond those identified above.

D. Other

Actual computer output from the simulation runs does not contain any information beyond the trajectory maps except for case run documentation. This computer output will be bound separately and provided (in single copy only) if desired. This could ultimately comprise approximately 500 pages of computer output.

X. Quality Assurance Plan

Sections 1 through 3 are not applicable. Section 4 is subsumed as part of Work Items 1 and 3, Section VIII.



SITE 1
11
18
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COOK INLET
74
92
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STATUTE MILES
0 5 10 20

XI. Special Sample and Voucher Archival Plans

This section not applicable.

XII. Logistic Requirements

This section not applicable.

XIII. Anticipated Problems

The major problems we expect to encounter were discussed and solutions proposed in Section VIII; they were:

1) How to analyze new wind and current meter data so that they are consistent with the requisite format

2) How to develop statistics to characterize systematic and random fluctuations in the environmental data.

XIV. Information Required From Other Investigators

Some of the participants in the 1976 effort are no longer with Dames & Moore although they remain in Anchorage. These individuals must be involved in the determination whether the net current was treated correctly in the previous study, an issue raised by Mr. Pelto. Mr. A. Allen of Crawley Environmental Services, and Mr. R. Miller and Mr. R. Britch of Nortech, Inc. were directly involved in the data analysis phase and have indicated an interest and availability for the necessary review process.

XV. Management Plan

Dr. Roger S. Schlueter will act as project manager for this project. He will be assisted by Mr. Charles Fahl of Dames & Moore's Anchorage office. Mr. Fahl will act as day-to-day manager of activities conducted in Anchorage.

In light of the fact that this is a relatively short single discipline project, no project management difficulties are anticipated. An activity/milestone chart is shown on the next page. This plan assumes a project initiation date of June 12; this schedule will necessarily slip if we cannot begin on this date.

XVI. Outlook

Both OCSEAP personnel and Dames & Moore recognize that the oil spill analyses as defined in this proposal represent only the most cursory treatment of the problem. Nevertheless, the results constitute a necessary first step and, in addition, should provide valuable input to other planning and research activities.

A more refined study might consider:

1) Non-surface release and transport modes

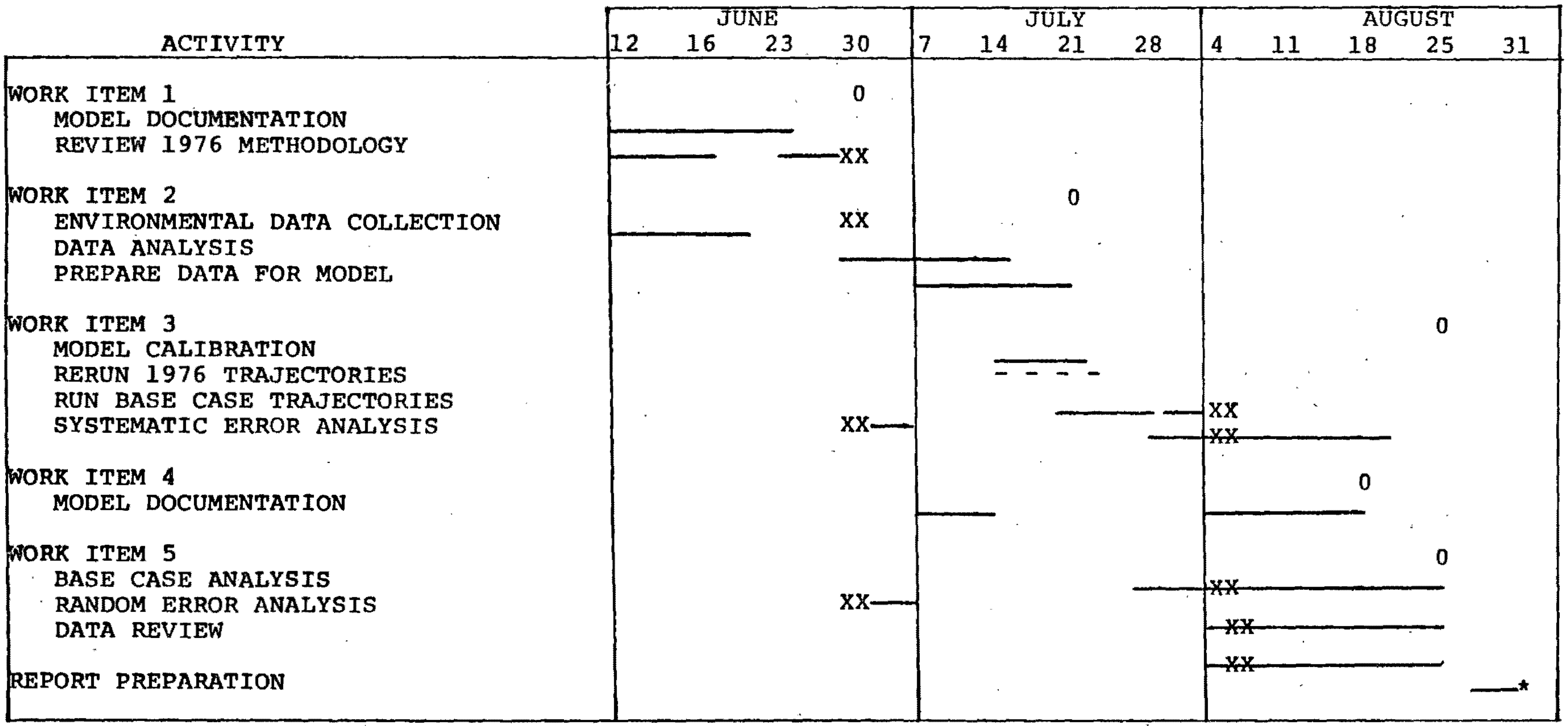
The focus in this proposal is on the surface transport of a coherent oil film. However, other processes may be important. For example, subsurface release mechanisms (as in a pipeline leak) have not been considered. These may be more important to pelagic and benthic communities than the "traditional" surface spills.

2) Spreading

This effort will focus entirely on the movement of the centroid of an oil slick. For larger

OIL SPILL TRAJECTORY ANALYSIS
MILESTONE CHART

PRINCIPAL INVESTIGATOR: ROGER SCHLUETER



0: Planned Completion Date
X: Direct OCSEAP/Dames & Moore Interaction
*: Final Report Submittal
----: Activity Contingent on Results of Work Item 1

spills, this approach becomes inadequate in that a wide range of spreading and dispersive phenomena can affect the final shoreline impact.

3) Other Physiochemical Processes

Both from operational, planning, and impact evaluation points of view, the many other processes affecting an oil slick may be quite important. These include evaporation, sinking, beach processes, oil/ice interaction, and so forth.

XVII. Standard FY79 Clauses

Subsections 1-8 are not applicable.

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."

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August 1, 1978

Outer Continental Shelf Environmental
Assessment Program
Bering Sea - Gulf of Alaska Project Office
P. O. Box 1808
Juneau, Alaska 99802

Attention: Mr. Mauri J. Pelto
Juneau Project Office

Gentlemen:

Amendments to the Statement of Work
dated June 1, 1978
Oil Spill Trajectory Analysis
RFx41-D&M-346
National Oceanic and Atmospheric Administration

The attached original and four copies of amending pages to our original proposal dated June 1, 1978 are in response to our meeting in Seattle on July 26, 1978. These pages should now be considered an integral part of our original proposal.

These amendements correspond to our verbal agreements and should allow us to begin the work. Please contact me if there are further questions.

Yours very truly,

DAMES & MOORE

Roger S. Schlueter
Acting Principal-In-Charge

RSS/nrr

Attachments

STATEMENT OF QUALIFICATIONS

PROJECT MANAGER

Dr. M. David Maloney is a project physicist assigned to Dames & Moore's Bethesda office. He received a B.S. in physics from Boston College in 1966, and a Ph.D. in Solid State Physics from Brown University, in Rhode Island in 1971. During the course of his undergraduate and graduate work he gained one year's experience doing experimental and theoretical work in semi-conductor properties and in shock wave analysis at the Harry Diamond Laboratories in Washington, D.C. He also held summer positions in molecular biology at the National Institutes of Health, Bethesda, Maryland and in cybernetics at the U.S. Patent Office. In 1967, he lectured in molecular genetics at the University of Virginia Department of Psychology.

Dr. Maloney has served as a principal investigator at Dames & Moore in statistical diffusion problems and modeling, including atmospheric diffusion, groundwater diffusion, oceanic diffusion and meteorologic modeling. He has developed algorithms for the simulation of hurricane and tornado storms. He has conducted comparative reviews, both in the office and in the field, of ocean surge modeling efforts and calibration schemes for these models. The calibrations involved the application of various distribution functions in the statistical analyses of tide records and water marks. He has performed thermal model calculations for the rejection of heat to soils, wetlands and marine environments.

Recently, Dr. Maloney undertook an R&D project in the area of oil spill dispersion modeling, resulting in a number of optional algorithms representing probabilistic and deterministic descriptions of the following processes: oil slick spreading, center of mass trajectory, evaporation, dissolution, emulsification, oxidation/degradation, subsurface transport and settling.

TECHNICAL PROPOSAL

VI. General Strategy and Approach

A. Documentation

i) Dames & Moore will include as part of the final report an annotated listing of both programs that constitute the oil spill model. Since they are not pertinent to this study, all portions of the codes dealing specifically with spreading calculations will be deleted.

ii) Formatted printouts of all gridded wind and current data for the base cases will be included as part of the final report.

iii) All output of computer runs included in the final analysis will be provided to OCSEAP. This output will show date and system time of the run plus all non-environmental input data.

C. Error Analysis

Three physically and environmentally disparate sites for error analysis will be selected in conjunction with OCSEAP personnel; all error analysis will be based on these sites.

XV. Management Plan

Dr. David Maloney will act as project manager for this study. Dr. Roger Schlueter will guide the technical direction and quality of the effort and act as interface between Dames & Moore and OCSEAP personnel.

We now expect the project initiation date to be September 1, 1978; the elapsed time and milestone schedule remains unchanged. This revised schedule is contingent upon the requisite wind and current data being received prior to September 1.

Other milestones are listed below:

September 15 -	all spill sites determined
September 30 -	Mr. M. Pelto to meet with Dames & Moore in Los Angeles for the purpose of progress review
October 9 -	Dr. Schlueter to meet OCSEAP personnel in Juneau with results of data review on previous project
November 30 -	final report submitted.

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

Proposal Date: June 15, 1978
Contract #: 03-6-022-35210
NOAA Project #: RU 460

FY 1979 RENEWAL PROPOSAL

Research Unit Number 460

Title: Analysis of Numeric Monitoring Techniques on Populations at Large Seabird Colonies

Cost of Proposal: FY 1979: $40,543
FY 1980: $15,939

Lease areas Chukchi 100%

Period of Proposal: October 1, 1978 through March 31, 1980. Final data analyses and report preparation will occur after the 1979 field season, i.e. from mid-September 1979 to March 31, 1980.

Required Signatures:

Principal Investigators:
Name Alan M. Springer Date 23 June 78
Name David G. Roseneau Date 23 June 1978
Address RRCS, Ltd. 3529 College Rd., Fairbanks, Alaska 99701
Telephone (907) 479-2669

Name Edward C Murphy Date 23 June 1978
Address Institute of Arctic Biology Univ. of AK, Fairbanks, AK 99701
Telephone (907) 479-7672; 479-2141

Required Organization Approval and Financial Officer:
Name David G Roseneau Date 23 June 1978

(3) Technical Proposal

I. Title: Analysis of Numerical Monitoring Techniques on Populations at Large Seabird Colonies.
Research Unit Number: 460
Contract Number: 03-6-022-35210
Proposed Dates of Contract: October 1, 1978 through March 31, 1980.

II. Principal Investigators: Alan M. Springer
David G. Roseneau
Edward C. Murphy

III. Cost of Proposal for Federal Fiscal Year (October 1, 1978 through September 30, 1979).
A. Science: $ 36,173
B. PI. provided logistics: $4,370
C. Total: $40,543
D. Distribution of effort by lease area: Chukchi Sea 100%

IV. Background:

An accurate and efficient numeric monitoring system on population numbers of large colonial seabird rookeries has not been devised. The lifespans of OCSEAP studies are too short to have encountered and documented long-term changes in numbers and species composition. However, at Cape Thompson, Alaska we have historical data from 1959-1961 and access to detailed field notes and photographs of L. G. Swartz, University of Alaska, who conducted the seabird studies during that period. The complete colony censuses of 1976 and 1977 indicated a decline of about 50% in numbers of murres *(Uria aalge* and *U. lomvia)* and less marked declines of kittiwakes *(Rissa tridactyla)* between 1960 and 1976-1977. Using these apparent natural declines in numbers as an analogue of possible future offshore petroleum-related events, the proposed research by RU 460 will be a two-stage effort: first to test the validity of using a small subplot approach to estimate total colony numbers, and secondly to field test the indicated approach and statistical treatments.

Swartz presented his 1960 murre counts not only as raw counts but also attempted to adjust the raw scores according to diurnal patterns of colony occupation by the murres. In 1977 we noted considerable variability in the time of day that maximum numbers occurred and we now question the accuracy of such "time-compensations". In addition, information from banding studies in Great Britian (C. M. Perrins, Oxford University, pers. comm.) suggests that numbers of individuals present at a colony may vary seasonally, as immature individuals apparently are not present at breeding colonies the entire breeding season. Thus, we will devote additional research effort to quantify diurnal and seasonal variation in numbers of individuals occupying selected sample plots.

The study will provide a methodology for efficient monitoring of seabird populations, a necessary first step for the detection of adverse effects of offshore petroleum-related activities on seabird populations. Yet murres and kittiwakes are slow-maturing and long-lived, and events which affect lower links in the food chain may not result in numeric declines at colonies for several years. Our experience to date suggests that productivity is particularly sensitive to variability in abundance of food species. Therefore a framework for monitoring productivity may represent a more sensitive and sophisticated approach to the detection of adverse effects of offshore petroleum-related activities on seabird populations. Concurrently with the above studies of population numbers we are planning to expand studies of productivity at Cape Thompson.

Although RU 460 is assigned to the Chukchi Sea, the project is essentially non-site specific, or general, in its application. Previous studies at Cape Thompson provide a historical perspective unique in OCSEAP studies of colonial seabirds.

V. Objectives

1. To test the suitability of counts on a small number of sampling plots for monitoring numeric changes of seabird populations.

2. To evaluate the precision, efficiency and practicality of simple random, stratified and multi-stage sampling techniques.

3. To field test the validity of a sampling technique chosen on the basis of the previous objectives.

4. To quantify diurnal and seasonal variation in numbers of murres and kittiwakes occupying the rookery.

5. To evaluate the use of productivity data for monitoring the effects of petroleum-related activities on seabird populations.

VI. General Strategy and Approach

Preliminary statistical analyses of variance will be run to evaluate the precision with which various sampling techniques and intensities monitor overall changes in population numbers between 1960 and 1976-1977. In 1979 we will conduct a complete census again and critically evaluate the sampling techniques deemed most suitable in the preliminary analyses. The census will be conducted in late July-early August, as were previous censuses at Cape Thompson. Two observers in a small boat will count numbers of murres and kittiwakes on each of the census plots originally mapped by L. G. Swartz in 1959. Concurrently two observers on shore will conduct hourly counts of murres and kittiwakes on specified sample plots. In the past these latter data have been used to "time-compensate" the raw scores. In 1979 we will test the validity of time-compensation thoroughly. Every several days we will conduct hourly counts of murres and kittiwakes on specified plots for 12 to 24 hour periods. During the one month period when four people are employed in the field we will expand the coverage counting at four plots simulaneously to determine if diurnal patterns of colony occupation by murres and kittiwakes are synchronous throughout the rookery. In their entirety the counts on the sample plots provide data on seasonal as well as on diurnal changes in number of seabirds at the colonies.

On days when counts are not being made we will collect productivity data. Weather permitting, we will visit each kittiwake nest and murre ledge on the following schedule: each day during egg-laying, once a week during incubation, each day during hatching and every fifth day after hatching. About 50 kittiwake nests and ledges containing up to 100 murre eggs are accessible for determination of egge weights and growth rates of young. Using a mirror on a 5 m pole we will be able to visually examine another 50-100 kittiwake nest for additional data on clutch size, hatching success, and fledging success. We also hope to weigh and band large numbers of young murres when they leave the cliffs; in many regions of the rookery they must cross small areas of beach before reaching the sea.

VII. Sampling Methods

The main objective of the study is to evaluate the efficiency, accuracy and practicality of several sampling techniques, e.g. simple random sampling, stratified sampling and two-stage sampling, using the census data. The census will be conducted in the same manner as in previous years to provide comparable results.

Weather permitting, the studies of diurnal patterns of cliff occupation will be conducted every fourth or fifth day. Each hour during a 12 to 24 hour sampling period, we will record total numbers of murres and kittiwakes present on two to four sample plots.

We will examine as many kittiwake nests and murre ledges as are safely accessible. Much of the rookery is innaccessible. From other studies we know that productivity varies between the center and periphery of rookeries. Unfortunately central portions of the Cape Thompson colonies are innaccessible and consequently, our results may not be representative of the entire rookery. Yet the study sites will be the same as those of previous seasons, thus permitting comparisons among years and quantification of interannual variation in reproductive success.

VIII. Analytical Methods

We will first conduct an analysis of variance (ANOVA) on the data from the 1960. 1976 and 1977 censuses. The ANOVA will be of mixed design: colony and year will be considered fixed effects; plots, being nested within colonies, are random effects. The statistical analysis is outlined in R. R. Sokal and F. J. Rolff (1969. Biometry. Freeman, San Francisco) and the rationale of the design is discussed by B. J. Winer (1956. Statistical Properties in Experimental Design. McGraw-Hill, New York). We will use the ANOVA program BMDP2V (Dixon, W. J. 1975. BMDP Biomedical Computer Programs. Univ. of California, Berkeley), which is available at the University of Alaska Computer Network. To further quantify the degree to which changes on individual plots reflect overall changes in numbers between years we will use correlation analyses (e.g. Sokal and Rolff, 1969).

A factorical ANOVA, grouping data by hour of day and Julian date, will be used to quantify the relative importance of diurnal and seasonal variation in numbers at the colonies. Plots of the data will allow visual assessment of the patterns and suggest the direction of additional analyses. J. C. Davis (1973. Statistics and Data Analsis in Geology. Wiley, New York) discusses statistical analysis of temporal sequences of data.

Data on productivity will be screened for skewness and kurtosis. The mean values of variables which are normally distributed will be compared with those for other years using the Student-Newman-Keuls procedure (e.g. Sokal and Rolff 1969). We will compare the distribution of variables which are not normally distributed (e.g. clutch size of kittiwakes) with those from other years with the Kruskal-Wallis test (Conover, W. J. 1971. Practical Nonparametric Statictics. Wiley, New York).

IX. Deliverable Products.

A. Digital Data.

We will utilize records A through J of the A35 New Bird Colony format (see p.10, Digital Data Products Schedule). On many of these records, however, there are fields which are either inapplicable or beyond the scope of this study. Some examples are noted here. On records F and I we will not measure tarsus, culmen, wing, or primary. On records G we will not record information on nest attentiveness of adults. We will not know the date on which a particular fledging leaves the study area and will leave this field blank on record H.

In general there is sufficient space provided in all applicable fields for minimum and maximum values. The only exceptions are the fields for dimensions on record B -- the study area and applicable area are too large for dimensions to be expressed in terms of meters squared in the 5 and 6 column fields.

The digital data of the proposed study will include sub-plot and subcolony counts (Objectives 1 through 4) and data on breeding phenology, egg weight, clutch size (kittiwakes only), hatching sucess, growth rates of young and fledging success (Objective 5).

B. Narrative Reports: As required of all OCSEAP reports.

Specifically, this effort will develop and recognize a methodology for small and efficient subsampling of large colonies of two species of murres and one kittiwake species, using the only rookery available with excellent historical documentation plus documented population changes. This methodology will be an important tool in the eventual process of monitoring for effects of offshore development in Alaska, as it will indicate the most cost-effective way to detect substantial populations changes of key colonial seabirds within a short period to time.

C. Visual data: Photographs of the colonies showing boundaries of census plots.

X. Quality Assurance Plan.

The only instruments to be used in the field portion of the study are vernier calipers, which we will use for measuring eggs, and Pesola spring scales for weighing eggs and young. Every several days we will check the accuracy of the scales using a set of weights.

We will emphasize here and in all reports that data on productivity may not be representative of the entire rookery, as there is no practical way to measure productivity in central portions of colonies at Cape Thompson.

The analytical techniques described in part VIII of this section are standard statistical procedures. We will use techniques of analysis appropriate to the nature of the data.

XI. Special Sample and Voucher Speciman Archival Plans. N/A

XII. Logistics Requirements. None (see pp. 11-15, "Logistics Requirements")

XIII. Anticipated Problems.

The only major problem which we might encounter is inclement weather. A severe storm would necessitate schedule revision but would not seriously affect successful completion of the proposed work.

XIV. Information Required from other Investigators.

All current data on chemical, physical and biological oceanography of the Chukchi Sea will be useful in interpreting population ecology of the seabirds breeding at Cape Thompson. Of particular interest are results of plankton and fish trawls and data on the natural history of principal prey species of murres and kittiwakes.

XV. Management Plan.

The PI's will be responsible for both financial and scientific management of this project. Maintanence of all financial records and book-keepign except detailed accounting of the subcontract will be done by RRCS, Ltd., Edmonton. Bookkeeping for the subcontract will be the responsibility of the Institute of Arctic Biology, University of Alaska, Fairbanks.

XVI. Outlook.

The results of this study will suggest an efficient scheme for monitoring seabird numbers. We hope that the sampling techniques appropriate for estimating numbers of murres and kittiwakes at Cape Thompson will also be valid for colonial seabirds at other breeding colonies. In the 1979 Annual Report we will present the final results and recommendations for monitoring of population numbers.

Once we have completed the analysis of numeric sampling techniques, we plan to focus our research efforts on more detailed studies of productivity. The productivity data we plan to collect in 1979 will be important in determining the direction and scope of the future studies. We anticipate that productivity studies will provide insight into the dynamics of numeric fluctuations, which we will continue to monitor. Cape Thompson is an ideal location for long-term demographic studies of seabirds due both to its historically unique data base and postponement of petroleum leases in the Chukchi Sea. Interannual variability in numbers of birds at breeding colonies and in breeding success may be of sufficient magnitude to preclude meaningful insight from short-term, i.e. one to three year, studies.

The Arctic Project Office has estimated a total cost of 40,000 for this study. The descrepancy between our proposed budget of 56,482 and this figure is due to inclusion of objectives 4 and 5 in the present proposal. Quantification of seasonal changes in numbers and the collection and analysis of productivity data (Objectives 4 and 5) will cost approximately $13,700 ($12,470 for salaries, overhead, and fees; $630 for food; $300 for oil, fuel and propane; and $300 for data analysis). This amount will be essential in clearly defining the future scope and direction of the study, but is not necessary for the completion of the primary objectives (1,2 and 3) of this proposal, which represent our current focus.

XVII. Copy of 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 comformity 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 perdiem 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 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."

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 Colony						
Location and Period of Study	Cards	1	A35, Rec A	Yes	6/79 - 8/79	3/80
Description of Study Area	Cards	1	A35, Rec B	Yes	"	"
Chronology of Nesting Season	Cards	4	A35, Rec C	Yes	"	"
Analysis of Production	Cards	12	A35, Rec D	Yes	"	"
Egg and Chick Mortality	Cards	4	A35, Rec E	Yes	"	"
Chick Growth	Cards	300	A35, Rec F,I	Yes	"	"
Nest History	Cards	150	A35, Rec G	Yes	"	"
Egg and Chick History	Cards	300	A35, Rec H	Yes	"	"
Census of Area Population	Cards	360	A35, Rec J	Yes	"	"
Text Record	Cards	100	A35, Rec T	Yes	"	"

MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date

RU # 460 PI: Springer, Roseneau and Murphy

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
Preliminary Data Analysis								0										
Field work												0						
Final Data Reduction and Analysis															0			
Completion of Annual Report																		0

PROPOSAL

Winter Research on Fish and Epibenthic Invertebrates, Nearshore Beaufort Sea

Research Unit 467

by

Joe C. Truett

LGL Limited-U.S., Inc.
environmental research associates
4600 Dale Road
Fairbanks, AK 99701
(907) 479-6519

submitted to

Dr. Gunter Weller
OCS Arctic Project Office
506 Elvey Building
University of Alaska
Fairbanks, AK 99701

2 August 1978

PROPOSAL

Winter Research on Fish and Epibenthic Invertebrates, Nearshore Beaufort Sea

Introduction

The Bureau of Land Management has indicated a need for information on characteristics and processes of the nearshore Beaufort Sea in winter. Investigators already funded for research in the nearshore Beaufort have been asked to propose winter research that they consider relevant to BLM's interests in assessment of impacts of OCS development.

LGL Limited-U.S., Inc. proposes the following research effort for winter studies of fish and epibenthic invertebrates.

Objectives

Objectives are to

1. investigate the distribution and provide an initial characterization of the ecological dependencies of anadromous (and to some extent, marine) fishes in the nearshore zone in winter.
2. document the general distributional characteristics of common epibenthic species in the nearshore zone in winter, giving special consideration to physical habitat factors (water depth, salinity, etc.) affecting this distribution.
3. provide an interpretation of the life histories of fish and invertebrate populations encountered, such that inferences can be made about how winter distributional patterns relate to the survival strategies of the important species.

Rationale

Recent studies (RU 467) show that important anadromous species of fish may overwinter in the brackish waters of nearshore areas. It was formerly thought that these fish were mostly confined to fresh-water streams in winter. Investigations of RU 467 also indicate that some of the invertebrate species that are important as food for fish and birds migrate seasonally between the lagoons and the marine environment. The seasonal movement and distributional patterns of these invertebrates need to be clarified so that the affects of development upon these patterns can be evaluated.

Methods

Fish

Sampling will be conducted during two time periods: 1-20 November 1978 and 20 April-5 May 1979. The primary area of sampling at these times will be in the vicinity of Simpson Lagoon. Three sites will be selected, one in the center of the lagoon between Pingok Island and Oliktok Point (water depth about 4 m), one seaward of Pingok Island at the 6-8 m depth contour, and one in Harrison Bay near the Colville Delta. Gill nets will be set under the ice for a period of several days at each site.

The second site recommended for fish sampling is in Leffingwell Lagoon behind Flaxman Island. We propose to sample at two places there---inside and seaward of the lagoon---in water depths similar, respectively, to the lagoon and marine sites at Simpson Lagoon. This sampling effort will be contingent upon a concurrent research effort in this area by other OCS investigators (e.g., Drew Carey and/or others). We propose to have biologists accompany these other investigators and either sample or direct the sampling of fish and invertebrates at the selected sites of study in the area of the Flaxman Islands.

Fish caught at these sites will be analyzed for condition, food habits, and life history data (sex, age, etc.). Interpretations of the feeding and habitat dependencies of the fish in winter will be made on the basis of these analyses in conjunction with the physical habitat factors (salinity, temperature, water depth, etc.) measured at the sampling sites.

Invertebrates

Two sampling periods, 1-20 November 1978 and 12 April-5 May 1979, are proposed for the winter program of epibenthic invertebrate research. The sampling sites and dates will be the same as those proposed above in the fish sampling program.

1-20 November 1978: At each site epibenthic invertebrates will be sampled by using baited traps and by towing a small Wildco dredge along the bottom. Baited traps---meat for amphipods and light sticks for mysids---will be placed just under the surface of the ice, at mid-water, and on the bottom. Traps will be checked and trawls conducted each time the gill nets are pulled from the water.

20 April-5 May 1979: During this period an under-ice diving program will be conducted from the cabins on Pingok Island. Diving operations will be carried out in the nearshore marine habitat and in a deep portion of Simpson Lagoon. The divers will collect invertebrates from several habitat types (e.g., under-ice, water column, and near bottom) using airlifts, hand operated nets, etc. Quantitative estimates of densities will be determined using quadrants and underwater photography. In addition, baited traps and the small trawl will be utilized in conjunction with the diver observations making it possible to evaluate the effectiveness of the traps and trawls as sampling devices. Correction factors can then be applied to the results of the November samples to account for some of the sampling inadequacies of the trawls and traps.

1979 Proposal
R.U. 473

TITLE: Shoreline history and processes, Beaufort Sea

PRINCIPAL INVESTIGATOR: David M. Hopkins

TOTAL COST OF PROPOSAL:	OCSEAP	$ 48,154
	OCSEAP-logistics	[18,800]
	USGS Contribution	[16,430]
	Total	$[83,384]

75% of this work will be conducted within the Beaufort Sea lease area and 25% will be conducted in areas immediately to the east.

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 K Smith (acting Chief Alaskan Branch)

Address 345 Middlefield Road, Menlo Park, CA 94025

Telephone FTS 467-2231

Organization Financial Officer

Name Elwood H. Like for Barbara L. Keville

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: Shoreline history and processes, Beaufort Sea
Research Unit: 473
Proposed Dates: October 1, 1978-September 30, 1979

II. Principal Investigator: D. M. Hopkins

III. Cost of Proposal for Federal Fiscal Year

A.	Science	$ 48,184	
B.	NOAA-provided Logistics	[18,800]	
C.	USGS Contribution	[16,430]	
D.	Grand Total	$[83,384]	
E.	Distribution of effort:	Beaufort Sea lease area	75%
		Coast of Arctic Wildlife Range immediately to east of Beaufort Sea lease area	25%

IV. Background

This study was originally conceived to provide supporting data for the development of an understanding of the distribution of offshore permafrost to supplement studies R.U. 105, 204, 253, 271, and 456. Discussions at the 1977 Barrow Synthesis meeting showed that the study could also provide information needed to assess the biological and geological impact of gravel mining of beaches and barrier islands and the impact of construction of causeways, jetties, and artificial islands. In 1977, fieldwork was designed to emphasize these topics, with a great deal of success, leading to Hopkins' writing of the gravel-mining and artificial island section of the Beaufort Synthesis report and to a report by Hopkins and Hartz now in press on the morphology and dynamics of the coast and barrier islands of the Beaufort Sea. We are also in the process of measuring rates of coastal retreat, using sequential airphotos, in parts of the region between Flaxman Island and Icy Cape where data has not been provided by previous investigators.

During the next 10 months we will largely complete work on the segment of the coast from Flaxman Island to Point Barrow and intend in 1979 to extend the study eastward across the Arctic Wildlife Range to the Canadian border. We feel justified in doing this, because the Arctic Wildlife Range is likely to be strongly impacted by exploration and possible petroleum production in the extremely promising area (two discoveries!) near Thomson Point and Flaxman Island immediately to the west, and because it is highly probable that offshore exploration will soon be extended to the even more promising area offshore from the Arctic Wildlife Range.

TECHNICAL PROPOSAL (cont.)

V. Objectives

1. Survey lithology, stratigraphy, geochronology, paleoecology, and ice content of rocks and sediments exposed in selected sections of the coastal bluffs.

   Relevance: Provides data needed for prediction of horizontal and vertical distribution of bonded permafrost on the continental shelf and potential for thermokarst subsidence in adjoining offshore areas.

2. Collect information bearing on climatic history (summer, winter temperatures, thickness and continuity of snow cover) during last 30,000 years, in coastal northwestern Alaska.

   Relevance: Thermal history is a parameter needed for development of predictive models for offshore permafrost.

3. Identify gravel sources and gravel sinks along Beaufort Sea coast.

   Relevance: Permits recognition of sites in which gravel can be removed with relatively little ecological effect as well as areas in which gravel mining will have drastic consequences.

4. In particular, identify sources of gravel composing individual or groups of Beaufort Sea barrier islands and estimate their net migration over millenia-long time base.

   Relevance: Permits assessment of geological and ecological consequences of removal of barrier islands for construction of artificial islands.

VI. General Strategy and Approach

Airphoto interpretation, supplemented by overflights to identify geomorphic features providing information on long-term coastal changes and information on ancient sediments beneath the adjoining sea bed.

Visit selected segments of mainland coast in order to identify and date major geomorphic-lithologic units such as alluvial fans and ancient marine terraces. Excavate selected sections of bluffs in order to examine stratigraphy and to collect samples for geochronological, petrological, and paleoecological analysis.

Brief visits to barrier islands between Point Barrow and Flaxman Island to collect pebble samples for lithologic study and to obtain overall impression of trends of change in gravel size.

Radiocarbon- and amino-acid-dating of selected samples; petrological study of gravel samples; paleontological analysis of selected samples.

TECHNICAL PROPOSAL (cont.)

VII. Sampling Methods

Samples selected by eye to obtain those providing maximum geochronological or paleoecological information.

VIII. Analytical Methods

Radiocarbon dating. Amino-acid-racemization analyses for purposes of correlation and age estimates. Some thin-section microscopy to identify distinctive pebble types that can be related to specific sources. Paleontological studies (pollen, mollusks, and vertebrates).

IX. Deliverable Products

A. Digital Data - none

B. Narrative Reports

Report on genesis and migration of Beaufort Sea Barrier Islands.

Report on thermal history of Prudhoe Bay region during the past 30,000 years (this will be joint report of R.U. 204 and 473).

C. Visual Data

Maps showing erodibility of mainland coast, long-term erosion rates of different segments of the coast, and vertical position of highest driftwood line for segments of the coasts of Beaufort and Chukchi Seas.

D. Other Non-Digital Data - none

X. Quality Assurance Plan

1. Not applicable.

2. Standard field-geologic methods will be used for field measurements. Samples in general require no special procedures for preservation except that radiocarbon samples must be dried as quickly as possible to avoid mold and pollen samples must be carefully sealed to avoid contamination.

3. Fossil identification will employ standard and mostly traditional techniques. Radiocarbon and amino-acid studies will employ standard techniques.

4. Not applicable.

XI. Special Sample and Voucher Specimen Archival Plans

Samples archived in Principal Investigator's office until no longer needed and then to be discarded.

TECHNICAL PROPOSAL (cont.)

XI. Special Sample and Voucher Specimen Archival Plans (cont.)

Important paleontological specimens will be retained in collections of Paleontology and Stratigraphy Branch of U.S. Geological Survey as long as needed. Types, illustrated specimens, and other significant material will ultimately be deposited in the U.S. National Museum.

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

1. We will need to have our camp placed and moved as follows:

   NARL (Barrow) to Demarcation Point
   Demarcation Point to Barter Island
   Barter Island to Camden Bay
   Camden Bay to Flaxman Island
   Flaxman Island to NARL (Barrow)

2. No observations

3. Flights at 7-10 day intervals within the period July 15-Aug. 31.

   Detailed scheduling can be negotiated in spring, 1979.

4. These are 4-hour round trips for a plane operating out of Barrow or 2-hour trips for a plane operating out of Prudhoe Bay.

5. Other activities can piggy-back on these flights.

6. None

7. Total gear will weigh about 2,000 pounds; largest items will weigh 200 pounds (oil drums, Zodiac boat components).

8. Twin Otter

9. NARL or one of the contractors at Prudhoe Bay.

10. $350?

11. Two to four.

12. Prudhoe Bay or NARL (Barrow).

XII. Logistics Requirements (cont.)

C. AIRCRAFT SUPPORT--HELICOPTER

1. Helicopter needed for transportation to selected coastal locations to observe accelerated coastal erosion after autumn storms have removed accumulated snow and mud from faces of bluffs. These flights will go from Prudhoe Bay to selected points between Flaxman Island and Oliktok Point and possibly from NARL (Barrow) to Cape Simpson and Drew Point.

2. Helicopter wanted to transport personnel to ground sites where they will wish to work for 2- to 4-hour periods.

3. These flights should be made at some time during the period September 1-15. If flexibility is possible, the scheduling should be based upon the weather of that period.

4. Propose 4 hours per day for 4 days.

5. Two people.

6. Light field packs (20 kg per man) and possibly 30 kg samples on return trip.

7. Bell 204 or equivalent.

8. NOAA or ERA Helicopters.

9. $350

10. Prudhoe Bay and possibly NARL (Barrow)

11. No.

D. QUARTERS AND SUBSISTENCE

1. Quarters and subsistence at NARL will be required while field party is mobilizing and demobilizing. Mobilization will take place in late July or early August 1979, and demobilization during early to middle September of that year, and will involve four men per day for total of 8 days.

2. Yes--Navy Arctic Research Laboratory, because our field gear is stored there and because it is the most convenient place available on the arctic coast.

3. $100/per day/per man. Guesswork.

XIII. Anticipated Problems - none

Contingency Plan - Patience is the only contingency plan applicable to this sort of logistics. Airplanes and helicopters can be replaced if they break down, but it takes time. The only cure for bad weather is to wait for it to get better. Other than that, there is not much to be done.

XIV. Information Needed from Other Investigators - none

XV. Management Plan

Management is the responsibility of the Principal Investigator and the administrators of the Geological Survey. The Principal Investigator will lead and supervise the proposed work.

Milestone sheet is given on following page.

XVI. Outlook

At present, we do not expect to continue fieldwork after summer, 1979. About 15 months will be required beyond termination of fieldwork to complete analysis of specimens and writing of reports. No additional equipment and no further logistical assistance will be needed after fieldwork is completed in September 1979, but we may need an additional large quantity of airphotos.

Project costs to OCSEAP for FY 1980 will be about $45,000 and for FY 1981 about $15,000.

Results of this study are being furnished to OCSEAP as a series of reports complete in themselves. We will continue to furnish such short reports and do not contemplate a large overall monograph.

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.

MILESTONE CHART

O – Planned Completion Date

X – Actual Completion Date

RU # 473 PI: D.M. Hopkins

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	
Demobilize, unpack from field season	O												O			
Analyze 1978 field data								O								
Airphoto study of coastal retreat					O											
Report on rates of Annual Retreat						O										
Prepare for 1979 field work										O						
Field work, Cape Bullen to Demarcation Point											O					
Helicopter study of coastal retreat												O				
Analysis of 1979 field data																
Report on morphology and dynamics																O
of coast E. of C. Bullen																O

XVII. 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:

XVII. "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."

RENEWAL PROPOSAL TO U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration, Environmental Research Laboratories for "Characterization of Organic Matter in Sediments from Gulf of Alaska, Bering and Beaufort Seas"

OCSEAP RESEARCH UNIT NO. 480
CONTRACT 03-6-022-35250

I.R. Kaplan, Principal Investigator
Institute of Geophysics & Planetary Physics, UCLA
Telephone Number 213/825-1805
Social Security Number: 546-56-6808

M. I. Venkatesen, Co-Investigator
Social Security Number: 485-76-4406
Telephone Number: 213/825-1805

Leon Knopoff, Associate Director, IGPP
Telephone Number: 213/825-1580

Jerry R. Fabian, Contract and Grant Officer
Telephone Number: 213/825-0759

October 1, 1978 to September 30, 1979
Amount Requested: $96,017
Date Submitted: July 28, 1978

The Regents of the University of California
Institute of Geophysics and Planetary Physics
University of California, Los Angeles, California 90024

IV. Background

The studies to be undertaken in this project will be the analyses of total carbon, organic carbon, high and low molecular weight hydrocarbons. Some of the samples from Lower Cook Inlet were already collected in spring of 1978 and the rest from Lower Cook Inlet and Norton Sound will be collected during the summer of 1978 and 1979 using the NOAA ship DISCOVERER. Analysis of the samples collected in 1976 and 1977 are almost complete and the results will be provided in the forthcoming Annual Report. The Annual Report submitted in April, 1978 (RU # 480) contains most of the data regarding Cook Inlet samples.

<u>Current</u> <u>Research</u>: Results of analysis of samples from Norton Sound (1967 and 1977), Kodiak Shelf and Beaufort Sea were submitted in the Quarterly Report, July 1978 (copy enclosed). Gas chromatographic analysis is complete and the data reduction is in progress. GCMS analysis of these samples will be performed in the second half of this year. Analytical difficulties have been resolved this year and smooth analysis of samples is possible. The details of the methodology followed are presented in the Annual Report, April 1978 (RU # 480). The major modifications introduced in the analytical procedures are as follows:

1. Wet extraction of the sediments with methanol for 24 hours followed by toluene:methanol (3:7) for 76 hours was carried out instead of freeze-drying and extracting with toluene-methanol only. This method eliminated any possible contamination from the freeze-drier.

2. A new silica gel column procedure (Dr. Bieri, Virginia Institute of Marine Sciences) was adopted which gave aromatic fractions free of methyl esters.

3. SCOT columns were replaced by glass capillary columns, which gave better resolution of the components. GCMS analysis are carried out on a Finnigan Model 4000 Quadrapole Mass Spectrometer directly interfaced with a Finnigan Model Gas Chromatograph. The mass spectrometric data are processed through a Finnigan Model 2300 Data System.

V. Objectives:

The major objectives of the investigation will be the analysis of both light and high molecular weight hydrocarbons in surface sediments from the two lease areas, Lower Cook Inlet and Norton Sound. Particular emphasis will be placed on analysis of sediments from the western part of Cook Inlet , where very few samples have so far been collected and analyzed, and the upper part of Cook Inlet, where exploration and production activities are underway.

In Norton Sound, samples will be collected at stations close to places suspected of containing natural seeps. In short, our three major objectives are:

1. Investigate light and heavy aliphatic and aromatic hydrocarbons in surficial sediments from Cook Inlet collected from areas suspected as zones of high deposition of suspended matter derived from Upper Cook Inlet and from areas which may have been impacted by exploratory drilling in Lower Cook Inlet.

2. Investigate the light and heavy aliphatic and aromatic hydrocarbon composition of sediments from the Norton Sound seep area to provide better definition of hydrocarbons emanating from the seep and to determine geographic spread of seep hydrocarbons.

3. Participate in continuing intercalibration and methods evaluation programs for both light and heavy hydrocarbons.

The seep in Norton Sound is believed to bring both gaseous and liquid hydrocarbons to the surface (J. Cline, RU 153; Kvenvolden, USGS). It is our objective to characterize and determine the distribution of hydrocarbons with depth in cores from the seep to elucidate hydrocarbon flux and to determine the geographical extent of seep-derived hydrocarbons to gain information on transport and weathering processes.

In addition to the above areas, samples have previously been collected in central and eastern part of the Cook Inlet, Norton Sound, Beaufort Sea and Kodiak Shelf and the data reduction of the gas chromatograms is in progress as mentioned earlier.

VI. Strategy and Approach

The procedures to be followed on the samples will be two-fold: 1) Low molecular weight hydrocarbons have been identified from samples of sediment stored in cans closed at the time of sampling. These cans will be kept frozen until the time for analyses. A measured volume of head space gas will be removed and injected into a gas chromatograph for compound identification and quantification. 2) High molecular weight hydrocarbons will be extracted by the procedures described in the Methodology Section. In addition to the procedure described for extraction and column chromatographic separation of the hydrocarbons, ten percent of all extracts will be analyzed by computerized GC-mass spectrometer to confirm the compound composition.

Where possible, the following information will be obtained:

1. Total weight of nonsaponifiable fractions,
2. Total weight of aliphatic hydrocarbons,
3. Total weight of aromatic hydrocarbons,
4. Pristane/n-C_{17} ratio,
5. Phytane/n-C_{18} ratio
6. Odd/even carbon ratio
7. Identification of homologous n-alkane series
8. Identification of individual aromatic compounds for fractions whose GC/MS analysis is carried out.

In addition to the above, the organic content will be further characterized by analysis of total carbon and organic carbon in the sediment. Mylar overlays of location, nonsaponifiable total and organic carbon content will be submitted.

A. Sampling Method:

During the past sampling season, we have used a sampling device and procedure which has recovered samples large enough for trace metals, grain size, sediment texture, and microbiology analyses. Its great advantage is that is does not "blow away" the surface layer of sediment prior to collection as other devices tend to do.

In the characterization and determination of baseline concentrations of hydrocarbons in recent sediments, it is critical that the surface layer be quantitatively collected because changes in the distribution of hydrocarbons in sediments as a result of petroleum development, will initially be detected in the surface layer. Furthermore, it is essential that the samples are not contaminated with hydrocarbons during the collection procedure, for example, from paint or grease on the sample collection device.

With these requirements in mind, a modified aluminum Van Veem grab sampler, constructed of non-contaminating materials and capable of quantiatively collecting the sediment surface was purchased at UCLA in order to collect samples during the 1976 summer sample collection period.

This sampling device was developed by A. Soutar for the Southern California Baseline study, and we were able to successfully use it in Alaskan OCS environments. The main features of this sampler, which is illustrated in Figure 1, are (1) the incorporation of a frame which orients the grab normal to the sediment surface, a completely vented top which not only prevents blowing away of the fine surface layer but allows easy access to the sample after recovery, (2) the use of aluminum, stainless steel and teflon in construction, which precludes any contamination from hydrocarbons or trace metals, and (3) ability to collect

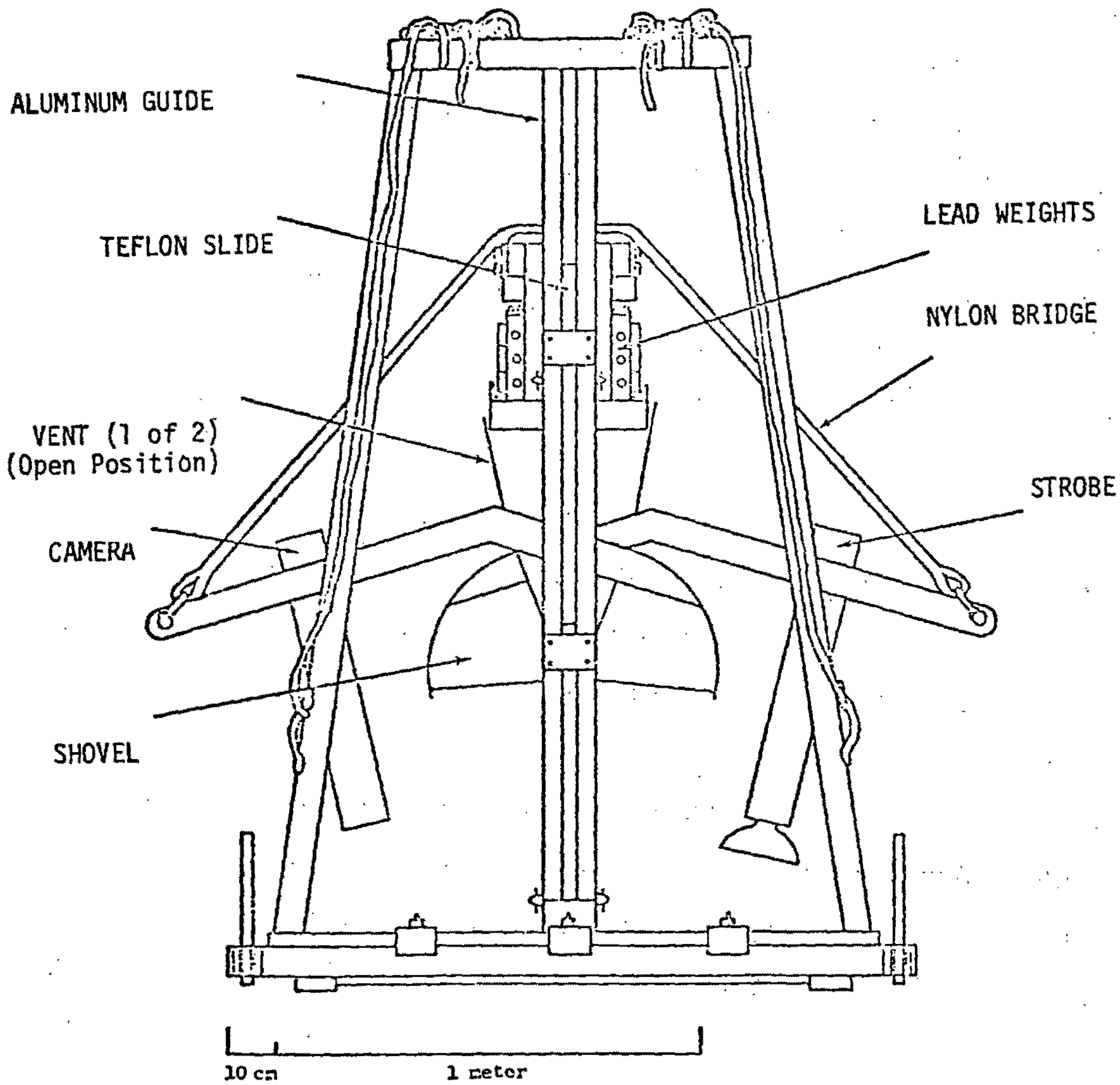


FIGURE. 1. Frame Supported Van Veem Grab Sampler

sand and gravel sediments.

The volume of sediment recovered is usually sufficiently large so that replicate HMWHC and LMWHC samples can be collected. Moreover, there was sufficient sediment for other investigators to collect samples for trace metals, Pb-210, foraminiferal, microbiological or textural analyses.

In addition to this improved sampling device, a procedure for subsampling that is accurate, reproducible and non-contaminating was used. This procedure has been developed for use in the BLM Southern California Baseline Analysis Program, and involves the use of a template and scoop which allow sampling from 0-2 to 2-4 cm depths on the undisturbed surface layer of sediment recovered in the grab sampler.

When the grab sampler is brought on deck, a plastic bag is placed beneath the weight stand to prevent water from the hydrowire or weights from dripping into the sample. The top-loading doors are opened, and any supernatant water is siphoned off. Pre-cleaned templates for MWSHC samples and stainless steel core tubes for LMWHC subsamples are pushed into the sediments. HMWHC subsamples are taken with a stainless steel scoop by sliding the scoop along the template. Thus, accurate, repetitive samples of 0-2 and 2-4 cm depths could be taken. If it appears that the surface layer has been disturbed during the sample collection, the template is not used and bulk or surface and subsurface samples are collected with a stainless steel spoon.

Upon recovery, the sample is inspected and graded on a subjective scale of 1 (poor) to 5 (excellent). For example, an excellent sample has an essentially flat surface, the supernatant water is clear, and fine particulate material are present. In some cases, intact polychaete tubes protruded from the surface or mullusks, arthropods, etc. are recovered, indicating little disturbance at the sediment-water interface of the recovered sample.

B. Analytical Methods

High Molecular Weight Hydrocarbons (HMWHC)

Samples will continue to be analyzed according to methods outlined in our Annual Report, April 1978, on "Characterization of Organic Matter in Sediments from Lower Cook Inlet" (copy enclosed). Table 1 provides the flow chart of the essential steps involved in the analysis of sediments. Gas chromatograms of two of the samples analyzed this year are presented in Figures 2 and 3. A glass capillary column (OV-101) was used in the Hewlett-Packard Model No. 5830A modified with a grob injector and equipped with flame ionization detector and electronic integrator. The column was temperature-programmed at 4°/min. from 35°C to 260°C and held isothermally for about 2 hours. Hexamethyl benzene (HMB) was used as an internal standard. The integrator values were fed into a PDP 11 Digital Computer and the data processed by using the program RATIO 1, a revised version of the original RATIO 1 (GCSAI) to include a new method of handling KOVATS. The computer printout of the data including ratios of different parameters is shown in Table 2. The same procedure will be followed for all samples.

Intra-laboratory separation and recovery efficiency will be determined using a synthetic hydrocarbon mixture and precision and inter-laboratory comparability will be determined by analysis of a reference sediment.

Low Molecular Weight Hydrocarbons (LMWHC)

Sediments will be placed in pint cans approximately 1/2 - 3/4 filled and distilled water will be added to almost fill the can. It will then be hermetically sealed on the ship and frozen.

In the laboratory, the sediment samples will be defrosted and the cans will be shaken in a "paint shaker" to dislodge the gases into the air space. A measured aliquot of air will then be sampled and injected into the gas chromatograph. Peak heights of individual compounds will be determined and the amount of individual gases computed. The method followed has been described in greater detail in the Annual Report (March, 1976).

TABLE 1. HMWHC METHODOLOGY

Frozen sediment
↓ thaw
Transfer into precleaned cellulose thimble
↓
Wash with 150 mℓ of org. clean 2 × dist. H_2O

Sediment
↓
Extract with MeOH → Extract with 3 × 100 mℓ hexane after diluting with water
↓
Hexane ext. (A)

Extract with MeOH
↓ 24 hours
Extract with Tol:MeOH 76 hr. (C) (3:7)

Water Wash
↓
Extract with 3×30 mℓ hexane
↓
Hexane ext. (B)

Combine (A), (B) and (C)
↓
Rotoevaporate to 5 mℓ
↓
Test for S
↓
If positive, remove S with Cu column
↓
Transfer to 100 mℓ flask
↓
Rotoevaporate to 5 mℓ
↓
Saponify for 4 hrs. with 1 N KOH in H_2O:MeOH
↓
Extract with 3×30 mℓ hexane after diluting with equal volume of Sat. NaCl.

Hexane (non sap. fr.) | Aqueous layer reject

Hexane (non sap. fr.)
↓
S. gel column

Hexane Eluate Aliphatics | Hex::Ben. (3:2) eluate Aromatics

→ GC and GCMS

VII. Deliverable Products

A. Digital Data

1. The following parameters will be supplied for the measurements which will be made:

   a. Total carbon

   b. Total organic carbon

   c. High molecular weight hydrocarbon

      (1) total weight of extractable lipid

      (2) total weight of aliphatic hydrocarbon

      (3) total weight of aromatic hydrocarbon

      (4) individual parameters for high molecular weight hydrocarbons:

         i. concentration list of individual HMWHC

         ii. pristane/n-C_{17} ratio

         iii. phytane/n-C_{18} ratio

         iv. odd/even carbon ratio

      (5) GC-mass spectrometer identified single compounds (aliphatic and aromatic)

   d. Concentration list of individual LMWHC

2. It is impossible to assign specific numbers for the parameters, because they depend on the exact components identified which may be quite variable from sample-to-sample.

3. Accuracy of the data will be performed by internal checking prior to submission.

B. Narrative Reports

All annual and final reports will have a narrative content. This will consist of a description of the sampling sites, the sampling and analytical procedures, the results and interpretations.

C. Visual Data

Visual data will be submitted in the form of maps, figures of gas chromatograms, figures of mass chromatograms, figures of data distribution either as linear plots or bar diagrams. Maps will be in the form of mylar overlays of the standard maps obtained from OCSEAP.

FIGURE 2.

Aliphatic Hydrocarbon
Chromatogram
for
Norton Sound Station #47

Collected in the Fall
of 1976

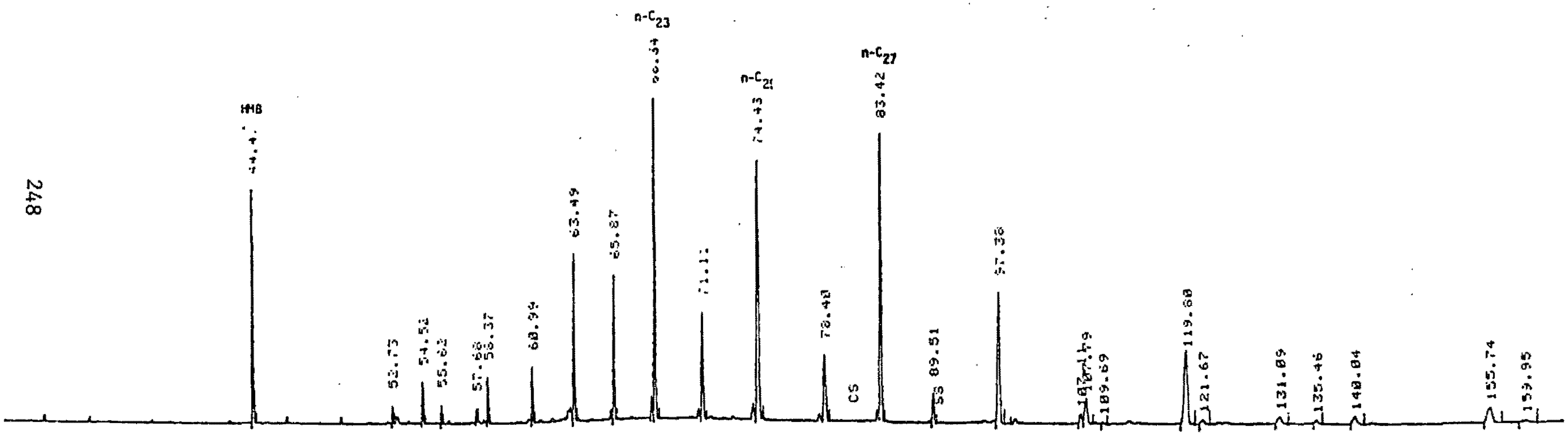
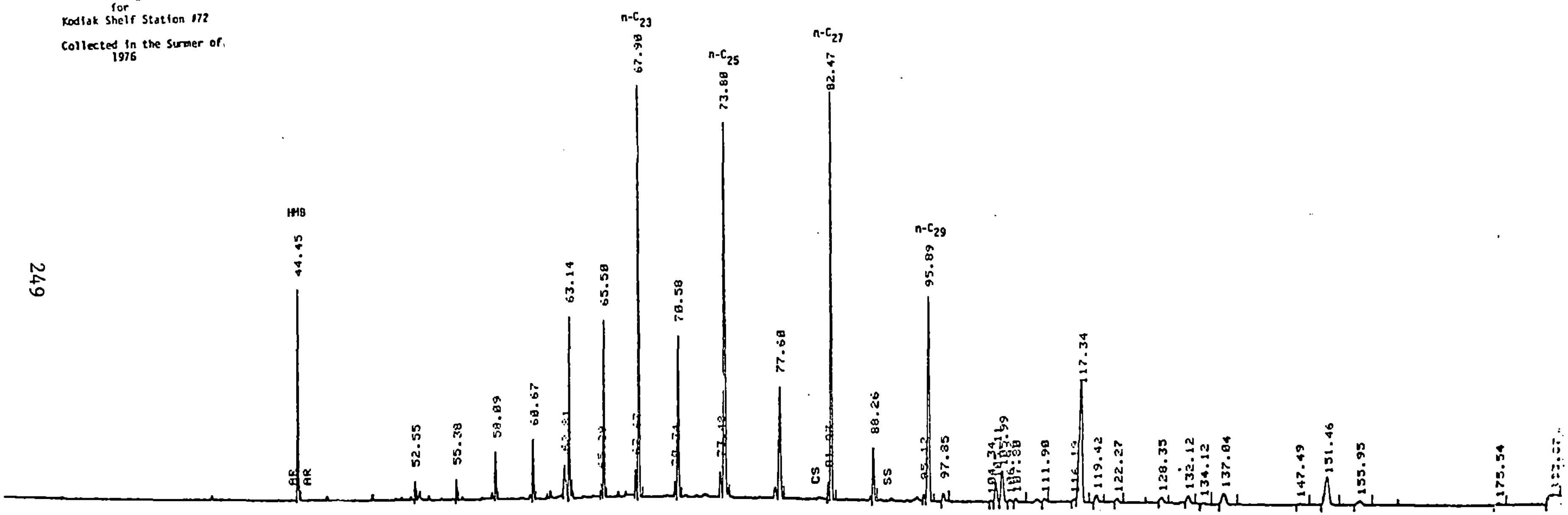


FIGURE 3

Aliphatic Hydrocarbon Chromatogram for Kodiak Shelf Station #72

Collected in the Summer of 1976



of the GC Data

```
ENTER KOVAT TOLERANCE: 4

NUMBER OF RESPONSE FACTORS=3

INPUT (RT,FACTOR) PAIRS
TIME      FACTOR
61,5.5E-06
84,6.0E-06
160,6.25E-06

INPUT SAMPLE WEIGHT (GM), FRACTION INJECTED
104.42,0.001

NOW INPUT (RT,PEAK AREA) PAIRS
  1:27.94,434

  2:44.47,4370

  3:52.73,203

  4:54.52,627

  5:55.62,226

  6:58.37,665

  7:60.99,830

  8:63.49,2863

  9:65.87,2479

 10:68.11,315

 11:68.34,6688

 12:71.11,24.05

 13:74.43,7554

 14:78.40,1941

 15:83.42,12880

 16:89.51,1371

 17:97.38,9016

 18:107.11,537

 19:107.79,2195

 20:119.80,8028

 21:121.67,447

 22:131.09,879

 23:135.46,352

 24:140.04,854

 25:155.74,2405

 26:159.95,496

 27:0

DO YOU WISH TO CHANGE GC DATA (Y=YES)?N

IDENTIFY STANDARDS BY PEAK #, KOVAT
3,1700
5,1800
6,1900
7,2000
8,2100
9,2200
11,2300
12,2400
13,2500
14,2600
15,2700
16,2800
17,2900
19,3000
20,3100
23,3200
25,3300
0
```

NORTON SOUND 47 ALI

RET TIME	KOVAT	CONC (UGM/GM)	% AREA
27.94	842.	0.0229	0.632
44.47	1414.	0.2302	6.363
52.73	1700.	0.0107	0.296
54.52	1762.	0.0330	0.913
55.62	1800.	0.0119	0.329
58.37	1900.	0.0350	0.968
60.99	2000.	0.0437	1.209
63.49	2100.	0.1645	4.169
65.87	2200.	0.1424	3.610
68.11	2291.	0.0181	0.459
68.34	2300.	0.3843	9.738
71.11	2400.	0.0014	0.035
74.43	2500.	0.4341	10.999
78.40	2600.	0.1115	2.826
83.42	2700.	0.7401	18.754
89.51	2800.	0.0021	1.996
97.38	2900.	0.5396	13.128
107.11	2993.	0.0321	0.782
107.79	3000.	0.1314	3.196
119.80	3100.	0.4805	11.689
121.67	3112.	0.0268	0.651
131.09	3172.	0.0526	1.280
135.46	3200.	0.0211	0.513
140.04	3223.	0.0511	1.243
155.74	3300.	0.1439	3.502
159.95	3320.	0.0297	0.722

```
TOTAL AREA =    3.9747 UGM/GM
THERE ARE  9 ODD N-ALKANES. TOTAL =   2.9329 UGM/GM
THERE ARE  8 EVEN N-ALKANES. TOTAL =   0.5455 UGM/GM
TOTAL N-ALKANES =   3.4783 UGM/GM
CPI =       5.473
ODD-EVEN RATIO =        5.176
```

VIII. Special Sample and Voucher Specimen

Archival Plans

When sufficient sediment is available, duplicate samples will be collected for archive. These archive samples will be stored in a freezer at UCLA for 12 months following the submission of the final report.

IX. Logistics Requirements

A. Ship Support

1. Study areas will be Cook Inlet (April), Norton Sound (June). Exact sampling stations will be determined later.

2. Surface sediment samples will be collected at each station with a frame-supported Van Veem-type grab sampler or a box corer. The Van Veem grab sampler will be used for sampling the surface layer of the sediments, while the box corer will be used to obtain samples at depth in the sediment. Samples for low molecular weight hydrocarbons and high molecular weight hydrocarbons will be sealed in tin cans and glass jars and frozen until analysis at UCLA.

3. A minimum of seven (7) days' collection in each area for a total of 14 sea days will be required.

4. Our investigation in site-specific study areas will require collection of uncontaminated, undisturbed surface sediments and thus will require collection of sediments with our frame-supported Van Veem grab sampler or box corer. We will not use the entire volume of sample collected, hence other investigators requiring sediment subsamples (e.g., microbiology, trace metals) may share the sediment recovered.

   Approximately 3-4 hrs/day will be required for each station. There are no requirements for daylight sampling, and processing time between stations will involve approximately 2 hours for cleaning of sampling equipment.

6. We would expect the ship to provide the following equipment:

   (a) An A-frame that can accomodate a sampling device 5'x5' x 7' high and weighing 1500 lbs (700 kg).

   (b) A winch with a minimum of 500 m of at least 7/16" diameter cable.

   (c) An operating tensiometer, meters out indicator, and rate indicator.

(d) A 12 kHz precision depth recording system and pinger.

(e) A navigation system such as radar, Loran or other such system that meets the requirements set by NOAA for this project.

(f) Laboratory space with at least 10 feet counter space, having at least one sink with running water.

(g) Freezer space of at least 30 cu. ft.

We would require the ship to provide one winch operator and two marine technicians during the sampling operation.

X. Anticipated Problems

We require that the sampler should be stored in a location where it will not be contaminated on board the sampling ship.

XI. Information Required from Other Investigators

Data from other investigators are not required to carry out the proposed investigation. However, complementary data from other research units e.g., 153, 162, 275, 290 in chemistry and 430, 152 in geology and 5 in benthic biology will be obtained from the Principal Investigators for incorporation into our narrative reports.

XII. Milestone Chart (enclosed).

XIII. Outlook

A continuation of this program beyond FY 79 would include:

A. The nature of the final results and the data products.

A synthesis of the data on hydrocarbon distribution for the Gulf of Alaska, Bering Sea, Beaufort Sea, Kodiak Shelf, Cook Inlet and Norton Sound. This would be a written report evaluating the data from the individual locations, comparing the distribution parameters for the various locations and interpreting the comparative data. Predictions of oil impacts of the various areas could then result. Several publications would result from this study.

B. Start October 1, 1979

Draft Report - June 30, 1980

Final Report - September 30, 1980

C. Cost of Project: $60,000.00

D. No field work will be carried out for this study.

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. 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 specified in Deliverable Products Section VII, (A through 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. The NODC Taxonomic Code is to be used for biological data submissions.

F. 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 become 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 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)	Submissi (Month/Y
Benthic Sediments						
(a) HMWHC	cards		044	yes	Apr. '79 - June,'79	Oct. 1979
(b) LMWHC	cards		043	yes	Apr. '79 - June, '79	Oct. 1979

MILESTONE CHART

O - Planned Completion Date

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

RU # 480 PI: I.R. Kaplan

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
FIELD SAMPLING							O		O						
SAMPLE ANALYSIS & PROCESSING	←					O						→			
QUARTERLY REPORTS	O			O						O			O		
ANNUAL REPORT							O								
FINAL REPORT															O

GI 78-102

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

Proposal Date: June 23, 1978

Contract #: 03-5-022-55

Task Order #: C-1 and C-9

NOAA Project #: N/A

Institution ID #: GI 78-102

FY 1979 RENEWAL PROPOSAL

Research Unit Number RU 483

TITLE: Part I. Evaluation of Earthquake Activity Around Norton and Kotzebue Sounds Part II. Seismic Attenuation Studies for Beaufort Sea Area

Cost of Proposal: Part I. $117,718

Part II. $ 26,692

Lease Areas Part I.

Norton Sound 50 %

Kotzebue Sound 50 %

Part II.

Beaufort Sea 100 %

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

N. N. Biswas Date 6/23/78
Nirendra N. Biswas
Co-Principal Investigator
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7373

Neta J. Stilkey Date 6/23/78
Neta J. Stilkey
Business Manager
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7644

Larry Gedney Date 6-23-78
Larry Gedney
Co-Principal Investigator
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7426

J. G. Roederer Date 6/23/78
Juan G. Roederer
Director
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7282

K B Mather Date 6/26/78
Keith B. Mather
Vice Chancellor for Research and Advanced Study
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7314

TECHNICAL PROPOSAL

I.

A. Title: Part I. Evaluation of Earthquake Activity Around Norton and Kotzebue Sounds
Part II. Seismic Attenuation Studies for Beaufort Sea Area
B. Research Unit Number: 483
C. Contract Number: 03-5-022-55
D. Proposed Dates of Contract: October 1, 1978 - September 30, 1979

II. Principal Investigator(s)

A. N. N. Biswas
B. L. D. Gedney

III. Cost of Proposal Federal Fiscal Year 1979

A. Science:

B. P. I. Provided Logistics:

C. Total: Part I. $117,718
Part II. $ 26,592

D. Distribution of effort by lease area:

1.	Aleutians		
2.	Beaufort Sea	100%	Part II
3.	Bristol Bay		
4.	Chukchi Sea		
5.	Kodiak		
6.	Lower Cook Inlet		
7.	NEGOA		
8.	Norton Sound	50%	Part I
9.	St. George Basin		
10.	Non-lease area laboratory management		
11.	Kotzebue Sound	50%	Part I

IV. Background

A six-station seismographic network was installed around Norton and Kotzebue Sounds during August and September of 1976 with OCS support. The new network was supplemented by two stations, one at Granite Mountain and the other at Tatalina, operated by NOAA in western Alaska. These two stations are a part of the Alaska Tsunami Warning network. The layout of the network, including the NOAA stations, are shown by triangles in Fig. 1. The station at Savoonga on St. Lawrence Island was not installed until the 1977 field season because, despite assurances from RCA, the microwave link from Savoonga to Nome could not be provided in 1976. The signal is presently being transmitted via satellite.

Although the network became operational in November and December of 1976, intermittent deterioration of the signal quality for some stations continued throughout the early part of 1977. These problems were fully resolved during the field season of that year when the Savoonga station was installed. Therefore, reliable data of good quality have been received without notable interruption only since July of 1977.

Tectonically, the study area lies about 500 km to the northwest of the nearest zone of lithospheric plate convergence in central Alaska. Because of this, we would normally expect the area to experience a low level of seismic activity. This is not the case; the Alaska earthquake catalog shows that a number of earthquakes in the magnitude 5-6.5 range have occurred in the area of interest during the last 50 years. Of necessity, these earthquakes had to be located by teleseismic networks around the world because, for the most part, seismographic coverage in Alaska was minimal or nonexistent.

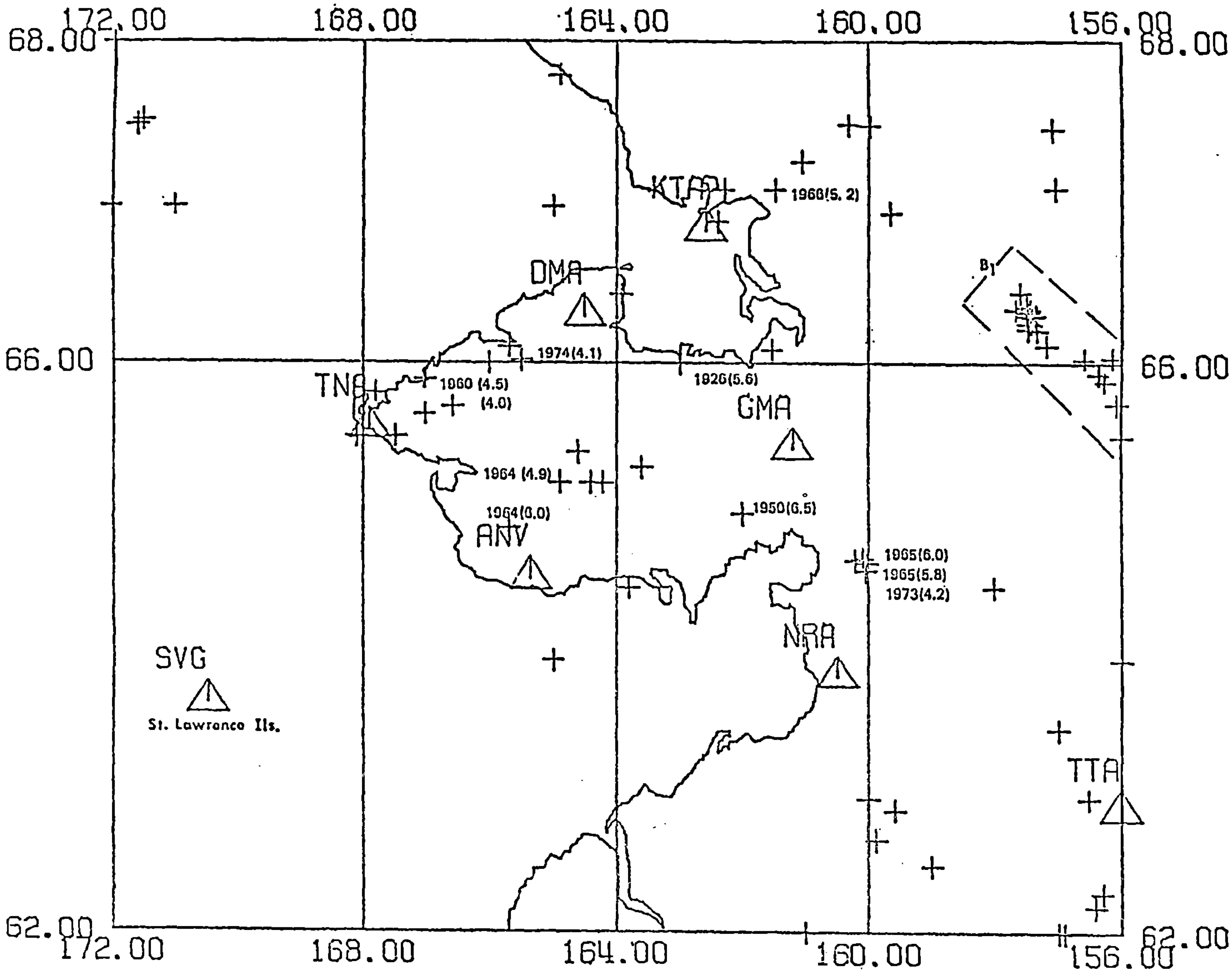


Figure 1. Location of seismographic stations (Δ) in western Alaska and epicenters (+) of earthquakes of M_L>4.0 located in the same area from world wide data.

Relatively large intraplate earthquakes such as these suggest that the crustal (and possibly sub-crustal) layers underlying western Alaska are in a state of relatively higher stress than would be expected in such a tectonic setting, and that these stresses are periodically released in the form of earthquakes, some of which are significant in size. Lesser levels of seismicity could not hitherto be detected, because of the remoteness of the area from seismographic monitoring equipment. Further, the accuracy of epicentral locations in existing earthquake catalogs, based on world-wide stations, is insufficient to permit the delineation of specific seismic zones, a factor of immediate concern to OCSEAP studies.

We briefly review below the nature of the spatial distribution of seismicity revealed from the analysis of the past and present data.

Figure 1 shows the locations of all earthquakes of magnitude (m_b) 4.0 or above which were located in the study area prior to 1976; magnitudes are given in parentheses. It can be seen that the largest earthquake to be instrumentally located during the past 27 years was of magnitude 6.5. This occurred about 30 km inland from the northern boundary of Norton Sound. It was followed by earthquakes of magnitude 6.0 (1964), 6.0 (1965) and 5.2 (1966) which were located, respectively, about 60 km, 40 km, and 15 km inland from Port Clarence, Norton Bay, and Hotham Inlet in Kotzebue Sound. Since all these areas are thinly populated, the seismic impact of these earthquakes passed largely undocumented. Further, the past data reveal a lineal epicentral zone, about 100 km long, trending NW-SE near 66°N, 156°W.

The data collected by the local network for the period December, 1976 through December, 1977 have now been computer-processed. In the initial computer runs, all focal parameters were allowed to vary. The results indicated that focal depths ranged from near-surface to about 20 km. In subsequent runs, focal depths were constrained to 10 km to eliminate one degree of freedom in the solution. The epicentral locations thus obtained are shown in Figure 2, and the mapped structural elements of the area are shown in Figure 3.

Comparison of Figures 2 and 3 reveals a number of interesting characteristics. First, the earthquake cluster labelled A closely follows the onshore mapped trace of the Kaltag fault (not shown in Fig. 3). The cluster labelled B_2 coincides with that of B_1 of Figure 1. The cluster C_2 traverses the epicentral area of the magnitude 6.5 earthquake of 1950 in a north-south direction. Also, this cluster closely follows the trace of the fault system passing through the eastern part of block C_2 in Figure 3. Further, cluster D_2 lies within block D_1 of Figure 3, which also includes a well-defined fault system. To the west, a number of earthquakes were located both onshore and offshore during 1977 around the site of the magnitude 6.0 earthquake near Port Clarence in 1964.

Comparison of Figures 1 and 2 reveals how little was known of the actual seismicity of the area during the earlier years, it being possible to locate only the larger events. A broad correlation between the locations of earthquakes and faults is beginning to emerge from the present data set, even though it represents only a relatively brief period of time. This is particularly true in blocks A, B_2, C_2, and D_2 in Figures 2 and 3. This implies that, in general, the mapped faults in the area are tectonically quite active. Although the scatter of epicenters

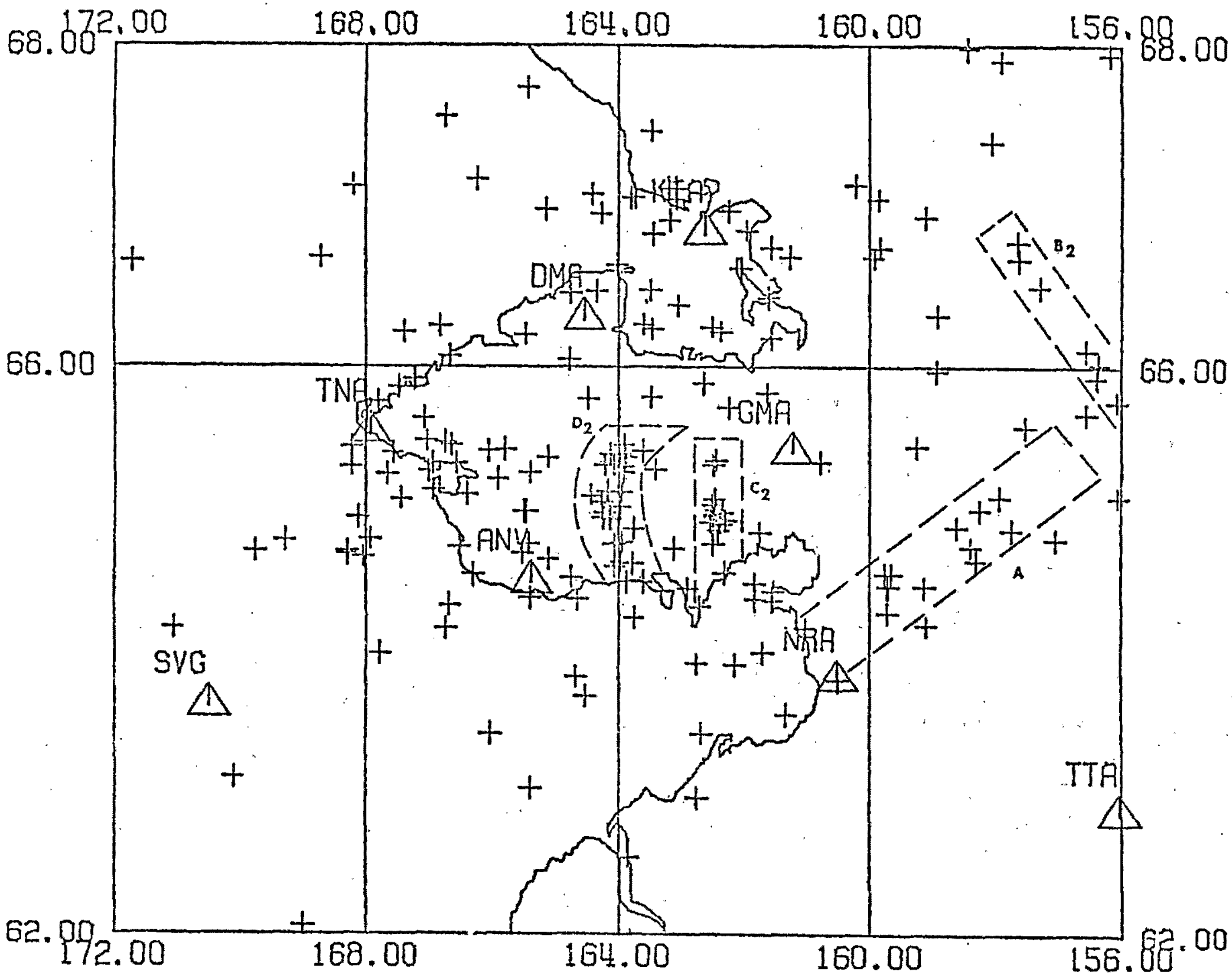


Figure 2. Epicenters (+) of earthquakes located during 1977 in western Alaska by the local seismographic network.

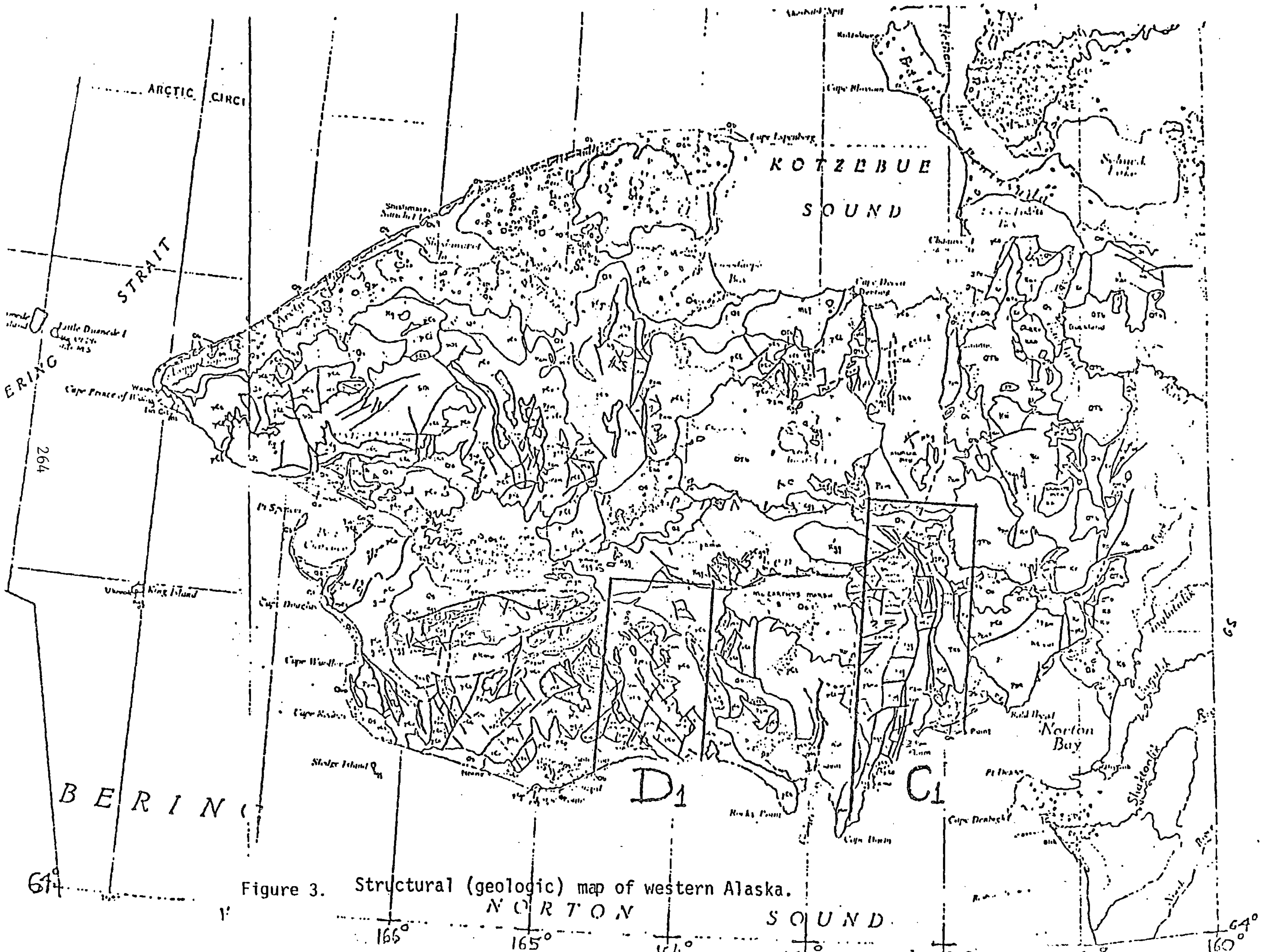


Figure 3. Structural (geologic) map of western Alaska.

around Norton and Kotzebue Sounds and near Port Clarence is somewhat diffuse, this is likely to be due in large part to uncertainties in epicentral location.

In addition to the results concerning the seismicity summarized above, the Kotzebue station of the network recorded three swarms of icequakes. To improve the recording capability of icequakes, the above station was converted from a one (vertical) component to three-component (vertical, north-south and east-west) station during the 1977 field season. The two hotizontal sensors, unfortunately, went off level with ground freeze-up. This unusual change in ground level appears to be due to surface proximity of the permafrost in Kotzebue area. We have carried out experiments during the winter months of 1978 at Fairbanks to overcome the above levelling difficulty, which is described in Section VI.

The results of this study, besides providing the nature of the seismicity for the area of interest, would be utilized to identify the level of activity along the offshore faults. The location and trend of these faults are now being investigated by marine seismic reflection and refraction surveys by OCSEAP investigators of Research Unit No. 429.

V. Objectives

It is planned to continue using the data from the local high resolution seismographic network to address the following problems:

(i) The spatial and temporal characteristics of seismicity in the study area and its relationship to mapped tectonic features.

(ii) The predominant failure mechanisms associated with earthquakes located along or near known geologic features or trends.

(iii) Characteristics of seismic energy attenuation as functions of epicentral distance.

(iv) Strain release patterns exhibited by the larger earthquakes for use in projections as to possible activity in the future.

(v) The elastic moduli of landfast ice sheets from the analysis of icequake data.

Answers to items (i) through (iv) are essential for a reasonable assessment of seismic hazards in a given area. Item (v) is essentially a feasibility study. If successful, the results should significantly add to the knowledge of sea ice properties presently gained by in situ measurements.

The summary of current observations, given in Section IV, leads to a number of specific questions under the broad definition of objectives outlined above. For instance, how far offshore do the active faults extend which are identified by onshore epicentral clustering? Does the offshore segment of the Kaltag fault mapped from marine geophysical evidence (Nelson, et al., 1974),exhibit present-day activity? Are the epicenters located around Port Clarence related to the east-west trending fault mapped through this area? To what extent do location uncertainties contribute to the apparent diffuseness in the spatial distribution of epicenters located in Norton and Kotzebue Sounds? What are the seismic implications of the Kotzebue arch (Eittreim, et al., in press) and the shallow and deep faults (Johnson and Holmes, 1977) mapped in Norton Sound by geophysical methods? What is the predominant sense of motion along major mapped faults in the onshore and offshore areas? What is the regional orientation of the principal stress axes, and how do they relate to the orientation of existing large faults? What is the maximum magnitude of earthquakes that might be expected in the area, particularly offshore, and what are the seismic wave energy attenuation characteristics of the offshore geologic sections?

Answers to these questions are fundamental for the seismic hazard evaluation of the study area. Although the list of problems is long, the solutions are easily tractable, provided a reliable data base can be compiled. It should be pointed out that, by the end of 1978, we will be able to gather and analyze an additional eight months of data. This will allow us to refine some of the results presented in Figure 2.

We intend to continue the present research effort by examining the relationships in spatial distribution between seismicity and active faults, with at least one goal being a possible interpretation of offshore earthquakes as being products of offshore extensions of faults presently mapped inland. Figure 2 demonstrates that, at least in some cases, such an onshore correlation of faults and earthquakes is reasonable, even at this early stage of the study. For more definitive studies in the future, however, we intend to project, onto a common base, all the available geological and geophysical data available for the area. The digitization of major structural elements of the area is already in progress. The necessary computer programs for unified projections were developed during FY 76, 77 and early part of 78 and are now cataloged on the University computer for routine use.

We intend to investigate the uncertainties in hypocenter locations to which we have attributed the large scatter seen in Figure 2. This will be done by comparing variations in solution quality parameters (see Secion VIII) from event to event. Focal mechanism studies, and the problem of resolving the orientation of the principal stress axes, will be addressed by preparing composite mechanism solutions for each cluster or trend of epicenters utilizing first-motion P-Wave data. The study of source mechanisms for larger events, particularly those occurring during the 1960's, is in progress. Data on 35 mm film from world-wide stations have been acquired from the Geophysical Data Center in Boulder, Colorado, for this purpose.

It has been stated that the stations were calibrated during the field season of 1977. However, it has been necessary to change system magnifications from time to time at the receiving end to reduce background noise due to high wind and surf, or other local conditions. Incorporating these changes, local magnitude computations (M_L) are in progress for the 1977 events. During the 1978 field season, system calibrations will be rechecked. With this reliable level of calibration, it should be possible to obtain the attenuation properties for the geological formations of Norton and Kotzebue Sounds to within adequate levels of precision.

The primary thrust of the present study is to provide reliable seismic information for the synthesis of geohazards for the area of interest. This is of immediate concern to OCSEAP since the geologic setting, particularly of the offshore parts, has attractive hydrocarbon potentials. Large scale geophysical exploration and eventual development of commercial hydrocarbon deposits are a certainty in the near future. Consequently, the present study is a logical undertaking. However, in order to fulfill the research objectives outlined in this proposal, the importance of the continued operation of the current seismographic network in western Alaska cannot be overemphasized. We wish to point out that, from our past and present experience in dealing with seismic hazard evaluations in other parts of the state, and from similar studies for areas outside Alaska appearing in the literature, the conclusions derived from a local data base of relatively short length have large uncertainties. It is the intent of the present study to avoid a similar shortcoming by assuring that an adequate data base is established.

VI. General Strategy and Approach:

a) Data Telemetry and Recording

The study area is relatively large, extending about 1800 km in an east-west direction, and about 700 km from north to south. Initially, the most economical method of operation, providing adequate seismographic coverage, appeared to be to spend as little as possible on new equipment, and to telemeter all signals on a single leased line to Fairbanks. Here, they could be recorded at the Geophysical Institute on the same gear being used to record data from the other Alaskan networks. At the time, this was the most economical method. However due to a recent (May, 1978) rate increase of 87% in line lease charges, this method no longer appears to be cost-effective. Rather, we feel that a better way would be to record the data on magnetic tape at Nome, thereby eliminating the longest segment of the microwave circuit, from Nome to Fairbanks.

The suggested change would necessitate the one-time acquisition of additional recording and playback equipment. The cost would be more than offset by savings realized in not having to pay the line charges between Nome and Fairbanks, which would otherwise be the single most expensive item in the budget, and would provide no tangible benefits to the project. Costs of operating the proposed new recording and playback equipment would be essentially nil after initial acquisition, and the equipment would be available for use in further studies in the years ahead. Details of equipment expenses are given in the Cost Proposal of Section 4.

The studies of ice quakes were interrupted due to the malfunction of the horizontal seismometers as mentioned before. To remedy the existing problem, the field tests of a new type of seismometer (Geotech S-500) has been completed with satisfactory results. Arrangement to replace the existing three sensors at Kotzebue with the new ones (non-sensitive to seasonal ground change over a large range) are in progress.

b) System Response

All the stations of the network were calibrated over a wide frequency band (0.1Hz to 20 Hz) during the field season of 1977. This was done by exciting the sensor by sinusoids (frequency calibrated function generator) of known frequencies and constant current through the cal-coil. The output of the main-coil after amplification (known decibel setting) was recorded at the field site. The same signal was telemetered via microwave to the central recording site at Fairbanks and recorded simultaneously with the recording at the field site. This was done to find the signal modulations, if any, caused by the long microwave link used in this study.

The difference between the results obtained for the data collected at the field and central recording sites was found insignificant, thereby asserting the reliability of the magnitude determination from the recorded traces. The peak magnifications for the stations were set in the range of 0.1×10^6 to 8.5×10^6, depending on the microseismic background of the station sites. This range corresponds to a local event detection capability of approximately $M_L \geq 1.0$ for the network as a whole.

VII. Sampling Methods

Telemetered data from the network are presently being recorded in analog form in real time on 16 mm film by Geotech Develocorder at the Geophysical Institute's seismology laboratory. 24 hours of recording produces a film roll 160 feet in length. These are scaled for first-arrival times of P-waves, and whenever possible, for S-wave phases as well. For purposes of computing magnitudes, maximum peak-to-peak amplitudes of the wave train are also measured. These raw data are punched on cards according to a specified format for computer input.

Since we do not anticipate a major structural transition from central Alaska westward into the Seward Peninsula region, we are using the structural model developed for the Alaskan Interior in locating earthquakes in the present study area. This velocity model is based on travel-time data obtained from quarry blasts and earthquakes, and is given in Table 1. It is necessary to more closely investigate similarities or disparities between the two areas, however, and this matter is presently being studied with partial support from the National Science Foundation.

The P and S-wave velocities for Arctic pack ice are available from field measurements (Press, 1966). With these values and the arrival time and amplitude of different wave phases, we would be able to locate the position of the sources of icequake with reasonable precision.

Table 1.

Crust and Upper Mantle P-wave Velocity Model
Used in the Hypocenter Location Computer Program

Depth (km)	Velocity (km/sec)
0	5.9
24.4	7.4
40.1	7.9
75.7	8.29
300.7	10.39
544.8	12.58

VIII. Analytical Methods:

The computer program (HYPO 73, Lee and Lahr, 1975) used to compute hypocenter parameters is the same as that utilized in processing earthquakes located by the other Alaska networks to maintain internal consistency in hypocentral parameters. This program minimizes the differences between observed and theoretical P-wave arrival times at the various stations by a weighted least-square method. The quality of the focal solution determined from the following parameters:

a) Number of station readings used to locate a given earthquake (NO).

b) Maximum distance in km of the nearest station from the epicenter (DMIN).

c) Maximum azimuthal separation betweeen stations (GAP).

d) Standard deviation of travel-time residuals (RMS).

e) Standard error in hypocentral depth estimates (ERZ).

f) Standard error in epicentral location (ERH).

The quantities under e) and f) are not computed if less than four station readings are used for the location. Traditionally, the accurracy in locations for a network is best estimated by either locating quarry blasts or by comparing the locations of aftershocks determined by portable seismographs in the epicentral area of larger shocks with epicenters determined by the network. Neither of these two methods would be applicable for this study. However, from a closer study of the range of variations for the parmeters from a) to f), it would be possible to estimate the uncertainties in the locations of the events.

For routine location purposes, the output of an initial computer run is checked for scaling or other human errors. The output of the final run, in addition to being in list form, can be obtained on cards or magnetic tape which can easily be supplied to the OSCEAP office.

Concerning icequakes, it is planned to compute synthetic seismograms for two-layer over a half space. In this model, a layer of sea ice lies over a layer of sea water which in turn lies over a solid layer (perfectly elastic) of infinite extent. The elastic moduli of the ice sheet will be derived by comparing observed and computed seismograms for the above geometry with specified source, essentially by perturbation technique.

IX. Deliverable Products

Primary data products to result from this project will be earthquake catalogues for the area of interest. The catalogue will list chronologically the date, origin time, epicenter location, focal depth, local magnitude (M_L) and solution quality given by parameters listed in Section VIII for each earthquake. The final catalogue will be prepared for basic seismological studies and for transmittal to OCSEAP on magnetic tape in the same format as used by other Alaskan seismicity programs.

In addition to the preparation of earthquake catalogues, the relationships between the spatial distribution of epicenters, comparable focal mechanism solutions for specific zones and other geophysical and geological feature will be presented in the form of maps. Also, seismic parameters like b-slope, energy release and attenuation properties of the subsurface formations will be given in the form of graphics and tables.

X. Quality Assurance Plan

The calibration of the seismographic network is given in Section VI and the quality of the focal parameters computed for each earthquake is discussed in Section VIII.

XI. Special Sample and Voucher Sepciman Archival Plans

N/A.

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).

   Nome to Anvil Mountain　Nome to North River　Nome to Kotzebue
   Nome to Tin City　Nome to Davil Mountain

2. Describe types of observations to be made.
   Service instrumentation, and if necessary, replace components and batteries

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

   N/A

4. How many days of helicopter operations are required and how many flight hours per day? 7 days, 4 hrs/day

   Total flight hours? 28

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

   2

6. What are the weights and dimensions of equipment or supplies to be transported?
   Approximately 300 lbs, 2' x 2' x 2'

7. What type of helicopter do you reommend for your operations and why?
   Bell Jet Ranger, 2-6B. We have had good experience with this aircraft on emplacing similar installations

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?

    Nome

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).

   For maintenance and servicing the station sites, we estimate that 8 man-days will be required during the project period. We project two personnel will made the trip(s) and they will be based in Nome.

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?

   $65/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?

   From the past experience in maintaining the seismographic network in the study area

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

XIII. Anticipated Problems

None.

XIV. Information Required from Other Investigators

During review and synthesis meetings, relevant information from other research units are gathered by the P.I.

XV. Management Plan

a. The 3-component (vertical, east-west and north-south) station at Kotzebue, primarily installed to study icequakes will be upgraded by replacing existing seismometers by Geotech S-500 model. This is anticipated to resolve the past problem completely.

b. The stations of the seismographic network have been operating without any interruption since August, 1977. From the experience gained to this date, we will be able to maintain this successful level of operation without any difficulty.

c. We intend to locate the recording site at Nome in the Community College. This College is a part of the University of Alaska and has several technically qualified faculty members. It is anticipated that in cooperation with them, the magentic tape recorder can be operated there without any difficulty. Arrangements will be made to ship the tape on a weekly basis.

d. The magentic tape playback unit that we intend to acquire is highly automated. This will allow us to maintain daily routine data scaling up to date.

e. The computer program is thoroughly tested. The daily data processing schedule is maintained without any difficulty.

f. The format of providing data to OCSEAP has been standardized. The results are transferred on magnetic tape as a routine operation for storage or transmittal to interested organizations.

MILESTONE CHART

– Planned Completion Date

RU # 483 PI: Nirendra N. Biswas

Major Milestones: Reporting, data management 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
Part I.	X														
Field work	X 1978												X 1979		
Data Scaling			X 1978										X 1979		
Analysis						X 1978									X 1979
Reporting						X 1978									X 1979
Part II.															
Laboratory Test						X									
Field Work (i) station installation								X							
(ii) data recording												X			
Data Scaling													X		
Analysis														X	
Reporting														X	

1978, 1979 these refer to data gathered during the calendar years.

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."

TECHNICAL PROPOSAL

I.

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II. Principal Investigator(s)

A. N. N. Biswas
B. L. D. Gedney

III. Cost of Proposal Federal Fiscal Year 1979

A. Science:

B. P. I. Provided Logistics:

C. Total: Part I. $119,718
Part II. $ 26,692

D. Distribution of effort by lease area:

1.	Aleutians		
2.	Beaufort Sea	100%	Part II
3.	Bristol Bay		
4.	Chukchi Sea		
5.	Kodiak		
6.	Lower Cook Inlet		
7.	NEGOA		
8.	Norton Sound	50%	Part I
9.	St. George Basin		
10.	Non-lease area laboratory management		
11.	Kotzebue Sound	50%	Part I

IV. BACKGROUND

A four-station seismographic network was installed around Barter Island during August and September of 1975 with U.S. Geological Survey support. In addition, we have received OCS support to service the stations during the field seasons. The layout of the network, including those stations located around Fort Yukon is shown in Figure 1.

The primary purpose for the installation of the network was to investigate the level of seismicity. This is because data products from a number of agencies, foreign and domestic, have noted a seismic zone near Barter Island on the eastern part of the Beaufort Sea, during the years prior to 1968. This zone appeared to be separated from the central Alaska seismic region by an aseismic zone trending approximately through the eastern Brooks Range. In addition, past data show a virtual absence of seismic activity west of approximately 152°W in the northern latitudes of the state.

The results obtained since the inception of the present study have shown (Gedney et al., 1977; Biswas et al., 1977) that the above zone is actually on a northward extension of the central Alaska zone of shallow seismicity. Earthquakes in the latter zone are thought to be a direct consequence of plate subduction, where the north Pacific lithospheric plate underthrusts Alaska, a phenomenon traceable as far north from the coast as the area around McKinley National Park. It is difficult, however, to invoke this phenomenon as being the immediate cause of earthquakes in northeast Alaska, which is more than 400 km distant from the Alaskan subduction zone. It thus appears that a more indirect association must be at work relating the activity of the two seismic regimes, which are generally contiguous in extent and contemporaneous in time.

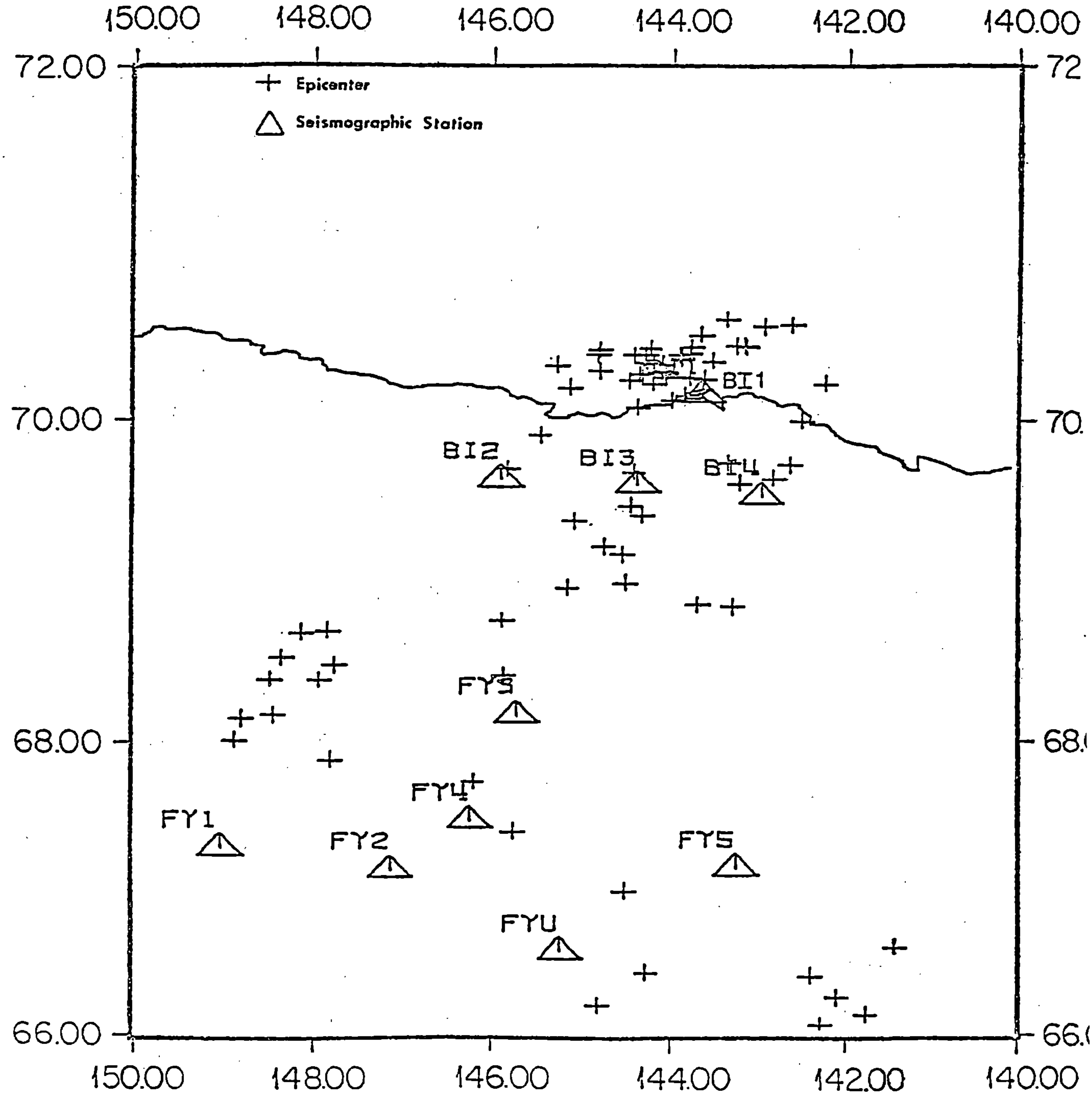

Figure 1. Locations of seismographic stations (Δ) in northeast Alaska and epicenters (+) of earthquakes located from 1968 through 1975 in the same area.

The largest earthquake reliably recorded in northeast Alaska during the past decade had a magnitude (M_L) of 5.3 and was located about 30 km north of Barter Island on the Beaufort Sea shelf. Since the emplacement of the local seismographic network, however, we have found that a great many more earthquakes, over a wider magnitude range, occur here than earlier data have revealed. During a two-year recording period (1976-77), locatable events ranged approximately in magnitude from 1.0 to 4.0, and many others occurred which were non-locatable due to equipment outages or low magnitude.

To relate the epicentral locations determined in this study to known tectonic elements, all earthquakes are plotted on an overlay of structural trends (Figure 3, Grantz et al., 1976) of the study area in Figure 2. The offshore traces of these structures were mapped by the above authors using marine geophysical methods.

In the offshore area, the primary epicentral concentration is that resulting from a magnitude 5.3 earthquake in 1968 and its aftershocks. The onshore distribution illustrates the extent of the active seismic zone, and how it merges smoothly with that of central Alaska. Besides these, a general northeast-southwest trend can be discerned, particularly north of 68° latitude. In the offshore area, these earthquakes tend to concentrate along the axes of synclines and anticlines. Between 68° and 70° the primary concentration parallels, approximately, the interface between the Colville geosyncline and the Romanzof Mountains. In these areas of known large-scale faulting, such as those in the Romanzof Mountains and the Brooks Range, the occurrences of earthquakes can be more readily interpreted.

For an earthquake in the eastern part of the study area (Yukon Territory, Canada), Leblanc and Wetmiller (1974) presented a fault plane solution which showed a principal horizontal compressive stress in a WNW-ESE direction.

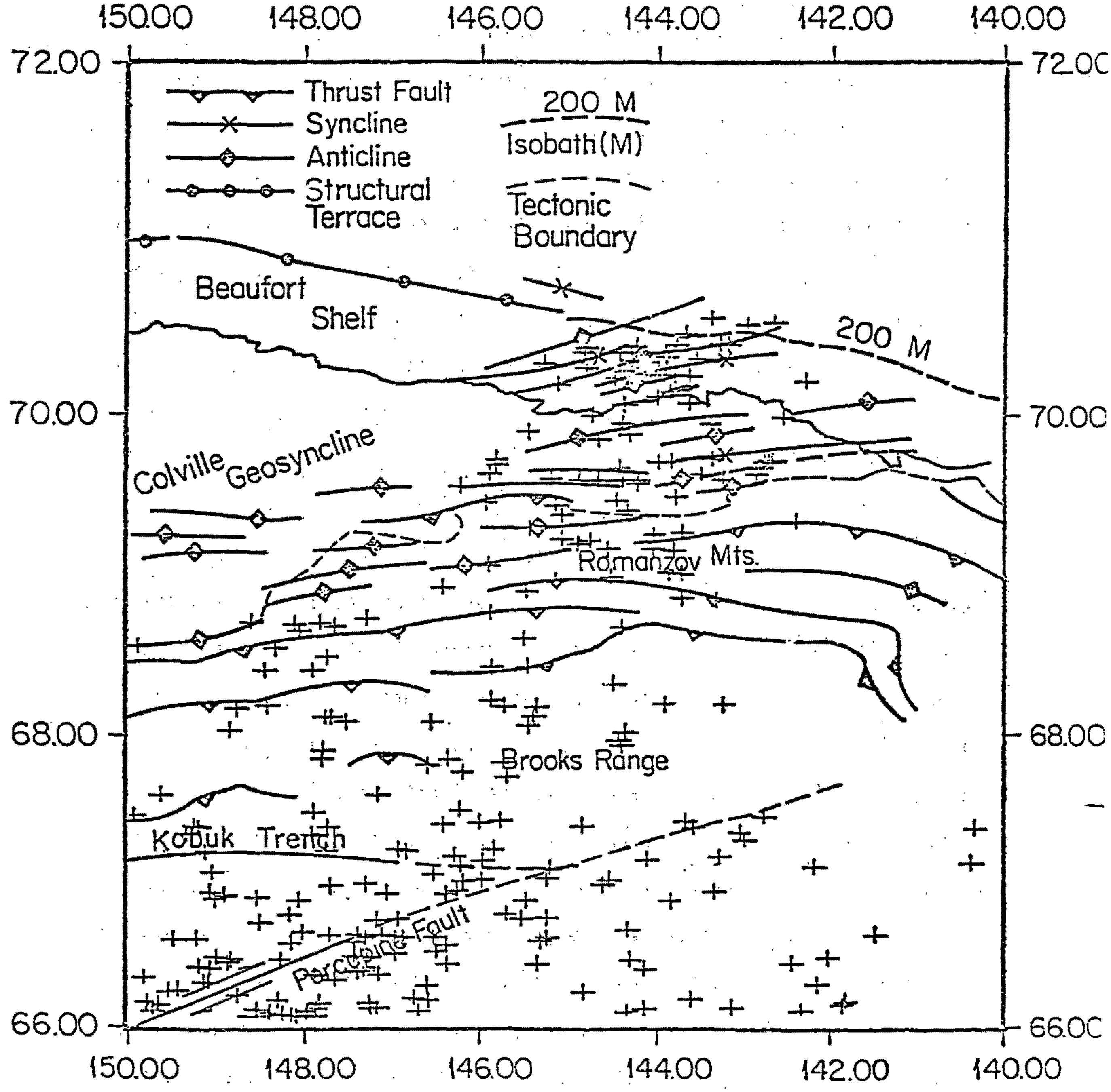

Figure 2. Spatial distribution of epicenters (+) of earthquakes and geologic strucural trends in northeast Alaska.

This is probably representative of the general direction of compressive stress in the North American plate in that area. West of here, in central Alaska, results of various studies as summarized by Bhattacharya and Biswas (1978) indicate a predominant northwest-southeast direction to this axis. Translating these two principal stress directions into the study area, it may be suggested that the area is under continuous compressive stress in an approximate WNW-ESE direction. The very orientation of the structural elements in northeast Alaska seems to substantitate this interpretation. Currently, the primary sources of stress released in the area appear to be associated with the mapped thrust faults along topographic highs, and along strike-slip faults, particularly the Porcupine fault and the Kobuk trench in lowlands on the south of the Brooks Range.

V. OBJECTIVES

The discussions of the previous section summarizes the trend of the seismic zone in northeast Alaska. One of the important features of this trend is that the interface between the Colville geosyncline and Brooks Range is a major seismotectonic boundary, a boundary which separates an aseismic zone on the north from the active Alaskan seismic zone on the south. However, concerning seismic hazards, an answer to the following question is important: What level of ground motion can be expected from a shallow earthquake (focal depth < 20 km) of maximum magnitude of 6.0 located a few hundred kilometers to the east of the proposed lease sale areas on the Beaufort Sea shelf? The answer to this question will be an integral part of the design criteria of offshore engineering structures. In order to answer this question, an estimation of the following two parameters is essential:

(a) Predominant failure mechanisms associated with earthquakes located in the area.

(b) The attenuation of the wave energy as a function of distance from the epicentral region.

From the available data, we will be able to find an answer to the first point. The study of the focal mechanism of the 1968 (M_L = 5.3) earthquake from global data is in progress. Regarding the second point, we note that the type of sediment distributed on the Beaufort Sea shelf is also present for some distance inland around Prudhoe Bay. This is shown by the line ABC in Figure 3. Thus, a measurement of the variations of wave amplitude as a function of epicentral distances in the onshore area around Prudhoe Bay should be equally valid for the shelf area.

VI. GENERAL STRATEGY AND APPROACH

It is proposed to relocate the four-station Barter Island array further west and immediately south of Prudhoe Bay. These four stations will be distributed on the circumference of a circle with a fifth station as the recording site at the center of the circle. The radius of the circle will be chosen to provide adequate coverage of the sedimentary section bounded on the south by the line ABC in Figure 3.

From the four distant stations, the data will be telemetered by using the existing VHF transmitter-receiver pairs to the recording site. The data will be recorded locally on magnetic tape; the time code will be recorded on a separate channel. The same tape playback unit as we propose to use for treatment of the data from the western Alaskan seismographical network will be utilized.

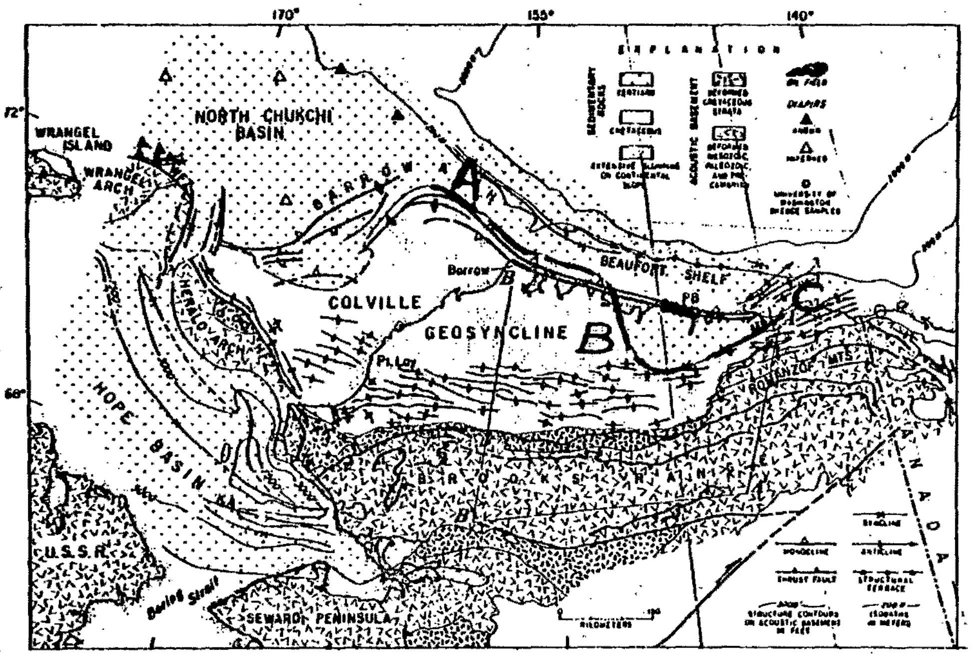

Figure 3. Geologic Structural map of northern Alaska and adjoining areas (Grantz et al., 1976).

VII. Sampling Methods

As mentioned in the earlier section, the data will be recorded locally from a network of circular layout. The duration of recording will be of the order of 3 to 4 months. During the first half of this period, the outer stations on the circumference of the circle will be emplaced in the north-south and east-west directions. During the latter part, the same stations will be moved to provide coverage in the northwest-southeast and northeast-southwest directions, keeping the central station fixed. This will permit the detection and measurement of any lateral heterogeneity, if it exists.

The frequency of occurrence of earthquakes within the network further south around Fort Yukon (Figure 1) is relatively high. Moreover, with the existing geometry of this network, the earthquakes can be located with reasonable precision. Using these earthquakes as an energy source, we intend to derive the attenuation properties of the geologic sections of interest by intrastation methods. The time period of recording appears sufficient to achieve the objectives of this study.

Since the cost of maintaining the Fort Yukon array is not a part of this proposal, its retention as part of the existing seismographic coverage can be justified only if the proposed attenuation study around Prudhoe Bay is approved. It should be pointed out at this stage that, once the stations of the array are moved out, it would be difficult, and at the same time cost-ineffective, in attempting to do any seismological research at later dates for such a remote area.

VII. ANALYTICAL METHOD

For two detectors, located in the same azimuth with respect to the source, the recorded traces for a given wave phase maybe expressed as:

$$A(r_1, t) = F_1(x)\, F_2(t)\, I_1(t) \exp\left[i\,(kr_1 - \omega t_1)\right] \quad (1)$$

$$A(r_2, t) = F_1(x)\, F_2(t)\, I_2(f) \exp\left[i(kr_2 - \omega t_2)\right] \quad (2)$$

where $A(r_{1,2}, t)$ are the seismograms obtained at distances r_1 and r_2 from the source, $F_1(x)$ and $F_2(t)$ are the source time and space functions and $I_1(t)$ and $I_2(t)$ are the instrument response characteristics at r_1 and r_2, respectively. k is the wave number, ω the angular frequency and t_1 and t_2 are, respectively, the travel times from source to the receivers.

In Eq. (1) and (2), the source functions (F) are common as the detectors are located in the source azimuth. Also, if we use identical detectors, we have

$$I_1(t) = I_2(t) = I(t) \quad (3)$$

Since k is a complex quantity, we can expres it as

$$k = \sigma + i\varepsilon \quad (4)$$

In Eq. (4), the real part of k, i.e., σ represents the decay of amplitude (≡ energy) as a function of distance r, since substituting Eq. (4) in Eqs. (1) and (2), we get

$$A(r_1,t) = F_1(x)\ F_2(t)\ I(t)\ \exp\ (-\sigma r_1)\ \exp\left[i(\varepsilon r_1 - \omega t_1)\right] \tag{5}$$

$$A(r_2,t) = F_1(x)\ F_2(t)\ I(t)\ \exp\ (-\sigma r_2)\ \exp\left[i(\varepsilon r_2 - \omega t_2)\right] \tag{6}$$

It may be noted in Eqs. (5) and (6) that the quantities in square brackets represent the phases of the particular wave.

Taking the logarithm of the ratio of the modulus of Eqs. (5) and (6), we get

$$\sigma = \frac{1}{(r_2 - r_1)}\ \ln\left[|A(r_1\ t)| \Big/ |A(r_2\ t)|\right] \tag{7}$$

It maybe noted in Eq. (4) that k is a function of frequency (ω) and so are σ and ε. Thus, if we take the amplitude spectrum of the seismograms recorded at r_1 and r_2, Eq. (7) becomes

$$\sigma(\omega) = \frac{1}{(r_2 - r_1)}\ \ln\left[|A(r_1,\ \omega)| \Big/ |A(r_2,\ \omega)|\right] \tag{8}$$

In Eq. (8), $\sigma(\omega)$ represnts the coefficient of attenuation and may be expressed in unit of dB/km.

The experimental setup described in earlier sections permits us to compute the quantity on the r.h.s. of Eq. (8) from the intrastations observed data and thus to determine σ. The tape recorded analog data will be digitized at closed intervals and then Fourier analysed to obtain the amplitude spectra in this study.

IX. DELIVERABLE PRODUCTS

A. Digital Data

The digitized seismograms will be stored on magnetic tape.

B. Narrative Reports

The recorded data quality, method of data reduction and analysis and the results will be presented in a report form.

C. Visual Data

(1) Earthquake list to be used to study the attenuation coefficient.

(2) Amplitude spectra in graphical form.

X. QUALITY ASSURANCE PLAN

(i) The study will be based on the relative amplitude data obtained by the different stations of the network. This will demand to operate the stations as well calibrated throughout. Since the seismology laboratory of the Geophysical Institute is well equipped with portable equipment for the calibration purposes, we will be able to achieve the above objective without any difficulty.

(ii) The analysis will be carried out in frequency domain. This will require digitization of the analog records. The Geophysical Institute is well equipped for this purpose.

(iii) For spectral analysis, we will be using standard FFT computer program. During other seismological studies, one version of this program has been checked for well defined functions. The program is now catalogued on the University computer for routine use.

XI. SPECIAL SAMPLE AND VOUCHER SPEICMEN ARCHIVAL PLANS

None.

XII. LOGISTICS REQUIREMENTS

See attached forms

XIII. ANTICIPATED PROBLEMS

None.

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).
From Prudhoe Bay to 8 remote locations around it; each location is about 150 miles from the origin point.

2. Describe types of observations to be made.
To install temporary remote seismographic 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?
N/A

4. How many days of helicopter operations are required and how many flight hours per day?
6 days, 4hr/day
Total flight hours?
24

5. How many people are required on board for each flight (exclusive of the pilot)?
2

6. What are the weights and dimensions of equipment or supplies to be transported?
approximately 300 lbs, 2' x 2' x 2'

7. What type of helicopter do you reommend for your operations and why?
Bell Jet Ranger, 206B. Have good experience with this aircraft for installing seismographic stations 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.
No

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

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

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) Prudhoe Bay (b) 1 May, 1979 to 31 August, 1978 (c) 1, 120

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?

   $120/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?

   From past experience in operating seismographic stations around Barter Island.

E. SPECIAL LOGISTICS PROBLEMS

None

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.

XIV. INFORMATION ACQUIRED FROM OTHER INVESTIGATORS

None.

XV. MANAGEMENT PLANS

(i) After acquisition of the necessary equipment, the performance will be checked at the laboratory.

(ii) Permitting weather conditions, the stations of the network will be installed at predetermined sites. Moreover, one member of the field crew will be stationed at the recording site to avoid any data loss.

(iii) The data on magnetic tape will be shipped weekly from the field to the laboratory where playback of data and analysis will be carried out simulatneously.

MILESTONE CHART

- Planned Completion Date

RU # 483 PI: Nirendra N. Biswas

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

MAJOR MILESTONES	1978 O	1978 N	1978 D	1979 J	1979 F	1979 M	1979 A	1979 M	1979 J	1979 J	1979 A	1979 S	1979 O	1979 N	1979 D
Part I.	X														
Field work	X 1978												X 1979		
Data Scaling			X 1978										X 1979		
Analysis						X 1978									X 1979
Reporting						X 1978									X 1979
Part II.															
Laboratory Test						X									
Field Work (i) station installation								X							
(ii) data recording												X			
Data Scaling													X		
Analysis														X	
Reporting														X	

1978, 1979 these refer to data gathered during the calendar years.

OCS 79-10
Modified

RESEARCH PROPOSAL

TO:	OCSEAP/NOAA Rx4 325 Broadway Boulder, CO 80302
TITLE:	Administrative & Technical Support for the OCSEAP Data Processing Center & the NODC/OCSEAP Representative - RU 497 & RU 370
PROPOSAL NO.	AEIDC p79-01
PRINCIPAL INVESTIGATOR:	David M. Hickok
TOTAL COST:	$83,000
INSTITUTION:	Arctic Environmental Information & Data Center University of Alaska 707 A Street Anchorage, AK 99501
DATE:	June 26, 1978 (Rev. August 24, 1978)
PERIOD:	October 1, 1978 - September 30, 1979

David M. Hickok
Principal Investigator
AEIDC, University of Alaska
Anchorage, AK 99501
(907) 279-4523

Mr. A. B. Frol
Director of Administrative Services
University of Alaska
Fairbanks, AK 99701
(907) 479-7551

Dr. K. Mather
Vice Chancellor for Research and Advanced Study
University of Alaska
Fairbanks, AK 99701
(907) 479-7551

TECHNICAL PROPOSAL

I.	Title:	NODC field representative to OCSEAP
	Research Unit Number:	497
	Proposed Dates:	October 1, 1978 - September 30, 1979
	Title:	NODC field representative support by AEIDC (Arctic Environment Information and Data Center)
	Research Unit Number:	370
	Proposed Dates:	October 1, 1978 - September 30, 1979
	Contract Number:	____________________

II. Principal Investigators

RU497	Michael L. Crane
RU370	David M. Hickok

III. Cost of Proposal	RU497	RU370
A. Science	0	0
B. PI Logistics	$ 15K	$ 83K
C. Total	$ 15K	$ 83K

D. Totally non-lease area specific management work.

IV. Background: The OCSEAP Data Base proposed the establishment of a field liaison person to support the Data Base in professional data management tasks such as format development, investigator interaction, and data receipt. The first twenty-four months efforts in format development and maintenance, in data processing support to investigators, and in management support in data management by providing tracking systems and inventory files, marked the initial phase of OCSEAP data management. The next phase was a minimizing of potential delay in data receipt, and this phase continues today. Concurrently another phase has developed and is noted by an emphasis on complete and accurate data submission. This last phase began nine months ago and remains the dominant phase in the data management of the Outer Continental Shelf Environmental Assessment Program.

V. Objectives: These research units have the primary objectives of assisting the Data Base in checking and certifying quality digital data. of assisting the BLM/OCS in Anchorage with data products, and of supporting the OCSEAP investigators and OCSEAP management located in Juneau, Fairbanks, and Boulder. In each of these three activities, the research unit proposes to insure the continued flow of information to the OCSEA Program by giving professional data management assistance in data processing. As one component of the OCSEAP Data Base, the activities directly support the information base in the decision-making process of offshore oil and gas development.

VI. Strategy and Approach

The processing facility will be managed by the Principal Investigator (RU497) on a daily contact basis. The Research Unit 497 provides professional and supervisory guidance to Research Unit 370 (processing facility proper). The Principal Investigator (RU497) is under the direct supervision of the Chief, Project Monitoring Branch, National Oceanographic Data Center.

Status reports to the OCSEAP management will provide the necessary management oversight to the data processing activity. In addition to quarterly reports, copies of monthly reports will be available to OCSEAP management.

To support the data processing requirements of the OCSEA Program, the Anchorage Data Processing Facility proposes to expand data checking capability, to continue data product support to the BLM/OCS office in Anchorage, and to assist the Principal Investigators and OCSEAP Management as required. The Arctic Environmental Data and Information Center (AEIDC), under RU370, proposes to maintain a data processing facility staffed to provide the technical support of the facility, and the National Oceanographic Data Center (NODC) proposes, under RU497, to provide the management and supervision of the professional data management functions of the facility.

The general strategy to accomplish the three areas identified for FY79 will be a cooperative effort by the NODC and the AEIDC dividing specific actions among the appropriate components. The specific functions to be accomplished are (1) developing check programs which meet NODC data base requirements and OCSEAP management's requirements; (2) advising and developing data processing support to the BLM/OCS in Anchorage; and (3) assisting the OCSEAP investigators in data processing support and the OCSEAP management offices in professional data management support. These three functions will be controlled by Dr. Wayne Fischer, Program Data Manager. Additional information will be incorporated from Jim Audet, OCSEAP data base coordinator, Toni Johnson, Administrative Assistant for Data Management (Fairbanks P.O.), and F. M. Cava, Data Manager (Juneau P.O.).

The relative priorities of these functions will be assigned by Dr. Fischer, and schedules will be established and distributed to all data management components.

The development of check programs requires the access to computer equipment configured to meet the requirements of data checking. These requirements are listed below:

(a) Media compatible to OCSEAP data base computers

(b) Flexible, easy-to-develop programming language

(c) A simple, easy-to-use operating system

(d) Editing equipment to make corrections

(e) Data communication to connect the NODC computers to local equipment

(f) Local computer maintenance available

(g) An output which provides a permanent record of results

The priorities in file types and the level of checking will generate from inputs from both OCSEAP management and the OCSEAP data base. The schedule of development will reflect the requirements of both management and the data base.

The major time component in data checking after the programs have been written is the feed-back time from investigators for corrections. The principal advantage of the Anchorage Data Processing Facility is the potential direct access to investigators to resolve data errors. Interaction with the investigator is directed to the specific problem and frees both parties from extensive administrative correspondence until the need occurs. Procedures are streamlined for investigator, management and data base. In this way direct costs will be reduced and missed opportunities will be avoided. Without streamlining, additional costs as high as forty percent will be incurred.

The NODC under RU497 proposes to offer effective administrative procedures to exploit the full benefits of data checking in Alaska.

The AEIDC under RU370 proposes to develop and implement the check programs.

Inventories of data submissions will be incorporated in the results of the data check programs. The AEIDC (RU370) proposes to develop inventory displays as part of the overall display of check program results.

The support to the BLM/OCS office in Anchorage will combine indirect and direct technical assistance. Explanations of potential program maintenance of current inventories and interactions with the OCSEAP data base in relation to requests from the BLM/OCS office are examples of indirect technical assistance. Developing predator/prey relationship programs, developing data selecting programs, and providing updates to taxonomic files are examples of direct technical assistance. The BLM/OCS has designed a special Predator/Prey Matrix file and program to be used in the decision-making process. Timely taxonomic updates are critical in maintaining this file. In conjunction with Dr. Elaine Collins, new entries in the NODC taxonomic code will be incorporated by RU370 into the Predator/Prey file. Data editing equipment such as a diskette keyentry work station is required to provide the direct technical support. Hard copy outputs of data products will also be available for the BLM/OCS and additional services will be available as required. Control of this function will remain with Dr. Wayne Fischer, Program Data Manager.

The data processing support to OCSEAP investigators and the professional data management support to OCSEAP management will continue and be provided as required. This function will be dramatically reduced from previous years because the guidance priorities and funding does not allow adequate staff levels. Data entry services have been identified by Mr. Rod Swope for research units 229 and 243. These services are included in the proposal from RU370. Additional keyentry services will be negotiated as required by OCSEAP management.

The NODC (RU497) proposes to support OCSEAP management with professional data management services as identified by each component. Current support activities include phone calls and reports to project offices, status reports and data processing schedules, and data inventories and summaries (e.g., results from check programs are forwarded to contract supervisors routinely). Transmittal and inventories of data receipts will be forwarded to the appropriate project office. This function is an administratively-oriented activity and RU497 proposes to be the principal point of contact for this management support activity. This function will be coordinated with Ms. Toni Johnson and Ms. F. M. Cava.

The NODC (RU497) proposes also to maintain a communication link between Anchorage and the OCSEAP data base, support data base pre-processing, and have meetings, phone calls, etc., with appropriate individuals as required to resolve data management problems. The funding indicated in the guidance to RU497 will be divided among data communication items, data processing items, and travel expenses.

The sampling methods and analytical methods (A) and (B) listed in the instructions do not apply to this proposal.

VII. Deliverable Products

A. Digital Data - No data generated by the research unit.

B. Narrative Reports - Quarterly and annual reports plus periodic status reports will be delivered in partial fulfillment of this agreement.

C. Visual Data - Not applicable.

D. Other Non-Digital Data - Not applicable.

E. Data Submission Schedule - Not applicable.

F. Check program results or a status report will be forwarded to the appropriate Project Office within 30 days.

G. Updates to the Parameter Checklist will be delivered to the OCSEAP as required.

H. Check programs for file types 023, 031, and 032 will be written. A schedule for development will be attached in the milestone section.

I. A copy of specified crunch tapes will be maintained in Anchorage.

J. Data entry services for RUs 229 and 243 will be included as part of the proposal. These services are available at no cost between 1 October 1978 to 1 March 1979.

VIII. Special Sample and Voucher Specimen Archival Plans

No applicable.

IX. Logistics Requirements

Not applicable.

X. Anticipated Problems/Recommended Solutions

A. Administrative procedures in transmittal of check program results have not been established. The distribution of check program results must also be established.

Solution: OCSEAP should develop and implement an administrative procedure for the distribution and transmittal check program results.

B. Potential delays in the response by investigators to corrections of data because field activities or laboratory activities demand a higher priority.

Solution: OCSEAP management should streamline administrative procedures, should provide direct access to investigators, and should identify potential areas for delay.

C. The term "error-free" should be defined.

Solution: OCSEAP management should establish adequate standards to test an "error" condition in data sets.

XI. Information Required from Other Investigators

Adequately coded digital data or coding forms are required of other investigators when keyentry service is to be provided.

Properly annotated data sets are required when computer compatible media are delivered.

From RU362, guidance on data processing steps and scheduling would be required.

XII. Milestone Chart

Not applicable.

XIII. Outlook

(1) Develop data product interface to users from the Data Base.

(2) (a) Interactive data access to OCSEAP data files, October 1, 1978.

(b) Data analysis programs developed to support OCSEAP users March 1, 1978.

(3) FY80 $105K labor costs.

(4) Remote Job Entry and Direct Data Entry equipment.

(5) Not applicable.

(6) Not applicable.

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, 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 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 US 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 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.

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

Milestone Chart

Check Program Development Schedule

File Type 023	Completed	Project Office Input Due
(1) START	September 78	*
(2) ID023	September 78	Aug/Sep 78
(3) PR023	October 78	*
(4) RL023	November 78	October 78
(5) SL023	November 78	*
(6) CD023	December 78	*
(7) MP023	December 78	November 78
(8) TX023	January 79	*

File Type 031	Completed	Project Office Input Due
(1) START	January 79	*
(2) ID031	January 79	December 78
(3) PR031	January 79	*
(4) RL031	February 79	January 79
(5) CD031	February 79	*
(6) DE031	March 79	February 79
(7) MP031	March 79	February 79
(8) TX031	April 79	*
(9) SL031	April 79	*

File Type 032	Completed	Project Office Input Due
(1) START	April 79	*
(2) ID032	May 79	April 79
(3) PR032	June 79	*
(4) RL032	June 79	May 79
(5) CD032	July 79	*
(6) MP032	August 79	July 79
(7) TX032	August 79	*
(8) SL032	September 79	*

Legend of Program Descriptions

START - Sets the initial values, sets ranges for lat/long, date, time
IDxxx - Checks taxonomic codes and data base required fields
PRxxx - Computes the predator/prey relationship
RLxxx - Checks the data fields, range and relationship
SLxxx - Selection program, complement of RLxxx
CDxxx - Code check program
MPxxx - Station location plotting program for tektronix 4051
TXxxx - Taxonomic code conversion program

DE031 - Special data entry program for file type 031

COVER SHEET FORMAT

Proposal/Revision Date: 7/31/78

To: Appropriate Project Office

Contract # : 03-5-022-69

NOAA Project #: N/A

Institution ID: N/A

FY 1979 RENEWAL PROPOSAL

Research Unit Number: 512

TITLE: Seasonal Composition and Food Web Relationships of Marine Organisms in the Nearshore Waters of Lower Cook Inlet - Including Fishes and Benthic Epifauna.

Cost of Proposal: $100K   Lease Areas: Lower Cook Inlet 100%

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

PRINCIPAL INVESTIGATOR(S):

Name: James Blackburn, Fishery Biologist   Date: July 28, 1978
Peter Jackson, Fishery Biologist

Signature: James E. Blackburn
Peter B. Jackson

Address: Alaska Dept. of Fish & Game
P.O. Box 686 Kodiak, Alaska 99615
Telephone Number: 907 - 486-5751   FTS: N/A

INSTITUTION: Alaska Dept. of Fish & Game

REQUIRED ORGANIZATION APPROVAL:

Name: Steven Pennoyer   Date:

Signature: ______________________

Position: Chief Research Scientist
Alaska Dept. of Fish & Game
Address: Subport Bldg. Juneau, Alaska 99801
Telephone Number: 907-465-4220

ORGANIZATION FINANCIAL OFFICER:

Name: John Stewart   Date:

Signature: ______________________

Postion: Finance Officer
Address Alaska Dept. of Fish & Game
Subport Bldg. Juneau, Alaska 99801
Telephone Number: 907 - 465-4157

TECHNICAL PROPOSAL

I. Title: Seasonal Composition and Food Web Relationships of Marine Organisms in the Nearshore Waters of Lower Cook Inlet - Including Fishes and Benthic Epifauna.

Research Unit: 512

Contract Number: 03-5-022-69

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

II. Principal Investigators:

James E. Blackburn

Peter B. Jackson

III. Cost of Proposal:

A. Science $100,000

B. P.I. Provided Ogistics - $0.00

C. Total - $100,000

D. Distribution of Effort by Lease Area: Lower Cook Inlet- 100%

IV. Background:

The need to develop new sources of oil for the U.S. was suddenly realized in the early 1970's and the sale of leases on subtidal land was comtemplated. The lower Cook Inlet area was one of those seriously considered. The need to prepare environmental impact statements for the leases led to the funding of research programs to gather data.

In the lower Cook Inlet area previous survey type data on marine resources was largely lacking. The National Marine Fisheries Service had conducted approximately 85 otter trawl hauls in Cook Inlet during 1958, 1961 and 1963, however, they were rigged for shrimp or crab and operated only between mid-July and late September. Various fisheries have existed in the inlet for some time and information based on these fisheries has been accumulating. The salmon fishery is conducted in summer, throughout the inlet, with local concentrations of effort and fish. The herring fishery has been active in Kachemak Bay, Kamishak Bay and in the vicinity of the Forelands. Rounsfell (1929) documented this fishery in Kachemak Bay in the early part of the century, however, due to fluctuations in price and stocks, this has not been a continuous fishery.

Halibut have been fished in Kachemak Bay, Kamishak Bay and to some extent around Kalgen Island. The International Pacific Halibut Commission conducted 26 otter trawl hauls in July of 1974 and 1976 in the mouth of Kachemak Bay as part of their work to index rearing stocks. The trawl shrimp fishery has been active but restricted to Kachemak Bay. Shrimp research has included fishery documentation and since 1971 trawl surveys have been conducted in May to index stock abundance (Davis 1976a).

The king and tanner crab fisheries have been active in Kachemak Bay and in the central inlet southeast of Augustine Island. In 1974 a pot index program for king and tanner crab abundance was initiated in Kachemak Bay and in 1975 the program was expanded to the Kamishak Bay area (Davis 1975, 1976b). Other fisheries include Dungeness crab and pot shrimp (those caught by pot as opposed to trawl) which are largely restricted to Kachemak Bay. Sport fisheries include king salmon and razor clam, which are largely restricted to the east side of the inlet between Anchor Point and the Forelands.

A compilation of existing information on the Cook Inlet fisheries was prepared by the Alaska Department of Fish and Game under a program funded by the Federal Coastal Zone Management Program Development Funds (ADF&G 1976). This work included a written narrative and a portfolio of mapped data. The narrative included characterizations of each fishery and tabularizations of statistical data. Historical catch, eff..t, economic value, and excapement statistics were included. The map section included distribution mapping for all significant finfish and shellfish species, major fishing areas for all commercial species, critical salmon and shellfish spawning areas by species where known and shellfish rearing areas by species where known.

A study of the effects of oil on biological resources was funded by the State of Alaska as a result of public concern over Alaska'a 28th Oil and Gas Lease Sale of subtidal land in Kachemak Bay. These studies included the fishery resources, birds, coastal morphology, circulation and a synthesis of the impact of oil on the Kachemak Bay environment (Trasky et al. 1977).

The studies initiated in 1976 under the Outer Continental Shelf Environmental Assessment Program (OCSEAP) were hastily assembled and were faced with a paucity of data concerning what to expect. The scope was broad: as much of the inlet as could be physically covered efficiently. Sampling was conducted with beach seines and surface tow nets from the east Forelands to Port Graham on the east side of the inlet and from Amakdedori Beach to Chinitna Bay (with a few samples further north) on the west side of the inlet. Surveys were repeated monthly during June through September of 1976. An otter trawl was successfully used in the central portion of the inlet during June, July, August, September 1976 and March 1977. A power purse seine and gill nets were used to study pelagic fish during July, August and September 1976. A number of conclusions resulted from this study as did some questions. (Blackburn, 1978).

Since this sampling effort the initial lease sale was held in October 1977 but a future lease sale is planned for March 1981. And, it is our current understanding that areas further south, into Shelikof Strait are being considered for lease. These areas have not been addressed in fishery surveys by OCSEAP, but NMFS has done some trawling in Shelikof Strait.

Additional field work was initiated in lower Cook Inet during the 1977-78 budget period. The objectives of this study were designed to develop an understanding of seasonal changes in composition and feeding habits of dominant marine organisms. These objectives are the same as number 1, 2 and 3 of this proposal, which is a continuation of that field work, without change.

Field collections are restricted to the northern Kamishak Bay area and Kachemak Bay in the Jakolof Bay-Tutka Bay vicinity. Field collections began in April and will continue through the end of the budget period, September 30, 1978. Food habits analysis is being conducted upon the catch.

This proposal is in response to a request by OCSEAP to continue the ongoing field work and food habits analysis through the end of October 1978, and to address additional objectives through the remainder of the year. These objectives are numbered 4 through 7 in section V.

V. Objectives:

The objectives of this study, as stated in the guidance letter for this proposal are:

1. Determine the feeding habits of principal life stages of dominant pe-pelagic and demersal fish and provide an initial description of their role in the food web.

2. Describe the temporal dynamics of pelagic and demersal fish at specific sites.

3. Evaluate the timing and use of specific areas by the pelagic and demersal fish.

4. Review all past information on the fisheries in lower Cook Inlet including commercial and sports catch statistics in order to determine the past and future trends in the importance of these species and to define the geographical and seasonal locations of fishing areas.

5. Define the geographical locations and seasonal use of spawning areas to the highest resolution possible.

6. Identify the geographical and seasonal locations of important prey.

7. Describe and evaluate the potential for impact on commercial, potentially commercial, and sports fisheries by OCS oil and gas explorations, development, and production based on the findings of the above six objectives plus existing information on the sensitivity of various life stages of these species, and geographcial areas of potential risk.

Objectives 2 and 3 should be reworded as follows:

2. Describe the distribution and relative abundance of pelagic and demersal fish and their seasonal changes.
3. Identify areas of unusual abundance or of apparent importance to fish, especially commercially important species.

The spawning areas addressed by objective 5 refer to king crab, tanner crab, shrimp, herring and Pacific salmon of the genus *Oncorhynchus*. Intertidal salmon spawning areas will be identified, season of use, species, and historic run size noted as available. Freshwater salmon spawning areas will be identified by stream, species, historic run size, and time of marine accumulation, as well as is known.

VI. Strategy and Approach:

Three basic tasks will be assigned to accomplish the desired objectives. The first consists of field collections, food habits analysis, data analysis and report preparation. This will address objectives 1,2 and 3. The second task will consist of literature search and comparision with field data to satisfy objectives 4,5 and 6. The third task will consist of literature review and evaluation to accomplish objective number7.

The experimental design for the first task will consist of sampling the fish community with a variety of gear types throughout the month of October. Fish will be selected from the predominant, important or little known species for food habits analysis.

A. Sampling Method

The gear being employed consists fo beach seine, try net, gill net, trammel net and surface tow net. The work conducted in October 1978 will be in Kamishak Bay from the Cottonwood Field Camp, unless it is jointly deemed appropriate by the P.I. and the Juneau Project Office of OCSEAP to move to Kamishak Bay, to work in the Jakolof Bay-Tutka Bay area (Figures 1 & 2). A series of standard stations will be sampled as frequently as possible, usually at about weekly intervals, with each of the gear types, as appropriate for each station. The fish captured in each sample will be sorted by species and life history stage, the number and weight of each recorded, a sample of the catch will be preserved and it will consist of the entire catch except that only stomachs of large fish and not more than 25 of abundant taxa will be preserved (Figure 3). In addition, once an adequate number (about 50) of any taxon has been preserved for food habits analysis during the time period 1-15 October or 16-31 October, then small additional samples of this taxon will be preserved. Length frequencies of specimens not preserved will be taken in the field. Sexual maturity will be noted on selected taxa, especially as their spawning season approaches. The length, sex, and sexual maturity will be recorded when the stomach is removed. Specimens captured in gill and trammel nets will not be used for food habits analysis unless an inadequate number of them is available from other gear types. The food habits of about 125 fish (modified by time demands) will be examined from each half month period. The attached priority list (Table 1) will be used to select these fish from those captured, however,

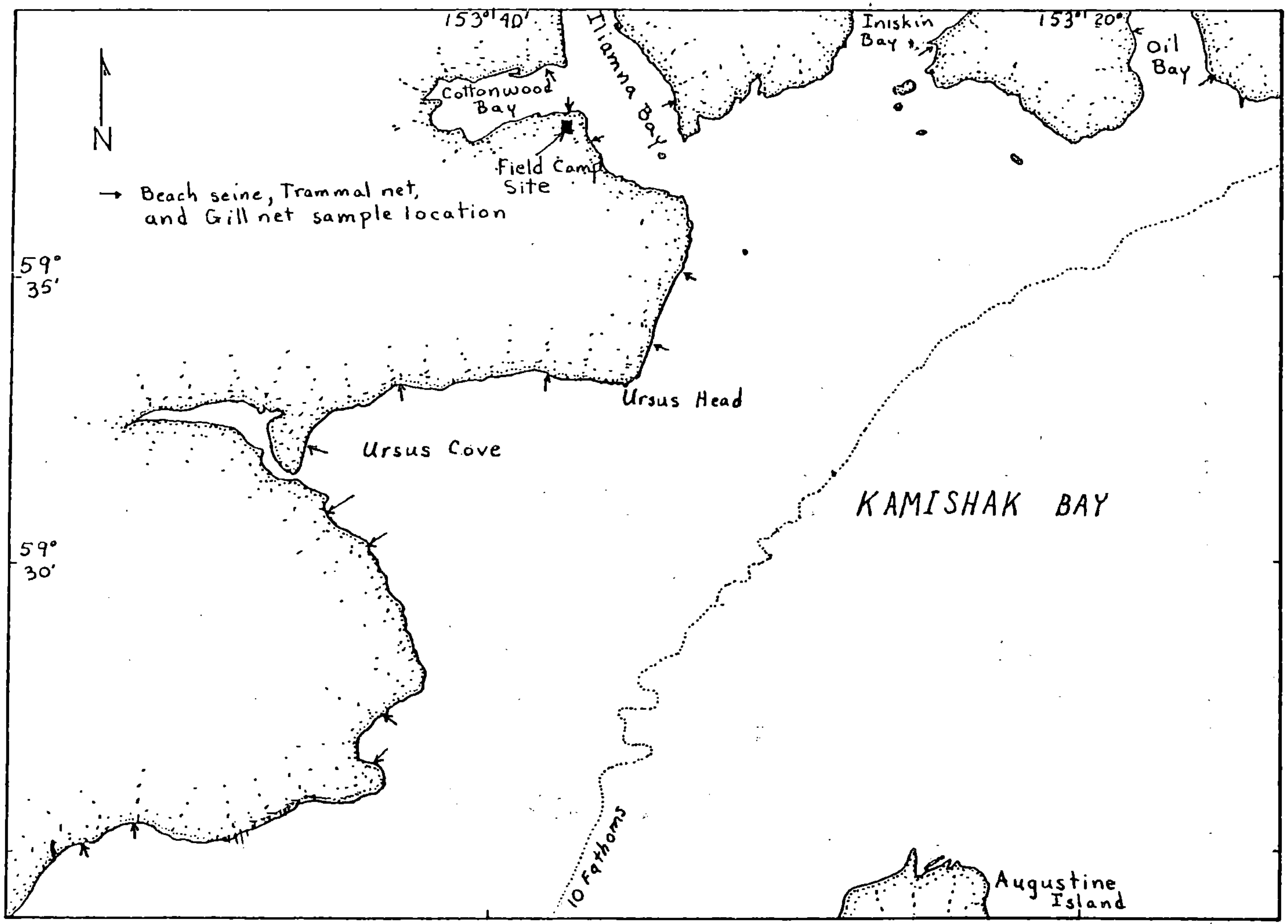

Figure 1. Kamishak Bay study site.

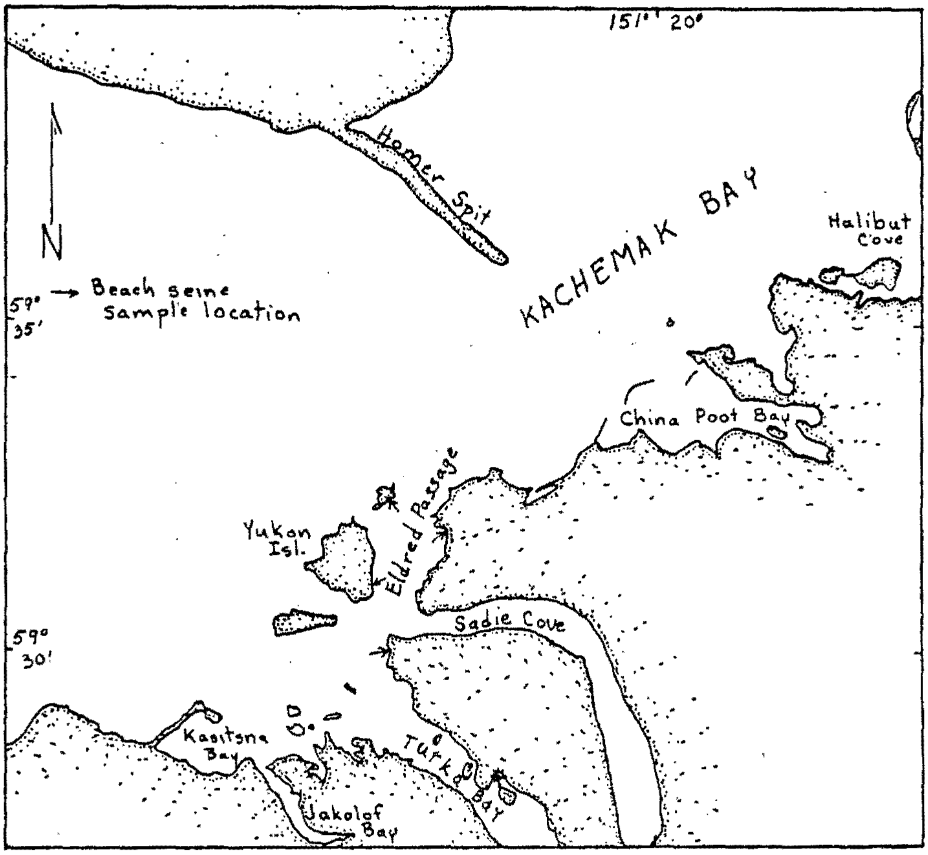

Figure 2. Kachemak Bay study site.

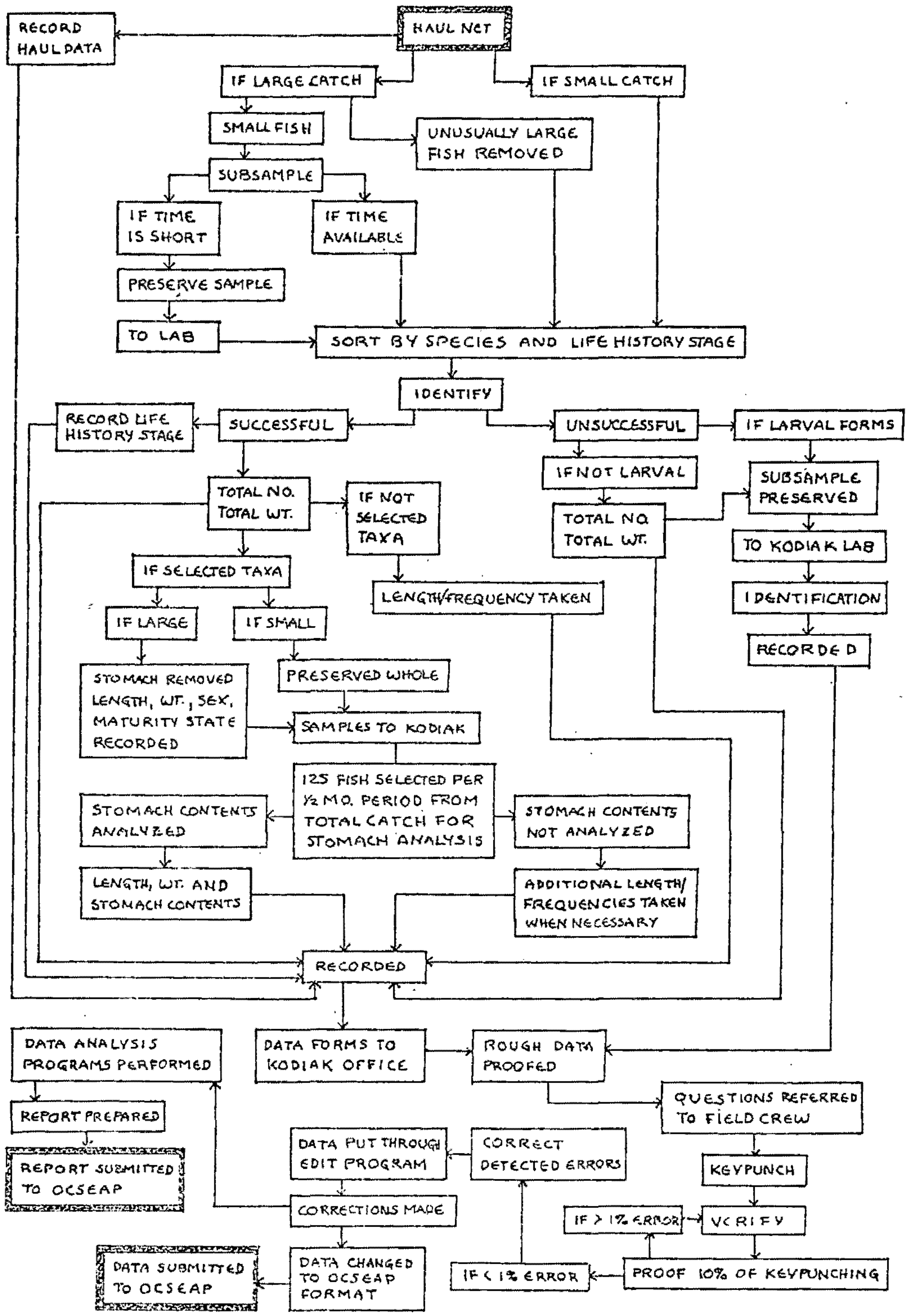

Figure 3. Data handling and verification procedures

Table 1. Priority list for selection of specimens for food habits analysis.

PRIORITY	SPECIES	MAXIMUM
1	Sandlance	25
2	Herring	25
3	Dolly Varden	25
4	Chum Salmon Fry	25
5	Chinook Salmon Fry	15
6	Red Salmon Fry	15
7	Coho Salmon Fry	15
8	Pink Salmon Fry	15
9	Whitespotted Greenling Juvenile	15
10	Whitespotted Greenling Adult	10
11	Masked Greenling Juvenile	15
12	Masked Greenling Adult	10
13	Capelin	20
14	Eulachon	5
15	Longfin Smelt	10
16	Great Sculpin	20
17	Yellow Fin Sole	10
18	Starry Flounder	10
19	Rock Sole	10
20	Staghorn Sculpin	10
21	Pollock	10
22	Pacific Cod	10

it may be modified to accomodate unanticipated abundance of a species.

Sampling adequacy of field collections will be expressed in appropriate statistical terms and these terms are not the same in all situations. For example in the expression of mean catch per unit effort (CPUE) of fish species, the different species have a wide variation in the degree of clumping or contagion in their distribution. The great sculpin is quite evenly distributed with a standard deviation of its CPUE approximately equal to the mean catch while sandlance occur almost exclusively in massive school during part of the year. The standard deviation of sandlance CPUE may reach 5 times the mean value, and at this time the frequency of occurrence may be of more value (the occurrence of one is the same as the occurrence of many and the data breaks down to simple presence-absence information).

In the description of fish abundance and distribution the basic catch data will be summarized as mean CPUE and standard error of the mean (SE) while the discussion will incorporate the frequency of occurence information and other features of the catches as appropriate to adequately portray the distribuiton and abundance features desired.

Statistically establishing the adequacy of food habits sampling is extremely difficult. There are a number of parameters that may be used to express dietary composition and a number of ways of presenting this information for this study. It is judged that the important elements to document are the predominant food tiems, the relative contribution of the predominant food items and seasonal cycles of these features of the diet. For each item a frequency of occurrence, a mean count and a mean weight may be calculated, but at times the descriptive value of these parameters may be in doubt due to differing degrees of digestion, differential digestion rates etc. The best compromise may be to present mean count with its standard error and mean weight with its standard error for total contents of each taxon of predator. In addition, for each of the major food items of each predator the frequency of occurence, number of predators examined, mean count with its standard error, and mean weight with its standard error may be presented. Unfortunately the volume of data necessarily presented by this approach may make the tabular presentation difficult to understand quickly and additional graphic presentation will be necessary.

Although it is not an important objective to document all the items that contribute to the diet, it may prove useful (and may be possbile) to use a species-area program to obtain an estimate of the completeness of the list of diet items for each taxon. It is considered less important and beyond the financial scope of this study to document short cyclic variation in food habits such as diet differences or differences by tidal state. Hence samples will be collected randomly from the tidal-diel cycle phases to cumulatively describe the mean total diet. It will be impossible to document the accuracy of this approximation without documenting the patterns or even the presence of these cycles.

The only instruments that will be used in the field will be hand held thermometers and a Yellow Springs Instrument Company model TS-33 meter for temperature and salinity. This will be calibrated before each reading and as recommended by the manufacturer.

B. Analytical Methods

Fish will be removed from the formaline preservative, put into a water and ammonia solution, and refrigerated overnight. Before examination, the specimens will be soaked in cold water.

The fork length of each fish will be determined to the nearest millimeter and the weight will be determined to the nearest 0.01 gm. The gut will be removed and cut open, and an estimate of stomach fullness will be made. Contents will be removed (under a microscope if gut is small)m weighted to 0.01 gm, and examined (again under a scope if needed) for individual taxa. Each taxon will be enumerated and weighted to the nearest 0.01 gm. The biomass of prey too small to be accurately weighted, will be estimated volumetrically. Degree of digestion of prey will be recorded.

Identification of prey will be made to class or order (gastropods, amphineurans, bivalves, amphipods, mysids, cumaceans, isopods, euphauside, cirripeds, shrimp), or to species where possible (fish, crab larvae). Samples of each prey from each species in each haul will be preserved for reference and further identification.

Data collected will be proofed, keypunched and edited. From the corrected data one copy will be put into OCSEAP format and submitted, while another copy will be used for analysis. The food habits data will be summarized in several ways. A table will be prepared listing the number of fish by species and life history stage examined from each time period. A table will be prepared listing percent composition (numberical or weight as appropriate) of food items in stomachs of all species from all times. For each of the major species and life history stages the numerical and weight composition of diet and their standard errors will be presented by time period and a graphical presentation, Index of Relative Importance (IRI) diagram (Pinkas et al. 1971), will be prepared by time period.

A species list of the fish captured will be presented. The catch information will be summarized as mean and standard error of catch per unit effort by gear, species and time period. The amount of effort will be summarized by gear and time period. Relative abundance and rank of abundance by taxon will be presented for each gear and time period.

Species association analyses will be conducted to attempt to define natural groupings of fish. The resulting groupings will be compared with the results of food habits analyses to determine the presence of differences in food habits between and within the groupings.

In general, tests of significance and confidence limits on statements will not be necessary. Since this study is a survey, the descriptive statistics, mean and standard error of the mean as well as a presentation of the level of effort, are the appropriate methods of displaying results.

In order to describe temporal dynamics of fish species at specific sites, the species will be individually discussed verbally with appropriate tabular and graphic presentations constructed to display the results and interpretation of results.

C. Literature Review

The literature review task number 2, to meet objectives 4, 5 and 6, will be accomplished by gathering the necessary information from within ADF&G,

other OCSEAP research units and from published information. Available expertise within ADF&G will be employed as much as feasible to produce the best possible product within the budget limitation.

The evaluation necessary to reach objective number 7 will also utilize the most efficient and complete method of literature accumulation and will employ available expertise within ADF&G to the fullest extent practicable. The ADF&G Marine/Coastal Habitat Protection Division has recently completed a similar study for Kachemak Bay (Trasky et al. 1977) and, although there has been insufficient time during the preparation of this proposal to make arrangements to work with them, it may be feasible to combine resources to accomplish this objective.

One aspect of objective 7 that is very important is to identify data gaps and suggest priorities for further research. The existing information base is inadequate to completely evaluate impact, but the efforts on this task will attempt to make as complete an evaluation as possible and to identify data gaps that should be addressed in future studies.

VII. Deliverable Products

A. Digital Data

1-2. Attached (Table 2) is a listing of the File Type 23 (Fish Resource) Format Parameters to be submitted with expected ranges for each. Additional parameters are requested for Record Type 7-Prey Record. These additional parameters are:
Length of Predator, Length Code, Weight of Predator, and Weight Determination. These are basic parameters to record. The amount of food a fish is capable of holding in its stomach is related to the size of that fish, thus recording fish size is essential.

These parameters may be recorded on record type 6 and for some specimens they are. However, to simplify data analysis and minimize data volume it is very important to be able to record all information pertinent to food habits analysis on one record type.

3. Procedures used to verify accuracy of digital data. See Figure 3.

B. Narrative Reports

Other than required quarterly and annual reports, preparation of

Table 2. Definition of File Type 23 Digital Data Parameters Utilized in Proposal Work for R.U. 512 in F.Y.79.

Record Type Headers - All Record Types

COLUMNS	IDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
1-3	File Type	I3	XXX	023
4-9	File Identification	I6	XXXXXX	100178-033179
10	Record Type	I1	X	1-8
11-12	Agency Code	I2	XX	21
13-14	Vessel Code	A2	XX	02-30: A-X
15-16	Cruise Number	A2	AX	N/A
17-19	Haul or Set Number	I3	XXX	0-999
100-104	Sequence Number	5	XXXXX	N/A

Record Type 1 - Haul Record

COLUMNS	IDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
29-35	Latitude	A7	XX.XX.XXA	59°00'00"N-60°50'00"N
36-43	Longitude	A8	XXX.XX.XXA	151°00'00"W-154°20'00"W
44-49	Date (GMT)	I6	XXXXXX	781001-781130
50-53	Time (GMT)	I4	XXXX	0-2400
54-55	Gear Type Code	I2	XX	10-92
56-58	Duration of Fishing	I3	XX.X Hrs.	00.1-36.0
59-61	Distance Fished	I3	XX.X Km.	00.0-08.0
62	Direction of Tow	I1	X	1-9
63	Performance Code	I1	X	0-8
70-73	Mean Bottom Depth	I4	XXXX M	0-275
76	Sounding Record	I1	X (Blank)	1-3
77-78	Bottom Trawl Type	I2	XX	00-40
79-80	Bottom Trawl Accessories	I2	XX	00-32
81-84	Scope or Warp Used	I4	XXXX M	0-1225
89	Present Weather	I1	X	0-9
90	Cloud Amount	I1	X	0-9
91	Sea State	I1	X	0-9

Record Type 2 - Trawl Gear Record

COLUMNS	IDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
20-21	Gear Type Code	I2	XX	10-92
22-24	Opening Height - Trawl	I3	XX.X M	00.5-03.0
25-27	Opening Width of Trawl	I3	XX.X M	00.5-11.0
28-30	Overall Trawl Length	I3	XXX M	01.0-15.0
31-32	Codend Length	I2	XX M	01.0-5.0
33-34	Footrope Length	I2	XX M	00.0-25.0
35-36	Headrope Length	I2	XX M	00.0-25.0
37	Gear Material Code	I1	X	0-2
38	Opening Mesh	A1	X	0-9: A-D
39	Average Body Mesh	I1	X	0-9
40	Codend Mesh	I1	X	0-9
41	Codend Liner	I1	X	0-9
42-43	Number of Floats	I2	XX	05-50
44-45	Float Diameter	I2	XX Cm.	10-25
46	Tickler	I1	X	0-1
47	Roller Gear	I1	X	0-1
48-50	Length of Bridles	I3	XXX M	001-037
51-52	Length of Doors	I2	X.X M	0.5-3.0
53-54	Width of Doors	I2	X.X M	0.3-1.5
55-58	Warp Length	I4	XXXX M	0005-0823
59-62	Depth of Gear	I4	XXXX M	0005-0275
72	Tide Stage Code	A1	X	F, E, H, L

Record Type 3 - Miscellaneous Gear Record

COLUMNS	IDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
20-21	Gear Type Code	A2	XX	10-92
22-25	Unit Length	I4	XXXX M	0-200
26-27	Net Depth	I2	XX M	0-100
34	Gear Material Code	I1	X	0-2
39	Seine - Average Body Mesh	I1	X	0-9
40	Seine - Bunt Mesh	I1	X	0-9
41-42	Gillnet, # of Shackles	I2	XX	1-20
43	Gillnet, Material	I1	X	0-2
44	Mesh	A1	A	0-9: A-D
65-68	Depth of Gear	I4	XXXX M	0-183
72-73	Trammel Net, # of Shackles	I2	XX	0-10
74	Material of Outer Panels	A1	X	1
75	Mesh of OUter Panels	A1	X	9
76	Material of Inner Panels	A1	X	1
77	Mesh of Inner Panels	A1	X	1
78-80	Gear Salinity	I3	XX.X PPT	0-35.0
84	Tide Stage Code	A1	X	F, E, H, L

Record Type 4 - Species Catch Record

COLUMNS	IDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
20-23	Sample Number	A4	XXXX	0-9999
24-33	Toxonomic Code	5A2	XXXXXXXXXX	1/
34-41	Total Weight by Species	I8	XXXXXX.XX kg.	0-1000.00
42	Weight Determination	I1	X	1-3
43-48	Total Number by Species	I6	XXXXXX	1-999999
49	Number Determination	I1	X	1-3
50	Sex Maturity Code	A1	X	0-5
51	Life History Code	A1	X	6-9,A,B
52-55	Number of Species Examined	I4	XXXX	0-20
56-60	Volume of Catch	I5	XXXXX	0-100
61-64	Fish Per Liter	I4	XXXX	0-100
65-68	Weight of Small Catches	I4	XXX.X gms.	0-999.9
97-99	Record Modifier	A3	XXX	Always Blank

1/ NODC Taxonomic Codes - March, 1977.

Record Type 5 - Length Frequency Record

COLUMNS	IDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
20-23	Sample Number	A4	XXXX	0-9999
24-33	Taxonomic Code	5A2	XXXXXXXXXX	See Record Type 4
34	Sex	I1	X	0, 1, 2, 3
35-38	Length of Class in mm	I4	XXXX	0-2000
39	Length of Code	A1	X	0-5
40-43	Length Frequency	I4	XXXX	0-200
44	Length Sample	I1	X	2, 4
97-99	Record Modifier	A3	XXX	Always Blank

Record Type 6 - Individual Biological Record

COLUMNS	IDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
20-23	Sample Number	A4	XXXX	0-9999
24-33	Taxonomic Code	5A2	XXXXXXXXXX	See Record Type 4
34	Sex Code	A1	X	0, 1, 2, 3
35	Maturity Code	A1	X	0-5
36-39	Length	I4	XXXX MM	1-2000
40	Length Code	A1	X	1-5
41-46	Weight	I6	XXXXXX gms	0-100,000
47	Weight Determination	A1	X	1, 2, 3
48-49	Age	I2	XX years	0-40
50	Age Structure	A1	X	0-4
51	Age Determination	A1	X	1, 2
52	Sample type	A1	X	1, 2, 3
53	Data Type	A1	X	1-9, A-F
55	Gut Collected	A1	X	Y, N

Record Type 7 - Prey Record

COLUMNS	IDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
20-23	Sample Number	A4	XXXX	
24-33	Taxonomic Code - Predator	5A2	XXXXXXXXXX	See Record Type 4
34-43	Taxonomic Code - Prey	5A2	same	same
44-48	Number of Prey Individuals	I5	XXXXX	0-99999
54	Organ Code	A1	X	1,2
55	Stomach Fullness Code	A1	X	1-7
56	Life History Code of Predator	A1	X	6, 7, 8
57	Stomach Digestion Code	A1	X	0-6
58-63	Weight of Stomach Contents	I6	XXXX.XX gm	0-3000.00
64	Life History Code, Prey	A1	X	1-9, A-F
65-71	Wet Weight of Prey	I7	XXXX.XXX	0-3000.000
72	Weight Method	A1	X	1-9, A-G
73	Gut Position	A1	X	1-4
74-77[1]	Length of Predator	I4	XXXX MM	1-2000
78[1]	Length Code	A1	X	1-5
79-84[1]	Weight of Predator	I6	XXXX.XX	0-9999.99
85[1]	Weight Determination	I1	X	1-3

[1]Requires approval

Record Type 8 - Comments

COLUMNS	IDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
20-99	Comments	A81	XX etc.	N/A

additional narrative reports is not anticipated at this time. In the event special reports are required by OCSEAP, as was the case in F.Y.76, they will be complied with. In this event, however, it would be appreciated if lead time of at least six weeks is given. The only other narrative reports possibly resulting from this proposed work would be formally published papers of an opportunistic nature depending on findings (species range extensions, newly developed sampling methodologies, etc.). In these cases, however, all stipulations in Parts I & J of Section XIV (Standard Statements) will be adherred to.

C. Visual Data:

All visual data products produced in conducting studies proposed here will be incorporated in quarterly or annual reports. These data will include maps showing spatial and temporal distribution of principal species in various life stages and distribution of principal species in various life stage and distribution of sampling sites in the study areas in respect to time period and/or habitat type. Photos of the study areas may be included to show the various habitat types, fish species obtained, various phases of sampling activity and methodologies utilized. Data on life history parameter (i.e. spawning areas, growth rates, spacial and temporal distribution, species and age class composition, etc.) will be depicted by computer or hand produced graphic methods, as well as narrative discussion. Depending on results, comparative data on other biological parameters may be presented through graphic, tabular or pictoral means. All maps submitted in conjunction with narrative data will be supplied on standard maps of the appropriate scale reduced to 8½" X 11" paper. In addition, these map products will be supplied as transparent mylar film overlays in an appropriate scale labeled with the appropriate information to define the origin and interpretation of the map.

D. Other

Submission of other forms of digital or non-digital data products other than those mentioned in A, B, and C of this section is not anticipated.

E. Data Submission Schedule - Table 3.

See attached Data Products Schedule.

Digital data on spatial and temporal distribution and abundance of pelagic and demersal fish species will be submitted to NODC on magnetic disketts in accordance with required schedules. In addition, in-depth analyses of these data will be presented in tabular, graphic and narrative form in quarterly and annual reports. Grahpic presentations of species distribution and abundance, will be prepared in a manner that these data may be compared over various time periods. Analyses of these presentations will be discussed in accompanying narrative reports. Detailed appendix tables of all data presented will be included in reports as a supplementary data product.

VIII. Special Sample and Sample Archival Plans:

Voucher specimens will be obtained, handled, preserved and cateloged generally in accordance with procedures for this purpose required by the OCSEAP Project Office, Juneau. As freezing facilities aboard vessels and at field camps will be limited, all specimens retained will be preserved. Preservation of fish samples will employ a solution of ten parts water to one part formalin as well as 70% ethyl alcohol (following dehydration) as primary fixatives and preservatives. Household borax (one teaspoon per quart) will be added to these solutions when used as preservatives in order to provide buffering and retard shrinkage. In general, specimens more than a few inches in length will have an incision made on the right side of the abdomen to facilitiate penetration of the preservative. The cut will be about half as long as the body cavity and made with a very sharp knife. Fish heavier than three pounds will be prepared for preservation by making a deep incision into the muscle mass on each side of the vertebral column, operating from inside the body cavity. Specimens retained for archival will be retained in formalin for two to three days, soaked in water for a minimum of two days (water being changed at least once during this period) and dehydrated to 70% alcohol. One change of 70% alcohol will be necessary prior to final preservation in order to prevent color loss. All specimens preserved in the field will be initially retained in wide mouth "Nalgene" bottles of appropriate size, completely immersed in preservative and covered with a leakproof closure. Specimens for archival will be placed in glass bottles or jars for final retention. Specimens will be transferred to the California Academy of Sciences for permanent archival at the option and direction of the OCSEAP Project Office.

IX. Logistics Requirements:

The proposed study will require a continuation of the existing logistics arrangements. These include a charter vessel, use of a field camp and its support, charter flights between Homer and the field camp and use of small boats, all of which has been arranged and financed by OCSEAP.

See attached Logistics Requirements forms.

X. Anticipated Problems:

1. Timely consideration of this proposal is critical as, if accepted, some lead time will be necessary for the State of Alaska to accept new funding prior to project initiation.

XI. Information Required from Other Investigators

In order to accomplish objectives 4,5 and 7 information will be required from other projects within Alaska Department of Fish and Game, which R.U. 512 will be responsible for gathering. Accomplishing objective 5 will require information from R.U.'s 005, 417 and 424 on spawning areas and seasons for important species. Information will be required of these same three R.U.'s on the geographical distribution of important prey taxa. Information will be required from R.U. 005 on results of trawling conducted within lower Cook to augment the existing data base of R.U. 512.

Information will be required of OCSEAP or BLM on lease tract location, exploratory rig locations, the BLM Development Scenario and the results of trajectory analysis being conducted by OCSEAP during 1978.

Additional published information will be necessary for accompanying these objectives, which R.U. 512 will be responsible for gathering.

XII. Activity/Milestone Chart

See attached Milestone Chart, Table 4.

XIII. Outlook

After completion of the proposed studies there are a few basic considerations for future work. The pelagic fish of the inlet should be studied, some areas probably should be explored by trawl, study of juvenile king and tanner crab distribution in Kamishak Bay should be undertaken and the portion of Shelikof Strait that may be affected by future sales should be studied. The specifics of these studies will probably be more clearly delineated after data gaps and sensitivities are identified during the proposed literature review and impact evaluation.

The herring fishery in Kamishak Bay during 1978 consisted of a floating processor, the YARDARM KNOT, about 56 seiners and 32 tenders. These vessels remained in the vicinity virtually all of the month of May. The intensity of the fishery is an indication of the value and the intertidal spawning habit of the fishery and the intertidal spawning habit of herring presents a potential conflict with oil. Further study of these herring may well be warranted. Currently, information is available on the time and location of spawning from aerial surveys conducted for management purposes in 1978 in Kamishak Bay. More study may be warranted to document vertical distribuiton and intensity of spawn. Knowledge of vertical and spatial distribution during the larval stage would be valuable as this is the stage of life during which the greatest variation in mortality occurs.

The migration of juvenile salmonids from their source streams to the ocean is partially understood. Residence time in the inlet and distribution in the open exposed areas is poorly known. The inlet is sufficiently large that a rough idea of distribuiton is probably all that can be expected and primarily of the more abundant species. The survey technique that seems most likely of success is use of electronic equipment (side scan sonar) as a primary sample tool and use of towed nets to determine species composition and relative abundance. There are portions of the inlet that have never been sampled by trawl primarily Kamishak Bay south of Augustine Island and the nearshore zone less than 20 fathoms off Chinitna Bay. At least cursory looks at these areas should be conducted.

Juvenile king crab and tanner crab settling areas should be identified in Kamishak Bay. At the present time it is known that juvenile crabs of both these species are abundant both north and south of Augustine Island at depths less than about 20 fathoms. The location of settling areas is not known. This area could be quite important in the production of the fished populations of king and tanner crab. During the proposal review of knowledge the pertinent questions and likely avenues of study should become clearer.

Similar studies in Kachemak Bay were conducted by grab sampling in search of newly settled crab and plankton surveys identified the location of pelagic larval abundance. OCSEAP studies have confirmed the abundance of tanner crab in northern Kamishak and indicated that larval settling may be important in Iniskin Bay (Lees, personal communication) and near Cape Douglas (Feder, personal communication). A synoptic survey on the appropriate spatial-temporal scale would be very valuable.

The possible expansion of the lease area to the south, into Shelikof Strait, would necessitate additional studies, if it became a reality. The OCSEAP studies to date have specifically avoided this area, consequently it is poorly known. Active fisheries in Shelikof Strait that may be of concern include halibut, tanner crab, salmon, and herring. There is also a greater population of bottomfish than is found in most of lower Cook Inlet and it is generally much more oceanic in nature, considerably different than the more estuarine lower Cook Inlet. It is also quite different from the west side of Kodiak where other OCSEAP studies are in progress. However, with the existing experience and level of knowledge available we are in a relatively better position to efficiently assess a new area and identify conflicts between oil and living marine resources.

XIV. Standard Statements:

A. Updated milestone charts iwll 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 schedule on dates mutually satisfactory to both parties. In addition, the PI may be requested to participate inprogram 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-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 maniscripts 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 achnowledge 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."

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

STITUTION Alaska Dept. of Fsih & Game PRINCIPAL INVESTIGATOR James E. Blackburn Peter B. Jackson

SHIP SUPPORT

Delineate proposed tracks and/or sampling grids, by leg, on a chart of the area. Include a list of proposed station geographic positions. All stations are located in immediate vicinity of Cottonwood Bay (Figure 1) or Jakalov Bay, Tutka Bay and Eldred Passage (Figure 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. Successive sets for various nearshore fish species with a variety of smapling gear types. Specifics of sampling operation in Section VI.

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.)

Continue ongoing survey into and through October 1978.

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

Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback? R.U.512 will be a principal user of the vessel. RU 512 will need full use of vessel about 2 days per week

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. Need 8-12 daylight hours per day. Sampling time per station will be about 20 minutes per haul. Processing time will be about 5 minutes to one hour, depending on catch.

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

Trawl winch, vessel captain.

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

800 lbs.; 50 cu. ft.

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

you require any gase and/or chemicals? YES If s, they should be on
l the ship prior to departure from Seattle or time allowed for shipment by
e.

Formalin solution

---

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

M/V HUMDINGER - Continuation of existing charter.

---

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

Approximately $350. Availability not confirmed.

---

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

ield, crew chief, Jim Sicina, Robert Sanderlin, Dan Locke, staff members.

RTERS AND SUBSISTENCE SUPPORT

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

Cottonwood Bay Camp, October 1, 1978 - October 30, 1978, 4-5 personnel per day, Total of 120 man days.

R.U. 512 will purchase food.

you recommend a particular source for this support? If "yes", please name source and the reason for your recommendation. Yes. Existing Cottonwood Bay Camp.

t is your estimated per man day cost for this support at each location?

did you derive this figure, i.e., what portion represents quarters and what tion represents subsistence and is the figure based on established commercial es at the location or on estimated costs to establish and maintain a field p? Subsistence will cost about 6/man day - 120 man days

TOTAL $720

CIAL LOGISTICS PROBLEMS

t special logistics problems do you anticipate under your proposal and how you propose that the problems be solved? (Provide cost estimates and in- ate whether you propose handling the problems yourself or whether you must end on NOAA to solve them for you?

N/A

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

Between Homer and Cottonwood Field Camp

types of observations to be made.
N/A

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

days of flight operations are required and how many flight hours per day?

ight hours? 8 hours 4 flights round trip

.onsider your investigation to be the principal one for the flight, :cluding other activities or requiring other activities to piggyback :k or could you piggyback? Field camp support and personnel transportation can piggyback.

›es of special equipment are required for the aircraft (non carry-on)? N/A

ɛ the weights, dimensions, power requirements, and installation ; unique to the specific equipment. N/A

ɛ the weights, dimensions and power requirements of carry-on equipment?
N/A

pe of aircraft is best suited for the purpose?

Otter or Beaver Floats required

recommend a source for the aircraft?
", please name the source and the reason for your recommendation.
ɛmak Air Service continue existing charter arrangement

the per hour charter cost of the aircraft?

y people are required on board for each flight (exclusive of flight crew)?

2

lo you recommend that flights be staged from? Homer, Alaska

Table 3

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/
Pelagic and Demersal Nearshore Finfish	Diskettes	1000-105 byte EDP Listings	File Type 23	YES	10-78	1-79
Food Habits	Diskettes	2000-105 byte EDP Listings	File Type 23	YES	10-78	4-79

Table 4

MILESTONE CHART

0 - Planned Completion Date

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

RU # 512 PI: James E. Blackburn, Peter B. Jackson

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
Field Sampling	0														
Submission of ROSCOP Forms	0														
Food Habits Analysis				0											
Laboratory Sample Analysis		0													
Keypunch Digital Data Field Sampling			0												
Food Habits						0									
Data Processing Completed Field Collections						0									
Data Processing Completed Foods									0						
Submission of Digital Data				0			0								
Submission of Quarterly Report			0						0			0			
Submission of Annual Report						0									
Submission of F.Y.80 Work Statement									0						
Submission of Final Report															0

CU Proposal No. 0678.9.381B
State ID No. 78-270210-381

A Proposal to the

National Oceanic and Atmospheric Administration

for the support of

ENVIRONMENTAL DATA MANAGEMENT SYSTEM AND COMPLEX OF COMPUTERIZED SYNTHESIS MAPS FOR BEAUFORT SEA

Research Unit 516

Name and Address of Institution:	The Regents of the University of Colorado Boulder, Colorado 80309
Desired Starting Date:	1 October 1978
Amount Requested from NOAA:	$80,000
Time Period for Which Support is Requested:	One Year
Principal Investigator:	Michael Vigdorchik, Research Assoc. Institute of Arctic and Alpine Research University of Colorado Boulder, Colorado 80309 303-492-6387

M Vigdorchik
Michael Vigdorchik
Principal Investigator

Jack D. Ives
Jack D. Ives
Director, INSTAAR

Milton E. Lipetz
Vice Chancellor for Research and
Dean of the Graduate School

TECHNICAL PROPOSAL

I. Title: Environmental data management system and computerized maps for Beaufort Sea.
Research Unit Number - 516.
Contract Number
Proposed Date of Contract - October, 1978 - September, 1979.

II. Principal Investigator: Michael Vigdorchik.

III. Cost of Proposal: $80,000

IV. Background:

A great deal of data in the OCSEAP was presented in the Quarterly and Annual reports and the materials summarized during the Point Barrow meetings. The synthesis of materials was presented in report form. The flow of material continues in this manner and some attempts to evaluate this material have been made from the point of view of the impact made on the environment by oil development. The point has now been reached where this multi-disciplianry material could be summarized and synthesized in computerized form.

This organization could be done through the framework of a computerized environmental data management system. The system would be used not only for data storage but primarily for generating new secondary data. From there, it could go on to a quantitative evaluation and synthesis of these multi-disciplinary materials. Such an evaluation would be computer generated environmental maps (source, derived, interpretive and composite). This evaluation will not be limited to natural phenomena but will include other important aspects such as offshore oil operation hazards.

Our experience is closely related to the proposed data management system as may be seen in the Quarterly and Annual reports. Many source and derived maps were generated by a CDC 7600 (1:000,000 scale). This work continues in progress at this time. Some areas of different disciplines are involved in our processing (oceanography, geology, glaciology). One year was spent in development and technical organization to reach the point we are at. Now any kind of data can be used for preparation of environmental maps and updated according to new materials at any time. Many source and derived maps were made from digital data base during our work on submarine permafrost problems. It will now be expanded to generate source, derived, interpretive and composite maps covering other disciplines and OCS programs.

V. Objectives:

Summarize and synthesize the OCSEAP and pre-OCSEAP environmental data in the Beaufort Sea, by using a computerized system to generate a series of source, derived, interpretive and composite maps, addressing OCSEAP tasks and subtasks--this is a major objective of the proposal.

The Barrow Synthesis meetings have made possible the further development of the Data Management system not only for submarine permafrost prediction but as the basic approach and tool that can be utilized on any project which requires the analysis of different types of geographically based data as a basis for developing a shelf use plan or evaluation. Many maps were generated at the Barrow meetings by different groups of scientists in biological, physical oceanographic and geological source materials for our system. From another side the scientists at Barrow have identified the salient issues related to the various physical conditions, social concerns, economic factors and legalities affecting the shelf use plan and evalution. These issues were to be determined at the meeting and some of them are related to engineering feasibility and construction costs, losses and so on, while others pertain to the concerns of public safety and environmental impact. For FY 79, emphasis will be placed on mapping data and preparing products based on physical science studies in the Arctic.

Having the source maps and "issues of concern," we can take the next step in the "Data Management system" display by structuring the information needs of each discipline in a clear, integrated and efficient manner and then generating computerized environmental composite and candidate area maps.

VI. General Strategy and Approach:

The need to synthesize the large amounts of data collected by OCSEAP and use modern, computerized methods to do so wherever appropriate is apparent. If the data base is adequate, secondary data in the form of maps can be generated, helping in the multi-disciplinary evaluation and synthesis of the collecting materials.

This proposal represents the continuation of our efforts to use computer techniques for managing large amounts of geographically based data. These techniques could be used in many different types of planning projects, including site selection studies, highway and pipeline route selection, resource management plans, environmental impact assessments, and so on. Indeed, the basic approach of this proposal can be utilized on any project which requires the analysis of different types of

data as a basis for organizing shelf use plan or evalution.

VII. Sampling Methods:

Not applicable.

IIX. Analytical Methods:

The continuation of the Offshore Geographic Based Information Management System (OGIMS) development.

Our data management system is designed to provide a comprehensive framework for recording, storing, manipulating and displaying mappable information used in preparing planning studies. This program entails the use of electronic data processing and computer graphics to organize and present a variety of complex data in an orderly and systemic manner. Data is stored on magnetic discs allowing retrieval, analysis, and display of the data in the form of computer-generated maps. Techniques and facilities available via NGSDC in Boulder are of considerable assistance in these respects (especially the data files at NGSDC/EDS on bathymetry, etc. and their facilities for digitilizing map data). The program gives a dynamic base that can be readily updated, and it allows the evaluation of many alternatives. The system can automatically generate a great deal of secondary data, saving time and money during the collection phase of the project. During the data analysis phase, it is possible to aggregate a number of subjective judgements into an integrated set of evaluations. This set of evaluations is based on a multiplicity of geomorphological, geological, cartometerical, geophysical, oceanographic and biological factors. The system provides a complete trace of the decision-making process as well as an up-to-date base which can be used for future siting and routing and environmental studies of this territory.

Using the computer-oriented approach, a team of investigators is able to coordinate the flow of information for projects analysis, to control the selection and format of the data used, and to establish their value. The Data Structure Diagram (Figure 1) represents and organizes data requirements, the stages of mapping, and the production of information resulting from the study.

A computerized environmental data management system will be used to generate maps, involving the following phases:

1. a) Data digitization and preparation for computer use (major part done by PI's and EDS).

   b) preparation of the Source maps (one map--one characteristic).

2. Generation of the Derived maps, based on Source maps and/or/on the physical and biological relations between different characteristics.

3. Preparation of the Interpretive data maps, based on the statistical correlation between characteristics belonging to the same discipline and given in the source and derived maps. Factor analysis and clustering will be used to choose the strongest links between different features. A cluster analysis technique will be used also as an important tool of mapping.

4. Compiling of the Issue based maps includes the work with information from previous sections, but in the framework of a more broad disciplinary range; for example, environmental hazards map is based on the data on permafrost, seismic, ice gouging and other physical phenomena.

5. Composite maps generation based on the assessment value setting obtained from all issue based maps. It shows the interdependence of the different components of the environments and OCS development ("maps of sensitivity").

6. Synthesis candidate area map based on all the previous analysis. This map will divide the Beaufort and Chukchi Seas territory on the areas of the different degree of the danger connected with OCS oil and gas development and transportation.

This data Structure Diagram illustrates the relationships among the data information used in the study, and it can be viewed as describing the flow of mappable information. The layout and content of the diagram is developed in response to the relevant issues (the distribution and the thickness of the permaforst in the Alaskan northern coast). The diagram is organized both horizontally and vertically, with the vertical organization arranged by the type of map analysis. The source data column contains "nonvalue-oriented" data from maps. The next two columns, for "derived data maps," contain the results of cartometrical and other ways of the first usage of the data management. Then the interpretive data maps and issue maps display information developed from source data and derived data maps. These maps are defined by disciplinary knowledge and the relationships between source data topics. They serve as the basis to further more experimental and subjective analysis. We will use computer methods as the mechanisms for identifying and organizing the multiplicity of the values of the data into a form useful in the composite analysis stages.

We will continue to use the base maps prepared in 1977. A Geographic Base Map as a basis for mapping all source data at the same scale and in a common format (each data category can be mapped onto a separate copy of the GBM) and a Grid Base Map in order to facilitate the referencing of mappable data for computer processing. It is used as an overlay for encoding the data. The individual cells on the Grid Base Map serve to represent discrete geographic areas which act as depositories for data. Each grid cell is indexed by its row and column number to provide a discrete address identifying a specific location. The scale of mapping will be 1:1000000's and 1:1500000's.

The capability to produce maps in both conical and UTM projections will be maintained.

The four basic computer techniques that are used for interpreting and analyzing the data are: (1) the Translation technique for converting a single source data map into a secondary data map; (2) the Comparison technique for comparing two or more maps in order to produce a third derivative map showing the results of the comparison; (3) the Overlay technique for combining two or more maps in order to produce a composite map showing the results of the overlay process; and (4) the Distance technique which is used for calculating the distance of all geographical areas from a given point, line or area.

XIII. Anticipated Problems Connected with Physical Field Mapping:

For Beaufort Sea we usually have observations only in a very limited number of points, and the real problem is to cover the whole region with some reasonable data. The data assimilation problem is the problem of creating an equal-distance network of grid points from very sparsely distributed observation stations.

In our work, we propose to continue using the following interpolation scheme. A two-dimension first or second order polinomal interpolation seems to give the best results. The numerical scheme follows. If we wish to calculate the value of some physical or geological feature at point M (Xo, Yo), we first limit our considerations to the domain p' {(Xi, Yi)}, which satisfied the condition:

$$\sqrt{(Xo-Xi)^2 + (Yo-Yi)^2} \leq R$$

In other words, the point M is inside the circle of radius R. Each point (Xi, Yi) has a special weight Pi, which increases when (Xi, Yi) is near (Xo, Yo) and decreases elsewhere. At the point M (Xo, Yo), the value is equal to 1. We take point M as an origin or coordinates. The value of the function in each point inside our domain can be approximated by polinom of 2nd degree or 1st degree,

$$Q_2(X,Y) = C_0 + C_1X + C_2Y + C_3Y^2 + C_4XY + C_5Y^2$$

or

$$Q_1(X,Y) = C_0 + C_1X + C_2Y$$

We will now show how to calculate the unknown coefficients C_0, C_1, C_2, C_3, C_4, C_5 in the case of second order polinom. This is done by using the least squares numerical method. To find such coefficients that will give the minimum to the sum

$$S = \sum_{i=1}^{N} Pi\ (C_0 + C_1 Xi + C_2 Yi + C_3 X^2 i + C_4 XiYi + C_5 Yi - \varphi i)^2$$

Where N in number of observations inside the circle of radius R, (Xi,Yi) are coordinates of the given observations and φi are the values of the function (salinity, temperature, depth) at these points. In order to obtain a minimum of S we must take the derivatives of this expression with regard to C_0, C_1, C_2, C_3, C_4 and C_5 and obtain six linear equations, which are called normal equations:

$$\frac{ds}{dc_0} = \frac{ds}{dc_1} = \frac{ds}{dc_2} = \frac{ds}{dc_3} = \frac{ds}{dc_4} = \frac{ds}{dc_5} = 0$$

$$C_0\ \Sigma Pi + C_1 \Sigma PiXi + C_2 \Sigma PiYi + C_3 \Sigma PiXi^2 + C_4 \Sigma PiXiYi + C_5 \Sigma PiYi^2 = \Sigma Pi\ \varphi i$$

$$C_0\ \Sigma PiXi + C_1 \Sigma PiXi^2 + C_2\ \Sigma PiXiYi + C_3 \Sigma PiXi^3 + C_4 \Sigma PiXi^2 Yi + C_5 \Sigma PiXiYi^2 = \Sigma PiXi\ \varphi i$$

$$C_0\ \Sigma PiYi + C_1 \Sigma PiXiYi + C_2 \Sigma PiYi^2 + C_3 \Sigma PiXi^2 Yi + C_4 \Sigma PiXiYi^2 + C_5 \Sigma PiYi^3 = \Sigma PiXi\ \varphi i$$

$$C_0\ \Sigma PiXi^2 + C_1 \Sigma PiXi^3 + C_2 \Sigma PiXi^2 Yi + C_3 \Sigma PiXi^4 + C_4 \Sigma PiXi^3 Yi + C_5 \Sigma PiXi^2 Yi^2 = \Sigma PiXi^2\ \varphi i$$

$$C_0\ \Sigma PiXiYi + C_1 \Sigma PiXi^2 Yi + C_2 \Sigma PiXiYi^2 + C_3 \Sigma PiXi^3 Yi + C_4 \Sigma PiXi^2 Yi^2 + C_5 \Sigma PiXiYi^3 = \Sigma PiXiYi\ \varphi i$$

$$C_0\ \Sigma PiYi^2 + C_1 \Sigma PiXiYi^2 + C_2 \Sigma PiYi^3 + C_3 \Sigma PiXi^2 Yi^2 + C_4 \Sigma PiXiYi^3 + C_5 \Sigma PiYi^4 = \Sigma PiYi\ \varphi i$$

Remembering that M (Xo, Yo) is the origin of the coordinates, we have only to find C_0; then $Q(Xo, Yo) = C_0$. When calculating the value of the needed function at point M, we need only to move to the next point and repeat the above calculations.

The value of Pi is a function of the distance

$$di = \sqrt{(Xi - Xo)^2 + (Yi - Yo)^2}$$

and must equal zero when di = R.

In our calculations we have chosen the expression

$$Pi = \left\{ \frac{R^2 - di^2}{di^2} \right\}^2$$

The radius R was chosen as $R = 25\Delta X$; however, it is very important to be sure that at least six observations are inside the circle when using a second order interpolation and three observations when using a first order. Generally all calculations were made with second order polinomials. Occasionally, as a test we used first order, and usually the results were almost the same. However, second order usually gives the smoothed contours.

Contingency Plans:

None. No field work is performed by this project.

IX. Deliverable Products:

1. Narrative Reports: As required by all OCSEAP projects; to include methods, results, data sources, etc.
2. Digital Data: This project will not generate digital data inself, but may digitize available data (OCSEAP and pre-OCSEAP) for use in the computerized system. It will make use of the available digital data base in EDS.

3. Visual Data: Computer-generated maps as listed under Methods and shown in the "Structure diagram." The main output of the proposal for 1978-1979 y.y. will be the creation of a system to organize the multiplicity of data values into a form useful in the composite analysis stages. In 1978-1979 we will concentrate only on three blocks of our system:

a. Physical environment;

b. OCS development;

c. Chemical.

4. Data Submission Schedule:

The stages of the computerized mapping are related to the TDP schedule. Following this schedule, most of the source and derived maps could be done during 1978-1979. We have used asterisks to specify these maps on the "structure diagram." These maps will be submitted to the OCS Arctic Project Office according the the attached "Data Products Schedule".

X. Quality Assurance Plan:

Throughout the map generation process, statistical confidence values will be computed and maintained in such a way that confidence limits can be applied to map projects for interpretation and evaluation processes. The sources of all raw data will be referenced and maintained.

XI. Special Sample & Voucher Speciman Archival Plans:

None. No field work is performed by this project. No voucher specimens or samples are collected.

XII. Logistics Requirements:

None. No field work is performed by this project.

XIII. Anticipated Problems:

(see page 9.)

XIV. Information Required from Other Investigators:

The information required from other scientists could include the data of David Shaw, David Barrel, David E. Robertson, Charles M. Hoskin (ambient contaminant levels), N. N. Biswas, Peter Barnes, Erk Reimnitz, David Drake, Paul Sellman, Edward Chamberlain, David M. Hopkins, Thomas Ostercamp, Will Harrison, James Rogers (environmental hazards), Kurt Aagard, Thomas C. Roger, I. K. Coachman, R. L. Charnell, I. D. Schumaher, Robin Muehch, Thomas C. Roer, Brian Mathews, I. C. H. Mundall, A. S. Naidu, Jan Cannon, Miles Hayes, Dag Nummedal, Seelve Martin, William Stringer, Albert Bellon, Mike Frank (transport) and others. We will use primarily the materials of the quarterly, annual and final reports, but personal communications, especially through the meetings in Boulder and Fairbanks are also part of the program.

XV. Management Plan:

See attached Milestone Chart, and statement of Principal Investigator intent.

XVI. Outlook:

Assuming that the research proposal for FY 1978 is successfully carried out and reaches the first major plateau of accomplishment, we can outline the following:

A computer-based system for systematic collection, storage and display of the environmental parameters is an important tool for an environmental assessment of the seashore continental shelf.

For incorporation in Impact Assessment considerations, it is anticipated that the research should be continued through FY 80 for the whole Beaufort and Chukchi Seas shelf area, and also that the environment be studied. The different stages of the computerized mapping processes may be seen on the data structure diagram. We propose to finish the source and derived maps in 1979, the greater part of the environmental hazards, ambient contaminant levels, development scenario, contaminant transport and the remaining part in 1980. In 1980, it should be possible to begin producing the source and derived maps of the biological and other blocks of the system. Generation of the interpretive and issue based maps, could be begun in 1980 and synthesis candidate area maps in 1981.

The cost of this work will be approximately $80 K a year, which is on the same level of the current proposal. We do not need additional major equipment or specail field efforts and with logistic requirements. Of course, we continue to consider this work as a collective effort of the OCSEAP participants and hope to share our authorship with the representatives of the different scientific fields.

Also, see Flowchart(a wall chart, copy available in Boulder).

XVII. Standard Statements:

Standard Statements #1,2,4,5,6,8,9,10 are appropriate to this project.

DATA PRODUCTS SCHEDULE

Data Type (i.e., Intertidal, Benthic Organisms etc.)	Media (Cards, coding sheets, tapes, disc)	Estimated Volume (Volume of processed data)	OCSEAP Format (If known) Scale:	Processing and Formating done by P.I. (Yes or No)	Collection Period (Month/Year to Month/Year	Submission (Month/Year)
Source data	Maps	19	1:1,000,000 1:1,500,000	Yes	Oct.1978 - June, 1979	July, 1979
	Coding sheets	19		Yes	Oct.1978 - June, 1979	July, 1979
	Punch cards	12.105		Yes	Oct.1978 - June, 1979	July, 1979
	Magnetic tapes	18		Yes	Oct.1978 - June, 1979	July, 1979
Derived data	Maps	10	1:1,000,000 1:1,500,000	Yes	July-Sept.1979	October, 1979
	Magnetic tapes	8		Yes		

MILESTONE CHART

RU #: 516 PI: M. Vigdorchik

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

MAJOR MILESTONES	1978			1979								
Data Management System and Computerized Maps	O	N	D	J	F	M	A	M	J	J	A	S
Source Data Maps (physical environment block)	+	+	+									
Quarterly Report	+	+	+									
Source Data Maps (physical environment block)				+	+	+						
Annual and Quarterly Reports				+	+	+						
Source Data Maps (physical environment block, chemical block)							+	+	+			
Quarterly Report							+	+	+			
Source Data Maps (OCS development block)										+	+	+
Derived Maps										+	+	+
Report										+	+	+

BOARD OF REGENTS
UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

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

TYPE OF SUPPORT REQUESTED: Contract (Renewal of 03-5-022-67)

TITLE OF RESEARCH PROJECT: Characterization of the Nearshore Hydrodynamics of an Arctic Barrier-Lagoon System: Meteorological Input (Revised Proposal)

Research Unit No. 519
Lease Area: Beaufort Sea - 100%

AMOUNT REQUESTED: $60,000

DESIRED CONTRACT PERIOD: 1 October 1978 - 30 September 1979

UNIVERSITY OFFICE TO BE CONTACTED REGARDING GRANT NEGOTIATION: Grant and Contract Services
Room 1, Administration Bldg. AD-24
University of Washington
Seattle, Washington 98195
Telephone (206) 543-4043

DATE: November 1978

Robert A. Brown
Co-principal Investigator

Thomas L. Kozo
Co-principal Investigator

Richard Trowbridge, Acting Director
Polar Science Center

Stanley R. Murphy, Director
Division of Marine Resources

OFFICIAL AUTHORIZED TO GIVE UNIVERSITY APPROVAL:

Donald R. Baldwin, Director
Office of Grant and Contract Services
Room 1, Administration Bldg. AD-24

TECHNICAL PROPOSAL: MODIFICATION OF PROPOSAL

I. Title: Characterizations of the Nearshore Hydrodynamics of an Arctic Barrier Lagoon System: Meteorology Input

Research Unit Number: 519

Investigation Period: October 1978 - September 1979

II. Investigators: Principal Investigator - Robert A. Brown, Professor (8% of time)

Co-Investigator - Thomas L. Kozo, Predoctoral Researcher

Performing Agency - University of Washington
Division of Marine Resources

III. Estimated cost FY 1979: $40,000 - Beaufort

A.	Science	$57,100
B.	PI provided logistics	2,900
C.	Total	$60,000
D.	Distribution of Effort by Lease Area: Beaufort Sea, 100%	

IV. Background

This is a modification of the proposal submitted in June 1978 by the University of Washington for the renewal of support for Research Unit 519 (Contract 03-5-022-67) to provide for the procurement, deployment and operation of two data buoys. This proposed modification includes a revised budget and a statement of work to be added to the proposal of June 1978.

The need for a more accurate synoptic wind field covering the upcoming oil lease area in the Beaufort Sea was noted in meetings with Dr. Knut Aagaard and at the May 1978 Orcas Island workshop. In addition, a pressure grid with at least one offshore station is necessary to merge Aagaard's ocean current studies on the Beaufort shelf with Dr. Brian Matthews' nearshore work.

The results from a 1976 study of a data base with inputs from two AIDJEX ADRAMS buoys within the ice pack, five coastal stations, and two inland stations (Kozo, 1977) demonstrated the greater reliability and higher resolution of this type of pressure grid when compared with analysis based on National Weather Service charts with limited data input within the area to be leased.

V. Objectives

It is proposed that two ADRAMS buoys transmitting pressure and position be placed in operation from March 1 through September 30, 1979 to provide a high resolution synoptic wind field in the oil lease area. This buoy data will be augmented in August 1979 by a land based microbarograph grid with three remote weather stations to provide 10 meter winds as described in the June 1978 proposal.

The buoys will transmit position and pressure data every three hours during the above mentioned time period, chosen to coincide with Dr. Aagaard's current meter deployment.

VI. General Strategy and Approach

The atmospheric pressure array will consist of one land based buoy, one buoy within the polar ice pack and the Barter Island National Weather Service station. The initial position of the offshore buoy will be chosen to best contain the lease area during its months of operation. The Barter Island data is essential to establishing the geostrophic wind direction since it completes a triangular grid. Once the buoys are in position, there should be no need for weekly maintenance involving aircraft flights.

In the event of malfunction or loss of the buoy within the ice pack, prior to August 1979, the land based buoy can be deployed offshore. However, the geostrophic wind will be poorly determined without some data input from a second manned inshore station. Since OCS experiments are staged from Deadhorse, it is proposed that a microbarograph be maintained at the Deadhorse tower by investigators in temporary residence from March through July 1979. If this station cannot be set up, we will be faced with guessing the geostrophic wind from relative pressure gradients between Barter Island and the buoy. In effect the lone buoy data will be useless until August when the inland pressure grid will be established.

VII. Sampling Methods

Position and pressure data will be obtained every three hours. Raw data will be retrieved from NASA with conversion to position and pressure accomplished at the Polar Science Center

Schedule: Data will be reduced as it comes from NASA and can be submitted in final form to OCS by December 1979. Note: Exchanges with Dr. Aagaard will be maintained throughout the experimental period.

BOARD OF REGENTS
UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

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

TYPE OF SUPPORT REQUESTED: Contract (Renewal of 03-5-022-67)

TITLE OF RESEARCH PROJECT: Characterization of the Nearshore Hydrodynamics of an Arctic Barrier-Lagoon System: Meteorological Input

Research Unit No. 519
Lease Area: Beaufort Sea - 100%

AMOUNT REQUESTED: $39,923

DESIRED CONTRACT PERIOD: 1 October 1978 - 30 September 1979

UNIVERSITY OFFICE TO BE CONTACTED REGARDING GRANT NEGOTIATION:

Grant and Contract Services
Room 1, Administration Bldg. AD-24
University of Washington
Seattle, Washington 98195
Telephone (206) 543-4043

DATE: June 1978

R. A. Brown
Robert A. Brown
Co-principal Investigator

Thomas L. Kozo
Thomas L. Kozo
Co-principal Investigator

Richard Trowbridge
Richard Trowbridge, Acting Director
Polar Science Center

Richard Trowbridge for
for Stanley R. Murphy, Director
Division of Marine Resources

OFFICIAL AUTHORIZED TO GIVE UNIVERSITY APPROVAL:

D R Baldwin
Donald R. Baldwin, Director
Office of Grant and Contract Services
Room 1, Administration Bldg. AD-24

6-23-78

TECHNICAL PROPOSAL

I. Title: Characterizations of the Nearshore Hydrodynamics of an Arctic Barrier Lagoon System: Meteorology Input

Research Unit Number: 519

Contract Number: 03-5-022-67

Investigation Period: October 1978 - September 1979

II. Investigators: Principal investigator - Robert A. Brown, Professor-(8% of time)

Co-Investigator - Thomas L. Kozo, Predoctoral Research Associate II (50% of time)

Performing Agency - University of Washington Division of Marine Resources

III. Estimated cost FY 1979: $40,000 - Beaufort

A.	Science	$ 38,525
B.	PI provided logistics	1,400
C.	Total	$ 39,925
D.	Distribution of Effort by Lease Area: Beaufort Sea, 100%	

IV. Background

This is a proposal to investigate the mesoscale wind field in the area of an arctic barrier lagoon system. The synoptic wind field exhibits an east-west bimodality in all seasons. The summer wind field which is of main concern to modelers appears to be a composite of the existing synoptic field plus thermally driven circulations which include sea breezes but not land breezes. The geography of the lagoon system in the Beaufort Sea makes it particularly susceptible to thermal circulations arising from horizontal gradients in surface heating (Defant, 1951).

The sea breeze cell is usually contained in the atmospheric boundary layer and is strongly influenced by eddy viscosity, surface roughness, and conduction processes. Yet its horizontal extent is large enough that the earth's rotation and the synoptic-scale pressure gradient cannot be ignored (Walsh, 1974). Previous investigators (Cotton, et al., 1976) have found that the synoptic environment is altered by the sea breeze through (1) perturbing the vertical thermodynamic profile, (2) increasing the depth of the planetary boundary layer, (3) inducing greater surface fluxes of momentum, heat, and moisture, (4) changing the vertical shear of the horizontal wind in the lower levels of the atmosphere, and (5) developing intense, horizontal convergence regions of heat, moisture and momentum.

Rawinsonde data from Barter Island, Alaska have shown the percentage of days with apparent sea breeze influence (Kozo, 1977) on the vertical wind profile to be 25% from July through September for 1976 and 1977. Recently analyzed wind direction data obtained at Pingok Island, Tolaktovut Point, Cross Island and Narwhal Island show a change in modal wind direction from 45-60° True in spring (limited thermal contrast across the coastline) to 75-90° True in summer (large thermal contrast across the coastline). Spectral analysis of the same data show a greater peak in the variance of wind speed and direction at the diurnal period for summer than for spring data.

The thermal forcing weakens a synoptic wind from the west, while strengthening one from the east. In the case of a weak synoptic field, the wind vector will rotate clockwise from a northeast direction to parallel to the coast in less than 8 hours (Kozo, 1978) to maintain an effective easterly flow. The greater the thermal gradient between land and sea, the greater will be the discrepancy between calculated synoptic winds and the actual measured wind (Kozo, 1978).

Therefore, this summertime phenomenon should not be neglected in nearshore hydrodynamic models dealing with rates of lagoon flushing and oil spill trajectories.

V. Objectives

The degree of influence of the thermally driven coastal atmospheric circulation on the measured wind field must be calculated. To do this the synoptic wind field must be produced with greater accuracy than the National Weather Service charts. In our case a 3 microbarograph array would be a minimum acceptable data base (*see attached note for possible alternative) for reconstruction of the synoptic wind. In addition, the actual (resultant) wind field must be measured in an area surrounding the main experimental site (Simpson Lagoon).

It should be noted that the data to be reduced for this project is identical to that needed by the lagoon modelers and storm surge modelers. This proposal has the added benefit of including a mesoscale thermally induced atmospheric circulation study.

Based on meetings with Dr. Knut Aagaard and the May 1978 Orcas Island workshop, a further use for this data must be mentioned. In order to tie in Aagaard's ocean current studies on the Beaufort shelf with the nearshore work, the above synoptic analyses coupled with wind velocity measured at the farthest offshore island (Cross) are essential. Continuing collaboration with Dr. Aagaard is expected to improve the final products of this study.

VI. General Strategy and Approach

The strategy will be to compare actual measured surface winds (10 meter towers) with the best available synoptic data collected from atmospheric pressure stations in the study area and National Weather Service charts.

VII. Sampling Methods

Sampling of pressure and wind velocity data will be done on a continuous basis over a six-week period to coincide with ongoing related oceanographic variables. The length of the study is chosen to make synoptic time periods (5-7 days) statistically significant.

Schedule:

<u>1978</u> October: Reduce and digitize data from July 15 - September 1 time period. Convert to OCSEAP format. Make graphics for time series presentations of measured winds and perform synoptic analysis by comparison of N.W.S. charts to pressure data.

December: Submit data to OCS. Use relevant data in two-dimensional least squares model-compare with actual wind measurements at sites. Run sea breeze model to test prediction capabilities.

<u>1979</u> March: Submit Annual Report

July 15: Install remote met stations on available towers surrounding Simpson Lagoon and on Cross Island to get "at sea" wind data farthest from coast. Put microbarographs at Oliktok, Umiat and Deadhorse. Maintain pressure stations for 6 weeks.

Sept. 1: Remove met stations and microbarographs from site area.

VIII. Analytical Methods

A. Data Reduction and Analysis

The basis data collected can be reduced and converted to acceptable OCSEAP format by December 1978 as accomplished in previous years. Time series presentations of measured winds and synoptic analysis can also be produced within the same time period.

B. Modeling Effort

A two-dimensional least squares model to reproduce the pressure field and calculate the geostrophic wind along the coast was automated and adapted to the study area in 1976. It normally requires a larger pressure network, utilizing data from two ADRAMS buoys offshore plus data from Lonely Dew site and Happy Valley. An in depth study of the summer 1976 data will be undertaken. A study of spring and summer 1979 could be initiated at minimal cost if buoys are provided.

Implementation of a working non-linear, time dependent, perturbation model of the thermal forcing at the coastline with an imposed synoptic wind field has resulted in a reasonable matching of the 1977 pilot balloon (wind velocity) profiles taken during sea breeze events. Pressure and wind velocity data, obtained in 1976, 1977 and 1978 will be further analyzed and used as input to this model. Technique for predicting wind direction and velocity changes as a function of the coastal thermal gradient and synoptic wind field is a desired product.

IX. Deliverable Products

A. Digital data, placed in OCSEAP format by investigator.

1. Wind speed and direction at four coastal sites in the barrier islands region

2. Atmospheric pressure at 4 sites in Northern Alaska

B., C. & D. - none anticipated

X. Quality Assurance Plans

Anemometer winds are annually compared to factory calibrations in wind tunnel tests. Microbarographs are compared to standards on a weekly basis. Instrument temperatures are recorded in the field for calibration purposes.

XI. Special Sample & Voucher Specimen Archival Plans

None anticipated.

XII. Logistics Requirements:

See attachment

XIII. Anticipated Problems

Contingency plan: Two-week lead time is planned to install remote weather stations and microbarographs. Personnel at microbarograph sites, if willing, can be trained to annotate the records and change the graph paper, if more than one week lapses between station visits.

XIV. Information Required From Other Investigators

None

XV. Management Plan

See attachment

XVI. Outlook

A. Data products for '79 will be similar to '78 data.

B. Modeling effort should bring out the effects of the thermal gradient a the coast.

C. Closer ties to oceanographic investigators should improve resulting reports.

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 Report 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 reposisory 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.

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). Flights are for transport. 2 trips each site: Deadhorse to Cottle Island; Deadhorse to Cross Island; Deadhorse to Tolaktovut Point

2. Describe types of observations to be made. NONE

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

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

   Total flight hours? 5

5. How many people are required on board for each flight (exclusive of the pilot)?
2

6. What are the weights and dimensions of equipment or supplies to be transported?
approximately 100 lbs, 2'x2'x3'

7. What type of helicopter do you reommend for your operations and why?
One with attached floats (not pop outs) for over water flights

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?

   approximately $450.00

10. Where do you reommend that flights be staged from?

    Deadhorse

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) Oliktor Dew Site (vicinity) (LGL sponsored camp), about 40 days
       Deadhorse, about 5 days
   (b) Late July to early September
   (c) 2 persons for 14 days
       1 person for 20 days

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?
   (a) $90/day Deadhorse
   (b) $40/day Pingok

   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?

   (a) Deadhorse estimate from past costs
   (b) Pingok estimate from NARL experience

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

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.)

   Pingok to Umiat to Happy Valley to Deadhorse to Pingok.

2. Describe types of observations to be made.

   None

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.)

   Once per week - late July to early September

4. How many days of flight operations are required and how many flight hours per day?
   7
   Total flight hours? 14

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

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.

   None

7. What are the weights, dimensions and power requirements of carry-on equipment?
   100 lbs., 2'x2'x2'

8. What type of aircraft is best suited for the purpose?
   no recommendation

9. Do you recommend a source for the aircraft? no recommendation
   If "yes", please name the source and the reason for your recommendation.

10. What is the per hour charter cost of the aircraft?
    $150.00

11. How many people are required on board for each flight (exclusive of flight crew)?
    2

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

    Pingok, Oliktok or Deadhorse

MILESTONE CHART

O - Planned Completion Date

X - Actual Completion Date

RU # 519 PI: R.A. Brown & T. L. Kozo

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
Data submission: 1978 field work			X												
Data submission: 1979 field work															X
Report: Impact of Thermal Gradient at Coast								X							
Field Season: 1979										X	X				
Report: Time series of Synoptic Events vs. Actual Measured Surface Winds								X							

DATA PRODUCTS SCHEDULE

Data Type	Media	Estimated Volume	OCSEAP Format	Processing & Formating Done by PI	Collection Period	Submission
Wind speed direction, air temp. 4 locations	Tape	2560 entries	yes - 101	yes	20 July - 1 Sept.	December 1979
Atmospheric pressure 4 locations	Tape	2560 entries	yes - 101	yes	20 July - 1 Sept.	December 1979

References

Cotton, W. R., R. A. Pielke and P. T. Gannon, 1976. Numerical experiments on the influence of the mesoscale circulation on the cumulus scale. J. Atms. Sci. 33, pp. 252-261.

Defant, F., 1951. Local Winds. Compendium of Meteorology, Boston, Mass., Amer. Meteor. Soc., pp. 655-662.

Kozo, T. L., 1977. Coastal meteorology of the Alaskan arctic coast. RU-519, OCS Contract #03-5-022-671011.

Kozo, T. L., 1978. Coastal meteorology of the Alaskan arctic coast. RU-526B OCS Contract #03-5-022-671013.

Walsh, J. E., 1974. Sea breeze theory and applications. J. Atms. Sci. 31, pp. 2012-2026.

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 #: 13

NOAA Project #: N/A

Institution ID#: GI78-103

FY 1979 RENEWAL PROPOSAL

Research Unit Number 526

TITLE: Characterization of the Nearshore Hydrodynamics of an Arctic Barrier Island-Lagoon System

Cost of Proposal: $ 156,451

Lease Areas Beaufort 100 %

%

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

Date 28 Feb 78
J. Brian Matthews
Principal Investigator
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7477

Date 2/20/78
Neta J. Stilkey
Business Manager
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7644

Juan G. Roederer / by NER Date: 21 July 1978
Juan G. Roederer
Director
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7282

Date 7/24/78
Keith B. Mather
Vice Chancellor for Research and Advanced Study
University of Alaska
Fairbanks, Alaska 99701
Tel. (907) 479-7314

3. TECHNICAL PROPOSAL

I. A. Title: Characterization of the nearshore hydrodynamics of an arctic barrier island - lagoon system

B. Research Unit Number: R.U. 526

C. Contract Number: 03-5-022-55, Task Order No. 13

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

II. Principal Investigator

J. B. Matthews, Associate Professor of Marine Science
Geophysical Institute, University of Alaska, Fairbanks, Alaska 99701

III. Cost of Proposal for Federal Fiscal Year (October 1, 1978 through September 30, 1979).

A. Science:

B. P.I. Provided Logistics:

C. Total: $156,451

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 or management

IV. Background

This project is an integral part of the barrier island-lagoon ecosystem process study which involves several OCSEAP research units. The original objectives of characterizing the nearshore water dynamics have been modified and adapted to the needs of the ecosystem process study. However the means of carrying out this work are not greatly changed. Thus the approach of using numerical models and verification data from the field is being utilized. Preliminary modeling and experimental field work were attempted in the first year. Extensive field work is being carried out in the second year using experience gained in the first year and making additional measurements requested by the R.U. 467 (L.G.L.).

During the third year we shall have extensive data analysis and model verification tasks to perform. The major field work is being carried by this R.U. and major modeling work by R.U. 531 (Mungall). The work proposed here will process field data and use these data to verify the models developed under R.U. 531.

In addition to the work originally forseen and requested by R.U. 467, the barrier island lagoon ecosystem process study, we have been requested to attempt additional field work to tie the lagoon dynamics to the shelf observations of R.U.'s 91 and 151 (Aagaard). This work is a logical extension of the work already carried out and is well within our present capabilities, it is detailed in this proposal with the associated budget items.

V. Objectives

It is proposed to determine, over a three-year period, the circulation patterns within a characteristic lagoon system, to estimate flushing times and dispersion characteristics and to attempt to determine the interaction of lagoon waters with the offshore waters, especially with respect to longshore flow and flow between the barrier islands.

A secondary objective, to investigate nearshore winter circulation and relate this to the shelf circulation as observed by other research units has been added with additional funds requested. This new work will involve extending techniques developed in earlier years in deployment of oceanographic instruments in shall water.

VI. General Strategy and Approach

The overall approach falls into two parts, (1) analysis of data from earlier work and (2) extension of field work.

(1) It is proposed to analyse and process data retrieved from instruments placed in and around Simpson Lagoon and use these data to verify numerical models simulating the nearshore water circulation. The data collected under this Research Unit will be combined with observations of other investigators co-operating with the ecosystem process study (R.U. 467) especially with those of Mungall (R.U. 531) and Leavitt (R.U. 519).

It had been originally thought that modelling work could be carried out economically on the University of Alaska's Honeywell dual 66/20 processors. However it is only economical to do the data preprocessing and very limited modelling on the Honeywell. Much of our data analysis will be carried out using a Tektronix 4051 for which we have developed considerable software for data preprocessing. It is proposed to extend the present system with a file manager which allows simultaneous access to several files and programs. This will allow complete current meter and tide gauge records to be filtered, analysed and plotted using existing software and without overflowing the memory capability of the system.

We are presently completing our software for data reduction so that by the beginning of the renewal period we shall have a complete suite of editing and analysis programs for production processing. At the same time our data from the summer field season will be available.

Data preprocessing will be carried out prior to the LGL Synthesis Workshop in December at which time our results will be presented and discussed. After further analysis subsequent to these discussions, data will be formatted and taped for easy acceptance by the numerical models. It is then proposed to meet with Dr. Mungall and his programmer and spend several weeks running numerical models with observed data as input. The models will be run using wind, pressure and sea level as primary input. The computed and observed currents and water mass characteristics will be compared.

It is hoped to have the results of these numberical simulations available for the LGL Synthesis meeting in April, 1979. The results of our work will be presented in a format useful in the ecosystem process model.

The needs for further verification data and modelling will be assessed at that time and future work carried out accordingly.

(2) The requested extension of the field program to cover the entire lease area and shelf will be carried out in conjunction with Aagaard (R.U. 91 and 151). It is proposed to spend about 10 days at the end of February or early March emplacing two current meters and two tide gauges in 10 m and 20 m water depths in lines extending out from the coast off Oliktok Point and Flaxman Island (see map p. 13). Aagaard and his group will place two instruments further offshore on the same lines using the same logistic support. Instruments will be recovered in early June before ice movement begins. Re-development requested to obtain summer coverage. However the risk of instrument loss due to ice is very high at that time. It is considered that the data are worth taking the risk to obtain. The recovery and re-deployment excess in June is carried out so as to increase the likelihood of obtaining good data for the first part of the field season.

Instruments will be Aanderaa recording current meters with temperature and salinity sensors and Aanderaa tide gauges. These will be bottom mounted in four cages equipped with pingers. We have used this deployment and recovery method from ship and through the ice with success. Aanderaa meters were chosen for ease of data retrieval and reliability under Arctic conditions. Additional equipment for diver protection and communication is required for winter operation. This is requested in the budget.

The proposed work can be carried out using existing instruments, contingent upon their recovery during the 1978 summer field season. If all instruments are not recovered, additional equipment will be requested. These instruments will be bottom mounted to minimize impact with ice keels offshore as mentioned above.

VII. Sampling Methods

We propose to continue our technique of using bottom-mounted, diver serviced Aanderaa recording current meters and tide gauges.

During the ice-covered season divers can be flown by helicopter directly to the instrument site using the aircraft's navigation system. It is possible to install our bottom-mounted instruments through the ice and recover them by this method. This method has already proved successful in the 1978 season. The bottome-mounted instruments are equippped with pingers which may be tracked from the surface or by diver operated sensors as requested.

Data recorded on these instruments can be readily analyzed using existing software. The Prudhoe Bay camp is conveniently located for the helicopter to service sites at both east and west ends of the lease area.

VIII. Analytical Methods

Field data will be translated from binary to engineering data using calibration constants. Translation and editing of data will utilize the Institute of Marine Science Aanderaa tape translator. Further editing and translation to engineering units is accomplished on the University of Alaska Honeywell dual 66/20 processors using software we have developed.

For tide gauge data we use in situ temperature and salinity data for water column density corrections and the sea level barometric pressure data supplied by Leavitt (R.U. 519).

Statistical, harmonic and spectral analysis, plotting and data reformatting are accomplished on the Tektronix 4051 system using existing software.

Computations of volume flow rates are made in the format requested for interface with the ecological process study compute simulation. Tapes of data for input to the hydrodynamical numerical models are also prepared using the Tektronix 4051 and Honeywell 66/20 processors.

IX. Deliverable Products

A. Digital Data:

1. Recorded Parameters:

Sea level
Current speed and direction

2. List of Digital Products:

Sea level

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 Level	tape	20,000 records	017	Yes	Feb. 1979 - June 1979	January 1980
Current Meter	tape	20,000 records	015	Yes	Feb. 1979 - June 1979	January 1980

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File Type 017

Pressure Gauge

Common to all records
- ✓ File Type
- ✓ File Identification
- ✓ Record Type
- Gauge Number

Record Type 1 - Text Record
- Text } optional
- Sequence Number } optional

Record Type 2 - Gauge Master Record I
- ✓ Latitude/Longitude
- ✓ Depth of Pressure Gauge
- ✓ Number of Detail Records

Record Type 3 - Gauge Master Record II
- ✓ Depth to Bottom
- Meter Usage Sequence Number
- ✓ Institution Code
- ✓ Location Name

Record Type 4 - Detail Record
- ✓ Date/Time
- ✓ Total Pressure
- ✓ Sequence Number
- ✓ Temperature

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 } if present
- Pressure } if present
- Conductivity } if present
- Sequence Number

C. Visual Data

Plots of observed currents and sea level observations. Comparative numerical and observational data.

D. Other Non-Digital Data

Esimates of flow rates in inter-island gaps.
Estimates of flushing times under various typical conditions in Simpson Lagoon.
Discussion of longshore circulation and its effect on the flow through the barrier islands.
Discussion of water quality within the lagoon and its dependence on longshore currents, wind stress and river runoff.

X. Quality Assurance Plans

Instruments used will be calibrated by the NOAA Northwest Calibration center prior to use. Care will be taken to ensure correct operation of instruments and interpretation of results.

XI. Special Sample and Voucher Specimen Archival Plans

N/A

XII. Logistics Requirements

See following page.

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).

On two lines off Flaxman Island and Oliktok Point as shown on attached chart.

2. Describe types of observations to be made.

Current meter and tide gauge.

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

Late February-early March. Deployment ±2 weeks early June recovery ± 2 weeks.

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

Total flight hours? 16

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?

250 lbs. equipment 2'x2'x3'

7. What type of helicopter do you reormend for your operations and why?

Bell 206. It has capacity and navigation aids.

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

Yes. NOAA.

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

$62.50 per hour

10. Where do you reommend that flights be staged from?

Prudhoe Bay/Deadhorse

11. Will special navigation and communications be required?

Yes.

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) Deadhorse/Prudhoe Bay
   (b) 2 weeks--3 persons--each end Feb.-early March and early June.

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

   Yes, Mukluk Camp. Prior successful experience.

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

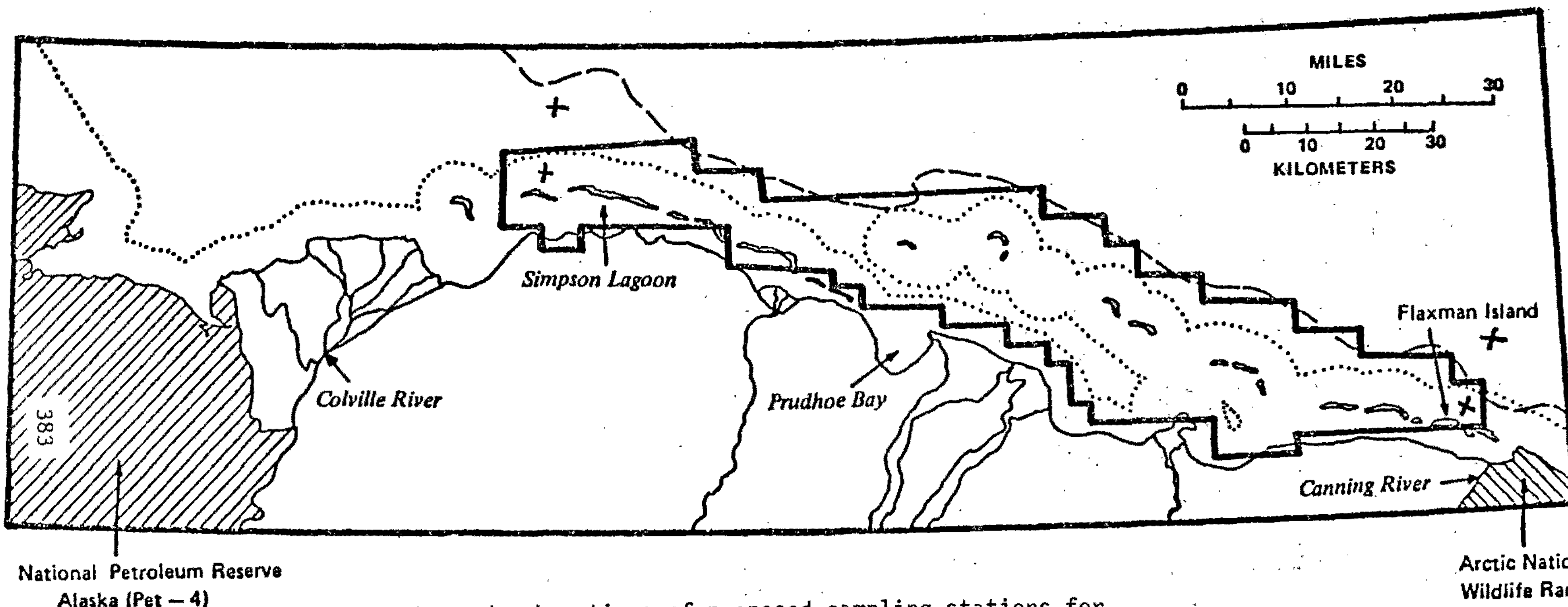
   $100 per day.

   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?

   Established Rates.

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?



Legend: Locations of proposed sampling stations for currents, tides, temperature and salinity are marked by +.

...... 3-mile State of Alaska jurisdictional area
_ _ _ 20-meter (10 fathom) depth contour (approx.)

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XII. Anticipated Problems/ Contingency Plan

None apart from the usual ones of working through the arctic ice pack in winter.

Helicopter is the only feasible platform from which the work can be done. Deployment in March and recovery in June eliminate any waterborne means of transport and distance prohibits use of surface vehicles such as snow machines or tracked vehicles.

XIV. Information Reguired from Other Investigators

Leavitt and Kozo (R.U. 519) will provide sea surface barometric pressure and wind speed and direction for the duration of the field program.

Mungall (R.U. 531) will provide numerical models for verification. Truett (R.U. 467) will provide project integration information and direction.

XV. Management Plan

Responsibility for management of the project rests with the principal investigator. The scope and direction of the project is determined by the barrier island-lagoon ecosystem process study in cooperation with the OCSEAP project office and the principal investigator. With four quarterly reports and two synthesis workshops, continuous monitoring of progress and segration into the overall studies is ensured.

Fiscal and contractual matters are handled by the Geophysical Institute Business Office in accordance with established policy. Data management is the responsibility of the principal investigator and will be carried out under the guide lines in the foregoing proposal.

XVI. Outlook

On the basis of our experience over the past year, the work will be carried out efficiently and with much cooperation between the other investigators under the general direction of the barrier island-lagoon ecosystem process study. We should have produced the first overall picture of summer hydrodynamics with numerical simulation and verification. It is anticipated that the first data on under-ice water quality and currents will be produced so that, together with the data of Aagaard a picture of the nearshore and shelf circulation can begin to be assembled.

It is more than likely that the results of the analysis of circulation in Simpson Lagoon will lead to demands for similar applications to other lagoons along the Beaufort Sea coast in an effort to determine the general applicability or uniqueness of our work. This will require more extensive field efforts and an extension of the effort both spatially and temporally. Now that we have some understanding of one lagoon in summer we need to examine other lagoons and estuaries. We need to know winter and spring circulation along the entire coastal region.

As oil development continues at a rapid pace the paucity of our hard-gathered data becomes apparent. An increase in the effort and funding devoted to this region is imperative if we are to come close to keeping pace with the industrial activity.

0 – Planned Completion Date

X – Actual Completion Date

RU # 526 PI: J. Brian Matthews

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
LGL Vancouver Synthesis Meeting			X												
Deploy current meter/tide gauges off Flaxman Island and Oliktok Point					X										
Interface model and observational data						X									
LGL Vancouver Synthesis Meeting Physical oceanography Review meeting							X								
Recovery of underice instruments									X						
Presentation of Results at International meeting.											X				

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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."

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Addendum to RU 526

TITLE: WINTER CIRCULATION AND WATER QUALITY IN THE BEAUFORT SEA LEASE AREA.

RESEARCH UNIT NUMBER: 526-W

CONTRACT NUMBER: 03-5-022-55

PROPOSED DATES OF CONTRACT: OCTOBER 1, 1978-SEPTEMBER 30, 1979

Date Nov 3,78

J. Brian Matthews
Principal Investigator
Geophysical Institute
University of Alaska
Fairbanks, AK. 99701
Tel. (907) 479-7477

Date 11/3/78

Neta J. Stilky
Business Manager
Geophysical Institute
University of Alaska
Fairbanks, AK. 99701
Tel. (907) 479-7644

Date 11/3/78

Al Belon
Associate Director
Geophysical Institute
University of Alaska
Fairbanks, AK. 99701
Tel. (907) 479-7393

Addendum to RU 526

I. Title: Winter circulation and water quality in the Beaufort Sea lease area.

Research Unit Number: 526-W

Contract Number: 03-5-022-55

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

II. J. Brian Matthews

III. Cost of Proposal: $45,474

IV. Background:

The general oceanographic features of the circulation along the arctic shelf have been described by Aagaard's work (RU's 91 and 151). The circulation in the lagoon and very-nearshore regions have been elucidated in the work of LGL (Matthews, Mungall); Barnes, etc. A successful attempt has been made to obtain water quality and sea level data in a major lagoon channel over the critical period from ice-covered to open-water season.

In an effort to examine flow along the shelf under the ice between the shelf break and the shorefast ice, we have already proposed to place four arrays of two current meters and a tide gauge off Oliktok Point and two arrays off Flaxman Island during winter and spring of 1979. Two other arrays of instruments are to be placed in deeper water on each of these same lines by Aagaard for the period February-August 1979.

Subsequently it has become apparent that in addition to these rather coarse measurements of overall winter circulation and water quality, more detailed data are required within the lease area. These additional data are to be used to set the physical factors controlling the biological and other processes within the ecosystems existing in the lease area. It has been proposed that a two-layer system may exist in which brine generated by ice formation drains seaward in the lower layer and replacement seawater flows in the upper layers. Additional data on this two layer current structrue are required to support the ecological studies. These studies will be in Simpson Lagoon and Steffansson Sound. This proposal is aimed at filling the needs of the Winter Studies program by adding some additional current meter and tide gauge arrays to those already proposed for deployment in conjunction with Aagaard (RU 151).

V. Objectives:

The objectives are to make continuous recordings of sea level, current speed and direction, temperature and salinity at the locations shown in the figure throughout the lease area and to record at two levels at all locations where this is possible for the period October 1978 through August 1979. In addition, vertical profiles of salinity and temperature with depth will be taken through the ice during field surveys by other investigators.

Data taken from the instruments should show the seasonal variations in water quality (temperature and salinity), currents and sea level and should demonstrate whether or not a two-layer system develops once ice formation begins. Data will be recovered in February 1979 and May 1979 to allow important findings to be correlated with the biological data and significant findings to be reported for use in the lease sale decision-making.

VI. Techinques:

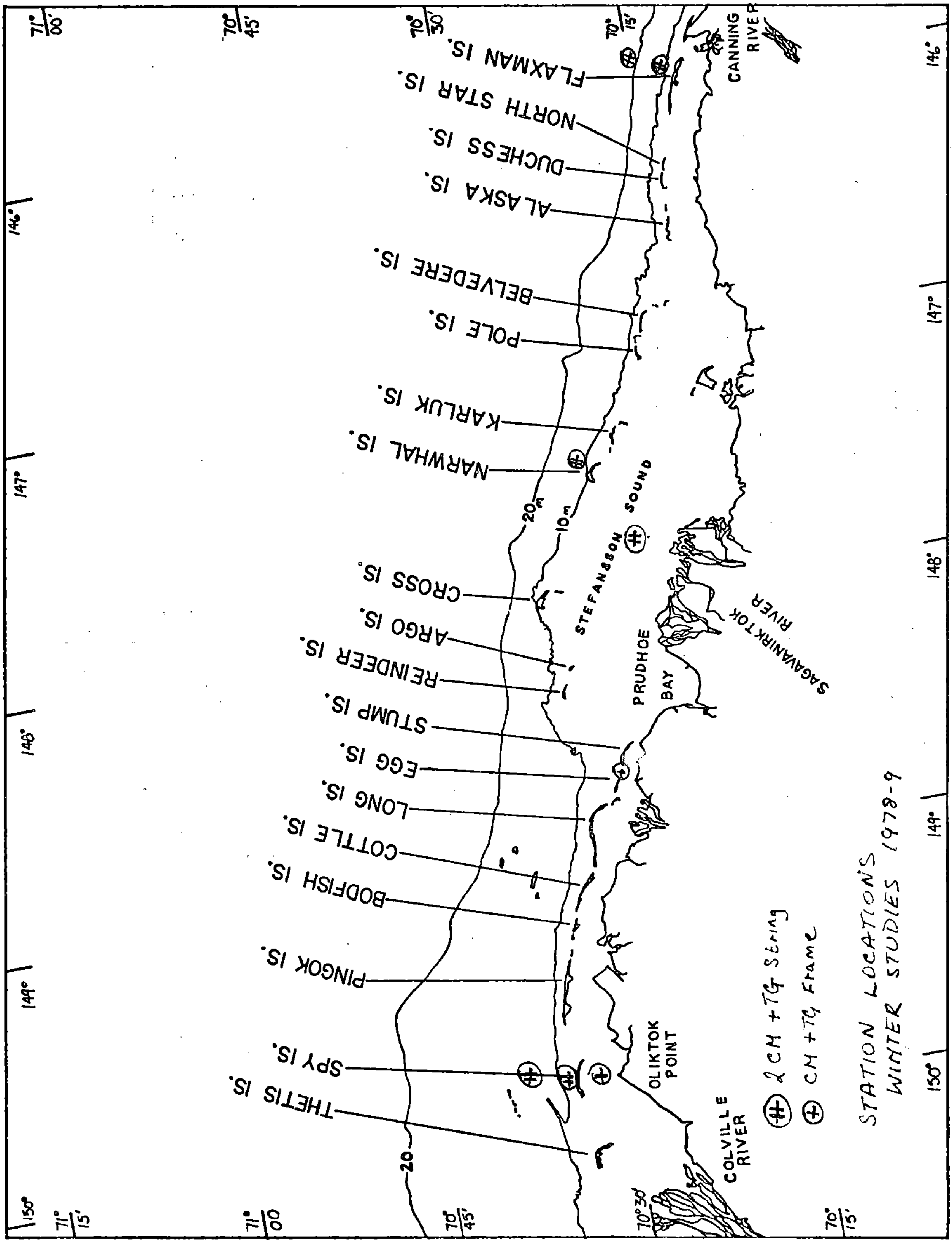
We plan to build upon experience gained during the previous spring season in the deployment of instruments. The techniques rely on helicopter logistic support and through-ice diver-servicing of instruments. For the deeper waters of Steffansson Sound and all stations except the Egg Island and Simpson Lagoon channel, we plan to use a special taut wire array which allows two instruments to be placed in the water column beneath the ice; one current meter just beneath the ice and one just above the sea floor. The assembly will be placed by helicopter through holes in the ice made for the purpose or used by other investigators for diving operations.

We have coordinated our work with that of Ken Dunton (RU 356), Lou Haldorsen (RU 467) and Don Schell (RU 537) and will have instruments at those sites designated as important for these related studies. Four of the eight sites were originally proposed for winter work in conjunction with Dr. Aagaard. We shall now emplace our instruments in November instead of February as originally proposed. The remaining station is the Egg Island channel site where we have monitored the sea level and water characteristics since spring of 1978. The Egg Island channel and Oliktok Point stations will have single current meter arrays because of the depth limitations.

Instrument strings will be placed through the ice as explained above at 7 sites in November 1978 and the Egg Island site will be serviced by divers at that time. The 8 sites will be serviced by divers in February 1978. At that time all the instruments deployed in November 1979 will be recovered and replaced with newly-serviced and calibrated instruments. This process will be repeated in May 1979 and finally all surviving arrays will be recovered in August 1979.

VII. Analysis:

Data tapes recovered in November, February, May and August will be translated, plotted, edited and evaluated as soon as possible after recovery to extract relevant data for use by co-workers and decision makers.


STATION LOCATIONS
WINTER STUDIES 1978-9
2 CM + TG String
CM + TG Frame
FLAXMAN IS.
NORTH STAR IS.
DUCHESS IS.
ALASKA IS.
BELVEDERE IS.
POLE IS.
KARLUK IS.
NARWHAL IS.
CROSS IS.
ARGO IS.
REINDEER IS.
STUMP IS.
EGG IS.
LONG IS.
COTTLE IS.
BODFISH IS.
PINGOK IS.
SPY IS.
THETIS IS.
CANNING RIVER
STEFANSSON SOUND
PRUDHOE BAY
SAGAVANIRKTOK RIVER
OLIKTOK POINT
COLVILLE RIVER
20m
10m
20
146°
147°
148°
149°
150°
71° 00'
70° 45'
70° 30'
70° 15'
71° 15'

Data analysis will use personnel and equipment budgeted in the existing FY 79 proposal for RU 526. The software is almost complete for this work. Field data recorded on serial tape will be translated to digital data on a new tape translator. The digital tape will then be edited, corrected and analyzed using existing software on the dual Honeywell 66/20 and Tektronix 4051 processors. It is hoped that the first plots of field data can be generated within about two weeks of recovery of the instruments. These graphical displays can be supplied to other investigators and E.I.S. writers for use in their work. Detailed analysis will continue for some considerable time after the preliminary data become available.

VIII. Logistics:

In the renewal proposal for project RU 526 we had previously requested field expeditions in February 1979 and June 1979 with helicopter support. This new work requires three people in the field based at Prudhoe with helicopter support from Prudhoe Bay. Logistic support for the STD profiles through the ice will be required with other investigators and will be coordinated with these investigators. For the diving work in November, February and May, a heated hut 20' X 20' at the dive sites is required. For our work this could be one hut moved from site to site. Accommodations and heated lab and storage facilities will be required at Prudhoe Bay.

IX. Equipment:

For the total proposed work at the eight stations a total of 14 current meters and 8 tide gauges are required. Current meters should have conductivity cells in the range 0-70 mmho, pressure sensors 0-100 p.s.i. and temperature sensors -2.5°C to 10°C. Tide gauges should have a 20m (45 p.s.i.) transducer.

We currently have 3 tide gauges and 7 current meters plus 4 tide gauges and 4 current meters borrowed from NOAA. That gives a total available of 7 tide gauges and 11 current meters. However, 1 tide gauge and 1 current meter are still in the field leaving 6 and 10 respectively for field deployment in November. It was requested that 2 tide gauges and 4 current meters be purchased for deployment in November. This request was approved through the Arctic Project Office.

To carry out the program as explained above we shall need to obtain 13 more current meters and 7 more tide gauges with the specifications given above for the replacement in February. (The instruments recovered in Egg Island channel will make up the numbers to the 14 and 8 total required.) In May the refurbished and calibrated instruments retrieved in February will be redeployed. This will not give us the NOAA standard 1 for 1 redundancy factor but will fill the proposed objectives as long as our losses are not excessive and additional equipment is available from NOAA.

The STD tape translator is requested to facilitate rapid turnaround of STD data. The same translator can accept Aanderaa data and will shorten our data processing schedule by at least two weeks. It will pay for itself in one field season in reduced data processing costs. The data printer completes the data analysis link allowing the raw binary data to be printed for rapid editing before conversion to engineering data and subsequent plotting. The equipment results in reduced labor and computer costs.

An ROM signal processing pack will be used to analyze data from the translator. This will speed data analysis by using hardware to achieve data analysis only previously possible through expensive and slow software.

FY 1979 Renewal Proposal

To:
The Environmental Research Laboratories -- NOAA
Outer Continental Shelf Environmental Assessment Program
Bering Sea -- Gulf of Alaska Project Office
P.O. Box 1808, Juneau, Alaska 99802

OCSEAP Data Processing Services (RU Number 527)

Cost of Proposal: $90,000 Lease Areas: Independent of lease areas

Period of Proposal: 1 October 1978 through 30 September 1979

INSTITUTION

Name: University of Rhode Island
Address: Rhode Island 02881

PRINCIPAL INVESTIGATOR

Name: Harold Petersen Jr. Date: 13 June 1978

Signature: Harold Petersen Jr.
Address: Data Projects Group
333 Pastore Laboratory

Telephone Number: (401) 792-2320

REQUIRED ORGANIZATIONAL APPROVAL

Name: William Ferrante Date: ________________

Signature: ________________________
Address: Vice President for Academic Affairs
Administration Building

Telephone Number: (401) 792-2447

or

Name: Nathaniel Sage Date: June 13, 1978

Signature: Nathaniel Sage
Address: Coordinator of Research
Davis Hall

Telephone Number: (401) 792-2635

TECHNICAL PROPOSAL

I. Title:

OCSEAP Data Management Services

Research Unit Number: 527 (Existing Contract)

Contract Number: 03-7-022-3519 (Existing Contract)

Proposed Dates of Contract:

1 October 1978 - 30 September 1979

II. Principal Investigator:

Dr. Harold Petersen Jr.
Data Projects Group
Pastore Laboratory
University of Rhode Island
Kingston, Rhode Island 02881

III. Cost of Proposal (Federal Fiscal Year 1979):

A. Science $90,000

B. Logistics None

C. Total $90,000

D. Distribution of Effort by Lease Area: Effort is independent of lease areas.

IV. Background:

Data management procedures associated with the BLM-sponsored, NOAA-administered program responding to the needs of petroleum development of the Alaskan shelf call for baseline study data to be submitted to the Bering Sea - Gulf of Alaska Project Office at Juneau, Alaska (JPO). These data are subsequently sent to the National Oceanic Data Center (NODC) for archival and product development.

The need arose for the application of detailed data validation steps to this data prior to its formal acceptance for archival. Checks have been found necessary in the areas of valid code use, reasonableness of data values (range and relational checking), and general format adherance.

During the period 1 March 1977 through 30 September 1978, this RU has been involved with the task of validating file type 033 data (Ship and Aircraft Census - Marine Birds), one of several data types associated with the program. The work is ongoing, and involves extensive code and raw number validation steps as well as data reformatting. A summary of these procedures is given in Appendix I. The procedures followed are heavily influenced by characteristics found in incoming data, and are frequently modified. Consequently, the report given in Appendix I should be viewed as a "working document", subject to revision.

The scope of activities related to validating file type 033 data has been greatly expanded during the most recent contract year, primarily in response to characteristics of incoming data. For example, previously unused codes and code groups came into use and required validation, new range checks were found necessary on certain data fields, and new techniques were implemented for other types of data field manipulations.

File type 033 data is only one of the file types which require validation. Work has recently begun on file type 038 data (Migratory Bird Sea Watch) as well. This task is presently at the stage in which appropriate range and relational checks as well as code group translation and verification steps are being set up. Work on many other file types is being carried out at NODC.

V. Objectives:

It is the objective of this research to provide, within budgetary limits, validity checks on and reformatting of file types 033, 038, and other data submitted to JPO, as well as to supply that office with other program products of value in terms of the efficient processing of OCSEAP data.

As a suggestion, these products could be divided into two types, input and output. In terms of input assistance, OCSEAP is presently exploring the use of prompted data entry in the field, using microcomputer-based systems equipped with floppy disk output. The RU's using this input medium could, instead of taking the additional step of copying these data to industry-compatible tapes prior to submission to JPO, send them to this RU for direct entry into existing range and relational checking and format verification programs. This RU could then process the data as in the past, generating industry-compatible tapes as output. The procedure would streamline the data processing flow and truly integrate the prompted data entry concept into an OCSEAP distributed data processing network.

Output assistance could be given in the form of analysis products provided to JPO and RU's. Two types of products are currently being delivered. These are the CODEPULL and LOGLIST outputs and the industry-compatible tape copies of verified data. The outputs CODEPULL and LOGLIST are also used as integral parts of data verification procedures themselves, however, RU's have requested final copies of these products for their own use along with a tape copy of the verified data in NODC format. Other products could take the form of data analyses. In the case of those RU's who have microcomputer-based entry systems, analysis programs could be provided to them for use on these systems in real-time analysis of data as it is acquired and entered. Such analyses could be extremely valuable in decision-making situations concerning sampling rates, changes in cruise operations, etc.

VI. General Strategy and Approach:

Introduction:

Data are presently received by JPO on tape either in a format unique to the Principal Investigator (PI), i.e. an "internal format", or in adherance to OCSEAP-designated format acceptable for subsequent delivery to NODC ("NODC format").

In the former case, the format may contain, in addition to program related data, other data not solicited by the program. Also, the codes used for coded data may contain extensions which are not part of NODC approved codes. In both cases, data may exceed reasonable ranges, some segments of a multi-segment data field may be missing, invalid data codes may be present, or data record types may be incorrectly coded.

The task, then, is to ensure that data sent to NODC conforms to approved style in terms of code use, data reasonableness, and format adherance, as well as to provide JPO and RU's with agreed-upon additional products such as those indicated and suggested in the Objectives section.

File Type 033 Data:

The steps involved in ongoing work on data of this file type are summarized in Appendix I, however a scenario of events is provided here in order to more fully describe the present day-to-day processing activities.

> Data for several field operations are received on tape. The tape is read and the contents made into a disk data set. The data set is backed up on another tape for security, and then split into separate data sets, one for each field operation. Each is passed through the program CODEPULL which first sorts the data by station number, transect type, record type (record types 4 and 5 are grouped together in the file type 033 format for this purpose), and sequence number within each record type. The program then checks each code field of each record type for adherance to allowable codes, and also flags cases where required card types are not present (for example, card types 1 and 2 should appear before card types 3, 4, or 5 in file type 033 data). Invalid codes and invalid record types are flagged.
>
> Examination of the flagged records sometimes shows that the record type has been incorrectly assigned. By inspection, the correct record type is discerned, and used with two programs, SETUPCTF and URUNCTF, to change the record type in the field

operation file. CODEPULL is again run, and output exhibiting invalid codes which require attention by the PI is returned to that site for resolution.

Data fields are then range and relationally checked (for example, if barometric pressure trend is coded, then barometric pressure must also be coded) using the program LOGLIST. This output is also sent to the PI for resolution, and all corrections received from the PI are used to update the file with the programs EDITLOG and FLDFILL. The two validation programs are again run on the data, and if no additional errors are found, the data are converted (if necessary) to acceptable NODC format prior to submission. The conversion process is quite elaborate, and involves unit conversions, code conversions, data truncation, and relocation of data fields within card types or between card types. The program CONVPROG is used for this purpose.

If subsequent quality control or processing is desired, the data are converted to a MIS data base, which then makes a variety of procedures, such as time-distance checks and plotting routines available. Any errors in the data found as a result of these techniques would be used to update the NODC files prior to their submission.

Work status as of June 1978 is summarized in Appendix II. While considerable progress is expected before the end of the present contract year, it is not possible to finish it by that time. Thus, it is proposed that this RU continue processing file type 033 data already received as well as any new data of this type received during the proposed contract period.

Other Bird Data:

Two additional situations present themselves with respect to validation of OCSEAP-related bird data. First, there are approximately seven bird data formats presently in use which require validation procedures. Second, the types of formats to be used in future field operations is under review at the present time, and may indeed result in replacement of existing formats with fewer, new ones.

One of the data types requiring validation procedures is file type 038, Migratory Bird Sea Watch. This data has been collected in a format internal to FWS. A draft setup of its conversion has been made, including unit conversions, field relocations, range and relational checks, code verifications, and "cosmetic" modifications such as deletion or insertion of leading zeros in fields, etc. This draft setup is included in Appendix III, and has been delivered to FWS through JPO. Upon receipt of input from these two groups, the indicated procedures can be put into motion. It is proposed that these steps be carried out and that all existing 038 data sponsored by OCSEAP be processed in this fashion.

Another file type requiring attention is file type 035, Bird Colony data. While significant amounts of data have been acquired in this format by FWS, the OCSEAP approved NODC format is presently under study. It is proposed that this RU participate in whatever way possible to assist in the resolution of this situation and the ultimate processing of this data into acceptable form.

VII. Deliverable Products:

A. Digital Data Products: Results of this work will be coded in EBCDIC on 9 TK tape in NODC-acceptable format for delivery to NODC. Also, tapes of the verified data and final copies of the outputs CODEPULL and LOGLIST will be delivered to the respective RU's. By the inherent design of the data validation steps described, no data which does not pass established criteria will appear in products generated in this work. The criteria are established in conjunction with JPO and PI representatives. Data fields not validated in this process are, of course, subject to errors.

B. Visual Data: If desired by JPO, cruise tracks, station position plots, other graphical displays, or additional quality control outputs will be provided.

C. Data Submission Schedule: Data should have a nominal four week turnaround time after delivery from JPO for validation checks, and conversion (if necessary). This schedule is subject to the conditions described above.

VIII. Special Sample and Voucher Specimen Archival Plans:

This section is not applicable to the proposed work.

IX. Logistics Requirements:

This section is not applicable to the proposed work.

X. Anticipated Problems:

While no major problems are anticipated in the production use of this scheme, it should be pointed out that new problems often arise from unanticipated sources. In work carried out to date, one of the most celebrated examples has been the use of unauthorized codes by PI's. When they are encountered, Program authorization must be secured with respect to their acceptance, rejection, or translation before the data sets can be further processed. This illustrates how an unanticipated event or perhaps a series of them can hold up processing. It is, of course, impossible to forsee all possible cases prior to their occurrence. Events such as these also underscore the need for flexibility in the system.

XI. Information Required from Other Investigators:

In order to successfully carry out the proposed activities, data must be collected by the RU's, entered, submitted to JFO, and subsequently sent to this site for processing.

XII. Activity/Milestone Chart

RU #: 527 PI: Harold Petersen Jr. -- University of Rhode Island

	1978										1979											
Major Milestones	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Choice of validation criteria for type 038 data		X																				
Procedures for validation of FWS type 038 data operational							O															
Completion date for file type 033 data editing - FWS format						O																
Procedures for reformatting FWS type 033 data to NCDC type 033 format operational	X																					
Quarterly Reports		X			O			O			O			O			O			O		
Typical set-up period for new type of data validation and reformatting, including meetings, programming, etc.							<---	----	----	-->												
Annual Report		X												O								
Final Report																					O	

Existing Contract
<-- Period --><--------- Proposed Contract Period -------->

O = Planned Completion Date
FWS = Fish and Wildlife Service

X = Actual Completion Date
NODC = National Oceanic Data Center

XIII. Outlook:

It is expected that the validation procedures similar to those established under the present contract and those anticipated for other types of data will also be required in FY'80. Funding requests for FY'80 should not be significantly greater than those in FY'79, increasing only as a function of inflation and small equipment changes (perhaps 10-15%).

Present data processing loads can be handled within the personnel and equipment framework described in the Cost Proposal below. However, this load is only a part of the entire JPO data flow. Should significant increases be made in this load, additional personnel and small equipment will be necessary. An increase of one staff member plus computer time, small equipment, etc. would cost approximately $33 K.

Other areas of potential increases in activity include: design and implementation of voice techniques for data entry, establishment of key/disk or other equivalent key entry services, use of microprocessor based prompted data entry techniques in the field, integration of such techniques into an OCSEAP distributed data processing network, and new analysis products which will aid JPO personnel in data management activities. It is difficult to assess the cost associated with these possibilities, however research in these areas would form a natural extension to existing and other proposed work.

XIV. Basic Agreements:

The following statements cover areas of agreement between the proposer and the granting agency.

A. Updated Activity/Milestone Charts will be submitted quarterly.

B. Quarterly Reports will be submitted in sufficient time during the contract period to be in OCSEAP hands by the first day of January, July, and October, and Annual Reports by 1 April. The Final Report will be submitted within 90 days of the termination of the contract.

C. At the option of JPO, 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 bourne by JPO.

D. Data will be provided in the form and format specified by OCSEAP, accompanied by a data documentation form (NOAA 24-13).

E. Reformatted and/or validated (as necessary) data will be made available within approximately one month after receipt from JPO or designated source when such procedures are in production status. New procedures will require approximately three months to be put into production.

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

G. Three copies of all publications or presentation manuscripts pertaining to technical or scientific material developed under OCSEAP funds will be submitted to JPO at least sixty days prior to release for information and for forwarding to BLM. The release of such material within a period of less than sixty days shall be made only with prior written consent of JPO. News releases will first be cleared with JPO.

h. All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship, using the standard acknowledgment.

APPENDIX I.

Data Validation Procedures for File Type 033 Data

OCSEAP DATA VALIDATION PROCEDURES
For File Type 033
(Release 3; March 31, 1978)

In order to provide data validation for the File Type 033 data from the OCSEAP Project, four areas need consideration. These include card type validation, data range and relational parameter checking, and format, code, or unit conversion. Since this is a multi-card type file, the card type designation must first be verified (an incorrect value would lead to the improper interpretation of remaining fields on that card), along with the occurrence and sequencing of card types. Second, codes used in each code field (ex. - a two digit weather code) must be compared against all valid codes for that field for verification. Next, range checks must be carried out on all appropriate fields (ex. - sea surface temperature should be between certain upper and lower limits), and relational checks on interrelated fields (ex. - wet bulb temperature readings should be less than or equal to corresponding dry bulb temperature readings). Lastly, if the data are not coded in NODC format, the necessary format changes must be carried out.

Card type designation and sequencing, and valid code field contents are checked in a program called CODEPULL. First the card type is verified. This must be between one and five, and certain other fields are also checked for further verification (ex. - a type five card must have a taxonomic code and a sequence number). Extra cards and missing cards are detected with the sequencing routine. This checks that the cards are in order, that each station has a unique one card followed by a unique two card, and that there are no duplicated or skipped sequence numbers. Then the appropriate code tables are called, and each code of each code field is compared with the appropriate table containing all valid codes for that field.

The output from CODEPULL is a listing of the file in order by station number. Any errors detected are flagged with a brief descriptive message, including a record count for ease in correcting, and, in the case of a bad code, a string of asterisks under the field. Following the file listing is a summary of all the codes used for each code field and their definitions. For a bad code, the record in which it appeared replaces the definition. Figure 1 is a list of the code groups checked and Figure 2 is a portion of a CODEPULL listing.

Data range and relational checking are done in a program called LOGLIST. This verifies the data coded as raw numbers, rather than as codes. The contents of the data fields are first checked for numerics, signs, and leading zeros and then compared to upper and lower limits appropriate to each field. In some cases the value of one field is dependent on the value of another field and these relational checks are also made.

Figure 1
File Type 033 Code Groups Validated

	Code Field	FWS Columns	NODC Columns
Card Type 1			
	Platform Type	67-68	69
	Ship Activity	70	71
	Sampling Technique	69	70
	Collection Code	-	72
	Zone Scheme	-	73
	Angle of View	-	74
	Observation Conditions	-	75
	Speed Type	60	-
	O.B.S. Region	28-30	-
	Observer Location	74	-
Card Type 2			
	Wind Direction	-	45-46
	Swell Direction	-	50-51
	Sea State	-	49
	Weather	16-17	55-56
	Cloud Type	-	57
	Cloud Amount	-	58
	Water Color	-	59
	Visibility	18	61
	Sun Direction	-	62
	Glare Intensity	61	63
	Glare Area	62	64
	Moon Phase	-	68
	Tide Height	-	69
	Debris	-	80
	Observation Conditions	19	-
	Turbidity	-	63
Card Type 3			
	Ice Cover	16,23,35	16,22
	Ice Pattern/Description	17, 24	32
	Ice Type	18, 25	17, 23
	Ice Form	19,26,34	18, 24
	Ice Relief	20, 27	19, 25
	Ice Thickness	21, 28	20, 26
	Ice Melting Stage	22, 29	21, 27
	Open Water Type	30	28
	Ice Direction	31, 36	29, 33
	Distance	32,37,40	30, 34
	Lead/Polyna Width	33, 39	31
	Ship in Lead/Polyna Location	38	-
	Collection Code	41,42,43	35,36,37
	Mammal Trace	44, 45	38, 39
	Pond Size	-	49
Card Type 5			
	Age Class	50	32
	Sex	51	33
	Color Phase	52	34
	Plumage	53	35
	Molt	54	35

Figure 1 (cont.)

Code Field	FWS Columns	NODC Columns
Card Type 5 (cont.)		
Counting m	-	42
Reliability	-	43
Distance Measurement Type	-	44
Association Type	55-56	50
Behavior	46-47	56-57
Special Marks	62	58
Bird Condition	63	59
Food Source Association	-	60
Debris	74	71
Oil	-	72
Habitat	-	76, 77
Substrate Type	-	81
Cover Code	-	82
Outside Zone	-	83
Text Flag	77	-

Figure 2

Sample CODEPULL Listing

CODEPULL consists of two major sections.

Figure 2A is a page from the first section showing how the file is listed. It is sorted by Station, Card Type and Sequence Number and has dotted lines dividing the Stations. The errors flagged are "Bad Card Type" because the Card Type 4 has no sequence number; "Bad Sequence Number" because the sequence number field is not numeric; and "Bad Code" because the code entered is invalid.

Figure 2B is a portion of the second section. This first gives a summary of the number of each type of record found in the file, then a list of the codes used and appropriate definitions. For an invalid code the definition is replaced by the record number in which it appeared. This can be seen for the Weather Code on Card Type 2.

***** CODEPULL *****

Figure 2A

FOR CRUISE FW7032

THE MARMAP INFORMATION SYSTEM   OCSEAP - GULF OF ALASKA PROJECT

*** CODEPULL - CRUISE FW7032

```
-----------------------------------------------------------------------------------------------------------------------------
                                    033FW70321 1073595250N1492600W7705232105                  10+09 1119  6      4       30
                                    033FW70322 1073 260                            2       03
RECORD #     3
TYPE 4 #     1  BAD CARD TYPE -->
                                    033FW70324 1073 WAY UP BACK SIDE. SEE FIELD NOTES.

RECORD #     4
TYPE 4 #     2  BAD SEQUENCE# -->
                                    033FW70324 1073 KIWH ALL 3 VERY GREY BACKS ONE FEMALE WITH NCTCH IN DORSAL HALF
                                    033FW70325 1073  91290106            1                                       001  0
                                    033FW70325 1073  9128020301          1                                       002  0
                                    033FW70325 1073  9129010502          2                                       003  2
                                    033FW70325 1073  9218021601     1    1        001                            004  0
                                    033FW70325 1073  9218C21601     2    4        001                            005  0
-----------------------------------------------------------------------------------------------------------------------------
                                    033FW70321 1173595130N1492615W7705232115                  10+09 1120  6      4       30
RECORD #    11
TYPE 2 #     2  BAD CODE -->        033FW70322 1173 256    + 81                    2       03
                                                                                           **
                                    033FW70325 1173  9129C11302          2      10         20                    001  0
                                    033FW70325 1173  9128020301          1                 20                    002  0
                                    033FW70325 1173  9129010301          4      10         20                    003  0
                                    033FW70325 1173  91290106            2      10         20                    004  0
-----------------------------------------------------------------------------------------------------------------------------
                                    033FW70321 1273595000N1492730W7705232125                  10+09 1118  6      4       30
                                    033FW70322 1273 256    + 84                    2       03
                                    033FW70325 1273  9128020103          1      09         20                    001  0
                                    033FW70325 1273  9129C10301          8      09         20                    002  0
                                    033FW70325 1273  9127070301          3                 20                    003  0
                                    033FW70325 1273  9109030201          2                 61                    004  0
                                    033FW70325 1273  91290106            2                 20                    005  0
-----------------------------------------------------------------------------------------------------------------------------
                                    033FW70321 1373594800N1492715W7705232135                  10+09 1118  6      3       30
RECORD #    24
TYPE 2 #     4  BAD CODE -->        033FW70322 1373 265                            3       03
                                                                                           **
                                    033FW70325 1373  9128020103          4      09         20                    001  0
                                    033FW70325 1373  9129011401          2      09         20                    002  0
                                    033FW70325 1373  9129011302          2                 03                    003  0
                                    033FW70325 1373  91290103            3      10         20                    004  0
                                    033FW70325 1373  9129010601          2                 03                    005  0
-----------------------------------------------------------------------------------------------------------------------------
                                    033FW70321 1473594600N1492715W7705232145                  10+09 1118  6      3       30
                                    033FW70322 1473 220                            3       03
                                    033FW70325 1473  9129011401          1                 20                    001  0
                                    033FW70325 1473  9128020301          1                 20                    002  0
                                    033FW70325 1473  912901              5                 20                    003  0
                                    033FW70325 1473  9128020103          1                 20                    004  0
                                    033FW70325 1473  91290103            2                 20                    005  0
-----------------------------------------------------------------------------------------------------------------------------
                                    033FW70321 1573594430N1492715W7705232155                  10+09 1118  6      3       30
                                    033FW70322 1573  91    + 78                    3       03
                                    033FW70325 1573  9129011401          5      09         20                    001  0
                                    033FW70325 1573  9129011401          9                 01                    002  0
                                    033FW70325 1573  9218022001          1                                       003  2
                                    033FW70325 1573  9128020103          1                 20                    004  0
                                    033FW70325 1573  9129011302          2      09         20                    005  0
```

Figure 2B

***** SUMMARY *****

FOR CRUISE FW7032

2219 TOTAL RECORDS

277 TYPE 1 RECORDS
277 TYPE 2 RECORDS
0 TYPE 3 RECORDS
6 TYPE 4 RECORDS
1659 TYPE 5 RECORDS

0 RECORDS WITH AN INVALID TYPE

RECORD TYPE 1

CODE FIELD: PLATFORM TYPE - NODC(1:69)

CODES	COMMENT
BLANK	-

CODE FIELD: SAMPLING TECHNIQUE - NODC(1:70) - FWS(1:69)

CODES	COMMENT
BLANK	-

CODE FIELD: SHIP ACTIVITY - NODC(1:71)

CODES	COMMENT
BLANK	-

CODE FIELD: COLLECTION CODE (PHOTOS TAKEN) - NODC(1:72)

CODES	COMMENT
BLANK	-

CODE FIELD: ZONE SCHEME (TRANSECT WIDTH) - NODC(1:73)

CODES	COMMENT
BLANK	-

CODE FIELD: ANGLE OF VIEW - NODC(1:74)

CODES	COMMENT
BLANK	-

CODE FIELD: OBSERVATION CONDITIONS - NODC(1:75)

CODES	COMMENT
4	AVERAGE
3	POOR
2	MARGINAL
7	EXCELLENT
6	GOOD
5	FINE
BLANK	-

Figure 2B (cont.)

RECORD TYPE 2

CODE FIELD: WIND & SWELL DIRECTION - NODC(2:45-46)(2:50-51)

CODES	COMMENT
BLANK	-
31	305-314 DEG.
14	135-144 DEG.

CODE FIELD: SEA STATE - NODC(2:49)

CODES	COMMENT
2	SMOOTH--WAVELET
3	SLIGHT
4	MODERATE
1	CALM-RIPPLED
0	CALM-GLASSY
BLANK	-

CODE FIELD: WIND & SWELL DIRECTION - NODC(2:45-46)(2:50-51)

CODES	COMMENT
BLANK	-

CODE FIELD: WEATHER - NODC(2:55-56) - FWS(2:16-17)

CODES	COMMENT
03	CLOUDS GENERALLY FORMING OR DEVELOPING
0	*** 000011 000024 000045 000051 000690 000721
68	RAIN OR DRIZZLE AND SNOW, SLIGHT
00	CLOUD DEVELOPMENT NOT OBSERVED OR NOT OBSERVABLE
71	CONTINUOUS FALL OF SNOW FLAKES, SLIGHT
61	RAIN, NOT FREEZING, CONTINUOUS, SLIGHT
41	FOG OR ICE FOG IN PATCHES
43	FOG OR ICE FOG, SKY INVISIBLE, THINNING DURING LAST HOUR

CODE FIELD: CLOUD TYPE - NODC(2:57)

CODES	COMMENT
BLANK	-
3	ALTOCUMULUS

CODE FIELD: CLOUD AMOUNT - NODC(2:58)

CODES	COMMENT
BLANK	-

CODE FIELD: WATER COLOR - NODC(2:59)

CODES	COMMENT
BLANK	-

CODE FIELD: VISIBILITY - NODC(2:61) - FWS(2:18)

CODES	COMMENT
BLANK	-

CODE FIELD: COMPASS DIRECTION (SUN) - NODC(2:62)

CODES	COMMENT
BLANK	-

CODE FIELD: GLARE INTENSITY - NODC(2:63) - FWS(2:61)

CODES	COMMENT
BLANK	-

CODE FIELD: GLARE AREA - NODC(2:64) - FWS(2:62)

CODES	COMMENT
BLANK	-

LOGLIST prints a columnular listing for each card type. The columns are identified by a three character field code defined prior to the data listing. The record number is listed on the left and any errors detected are flagged in the diagnostics section on the right. A totally blank field is indicated by a row of dots and imbedded blanks by an asterisk. Figure 3 is a list of the limit and relational checks made and Figure 4 is a portion of a LOGLIST listing.

These outputs are sent to the Principal Investigator for correcting. He checks the diagnostic messages and the data and marks any necessary corrections directly on the listing. These are returned to us and the updates made to the file with an interactive program called EDITLOG. Then CODEPULL and LOGLIST are rerun for final verification.

Finally the data is converted to NODC format (if it was coded in another format) and submitted to NODC. Format conversion is done with a program called CONVPROG. Many different operations are carried out at this point. For example, data fields are moved from one place to another on a given card, or onto a different card; units are converted and rounded or truncated, or converted to codes; and codes are converted to those equivalent codes acceptable to NODC. Figure 5 is a list of the conversion routines carried out.

All of these programs form part of the MARMAP Information System. Their operation is directed by a Master System Table (MST). The MST has an entry for each field of each card type in a file. This contains all the information needed for processing, including field code, data type, position, upper limit, lower limit, relational checking and conversion routines. The programs therefore are data independent and readily adaptable to any file type.

Figure 3

Limits and Relational Checks

Note: Entries apply to both FWS and NODC unless otherwise noted.

All Card Types

File Type must be 033.
File ID of all subsequent records must match that of first record.

Card Type 1

FWS start and end latitude between 40 and 70 degrees, 0-599 tenths of minutes.
FWS start and end longitude between 120 and 180 degrees, 0-599 tenths of minutes, and hemisphere = W.
NODC start and end latitude between 40 and 70 degrees, 0-59 minutes, 0-59 seconds, and hemisphere = N.
NODC start and end longitude between 120 and 180 degrees, 0-59 minutes, 0-59 seconds, and hemisphere = W.
Date: Day between 1 and 31, month between 1 and 12.
Time: Hour between 0 and 23, minutes between 1 and 59.
Elapsed Time should be between 0 and 30 minutes.
FWS Heading between 0 and 359 degrees. (NODC between 00 and 35).
FWS Speed between 0 and 15 knots when platform type is ship.
FWS Speed greater than 5 knots when transect type is 71.

Card Type 2

FWS Wind Direction between 0 and 360 degrees. (NODC uses a code).
Wind Speed between 0 and 50 knots.
Swell Height between 0 and 25 feet.
Sea Surface Temperature between -2°C and +10°C.
Wet and Dry Bulb Temperature between -10°C and +70°C.
Wet Bulb Temperature should be less than or equal to Dry Bulb Temperature.
Temperatures are also checked for signs, numerics, and leading zeros.
Barometric Trend should not be coded when Barometric Pressure is blank.
Barometric trend must be +, -, ƀ, or ϕ.
Salinity between 20°/oo and 34°/oo.
Thermocline Depth between 0 and 100 meters.

Card Type 3

Excess Sediment, Ice Algae, or Other Features fields should be blank. (FWS only).

Card Type 5

Taxonomic Code between 88 and 92.
FWS Direction of Flight between 1 and 12 o'clock.
NODC Direction of Flight between 0 and 35 degrees.
FWS Begin Zone should be less than End Zone.
FWS Begin Zone and End Zone between 0 and 30 when Transect Type is 71 or 78 (unless BZN is coded 97-99).
FWS Begin Zone and End Zone between 0 and 60 when Transect Type is 70 or 77 (unless BZN is coded 97-99).
Number of Individuals must be numeric.

Figure 4

Sample LOGLIST Listing

LOGLIST lists the data for each card type individually. Fields in each record are then keyed by acronym codes.

Figure 4A shows the header page and the list of acronym definitions.

Figure 4B is a page from the data listing of Card Type 1. Blank data fields are depicted by a series of dots as in the LTD and LNG fields while leading or imbedded blanks appear as asterisks as in the SPD and HGT fields. The diagnostics are flagged with the messages at the right. Here the HED field is out of range because it should be between 0 and 35 degrees.

Figure 4A

***** LOGLIST *****

FOR CRUISE FW7032

CALL FILE ********

CARD TYPE 1

THE MARMAP INFORMATION SYSTEM   OCSEAP - GULF OF ALASKA PROJECT

*** LOGLIST - CRUISE FW7032 - CALL FILE ******** - CARD TYPE 1

ACRONYM DEFINITIONS

STA	STATION
LAT	START LATITUDE
LON	START LONGITUDE
DEG	DEGREES (SUBFIELD OF LON)
DAT	DATE - YYMMDD
DAY	DAY (SUBFIELD OF DAT)
MON	MONTH (SUBFIELD OF DAT)
TIM	TIME - HHMM
HOR	HOUR (SUBFIELD OF TIM)
MIN	MINUTES (SUBFIELD OF TIM)
LTD	END LATITUDE
LNG	END LONGITUDE
ELT	ELAPSED TIME
TZS	TIME ZONE SIGN
TZN	TIME ZONE NUMBER
SPD	SPEED MADE GOOD
HED	COURSE MADE GOOD
HGT	HEIGHT OF OBS. EYES (ABOVE SEA)
PLT	PLATFORM TYPE
SMP	SAMPLING TECHNIQUE
ACT	SHIP ACTIVITY
PHO	PHOTOS TAKEN
TRW	TRANSECT WIDTH
ANG	ANGLE OF VIEW
OBC	OBSERVATION CONDITIONS
DIS	DISTANCE MADE GOOD

ACRONYM DEFINITIONS

WTP	WATCH TYPE
TRN	TRANSECT WIDTH

SPECIAL CHARACTERS

-	INDICATES A CODE FIELD
*	INDICATES A BLANK CHARACTER IN A FIELD
.	INDICATES A TOTALLY BLANK FIELD
/	FIELD IS LISTED IN THE DIAGNOSTICS IF NON-BLANK (DATA WOULD OTHERWISE NOT FIT ON ONE LINE)

Figure 4A (cont.)

*** LOGLIST - CFLISE FW7032 - CALL FILE ******** - CAPD TYPE 1

	STA	LAT	LON	DAT	TIM	LTD	LNG	ELT	TZS	TZN	SPD	HED	HGT	PLT	SMP	ACT	PHD	TPW	ANG	ODC	DIS	WTP	TRN	DIAGNOSTICS
52	*7279	565358N	1523630W	770528	1950	....	....	10	+	09	**9	36	**8	.	.	.	.	.	.	6	....	.	*30	* HED FIELD OUTSIDE *
53	*7379	565408N	1523518W	770528	2000	....	....	10	+	09	**9	36	**8	.	.	.	.	.	.	6	....	.	*30	* HED FIELD OUTSIDE *
54	*7478	565537N	1523458W	770528	2010	....	....	10	+	09	**9	36	**8	.	.	.	.	.	.	7	....	.	*30	* HED FIELD OUTSIDE *
55	*7578	565712N	1523446W	770528	2020	....	....	10	+	09	**9	35	**8	.	.	.	.	.	.	7	....	.	*30	
56	*7679	565850N	1523508W	770528	2030	....	....	10	+	09	**9	35	**8	.	.	.	.	.	.	7	....	.	*30	
57	*7779	570022N	1523530W	770528	2040	....	....	10	+	09	**9	35	**8	.	.	.	.	.	.	7	....	.	*30	
58	*7878	570155N	1523554W	770528	2050	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	7	....	.	*30	
59	*7978	570308N	1523712W	770528	2100	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	7	....	.	*30	
60	*8079	570418N	1523823W	770528	2110	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	4	....	.	*30	
61	*8178	570548N	1523948W	770528	2120	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	4	....	.	*30	
62	*8279	570706N	1524106W	770528	2130	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	4	....	.	*30	
63	*8378	570830N	1524236W	770528	2140	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	4	....	.	*30	
64	*8479	571000N	1524044W	770528	2150	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	5	....	.	*30	
65	*8578	571116N	1524524W	770528	2200	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	5	....	.	*30	
66	*8678	571242N	1524648W	770528	2210	....	....	10	+	09	**9	33	**8	.	.	.	.	.	.	5	....	.	*30	
67	*8777	571707N	1525048W	770529	0400	....	....	20	+	09	**0	..	**4	.	.	.	.	.	.	7	....	.	*60	
68	*8873	571448N	1525027W	770529	1737	....	....	10	+	09	*10	18	**4	.	.	.	.	.	.	5	....	.	*30	
69	*8973	571310N	1525025W	770529	1747	....	....	10	+	09	*10	18	**4	.	.	.	.	.	.	5	....	.	*30	
70	*9073	571124N	1525028W	770529	1757	....	....	10	+	09	*10	18	**4	.	.	.	.	.	.	5	....	.	*30	
71	*9179	570942N	1525030W	770529	1807	....	....	10	+	09	*10	19	**4	.	.	.	.	.	.	5	....	.	*30	
72	*9278	570757N	1525100W	770529	1817	....	....	10	+	09	*10	19	**4	.	.	.	.	.	.	5	....	.	*30	
73	*9378	570612N	1525200W	770529	1827	....	....	10	+	09	*10	19	**4	.	.	.	.	.	.	5	....	.	*30	
74	*9479	570315N	1525250W	770529	1837	....	....	10	+	09	*10	19	**4	.	.	.	.	.	.	5	....	.	*30	
75	*9578	570255N	1525326W	770529	1847	....	....	10	+	09	*10	19	***	.	.	.	.	.	.	5	....	.	*30	
76	*9678	570114N	1525345W	770529	1857	....	....	10	+	09	*10	19	**4	.	.	.	.	.	.	5	....	.	*30	
77	*9779	565925N	1525345W	770529	1907	....	....	10	+	09	*10	18	**4	.	.	.	.	.	.	5	....	.	*30	

Figure 4B

Figure 5

Conversion Routines

Field	FWS Cols	NODC Cols	Special Processing
Card Type 1			
File Type	1-3	1-3	-
File ID	4-9	4-9	-
Station Number	10-14	11-15	-
Record Type	15	10	-
Start Latitude	16-20	16-22	Degrees, minutes, and tenths converted to degress, minutes, and seconds. Hemisphere "N" is added.
Start Longitude	21-27	23-30	Degrees, minutes, and tenths converted to degrees, minutes, and seconds.
O.B.S. Region	28-30	-	No NODC counterpart
Date	31-34	31-36	Add year and convert from day, month for YYMMDD.
Time	35-38	37-40	-
End Latitude	39-43	41-47	Same as above
End Longitude	44-50	48-55	Same as above
Elapsed Time	51-52	56-57	-
Time Zone Sign	53	58	-
Time Zone Number	54-55	59-60	-
Speed	56-59	61-65	Round tenths of knots to whole knots.
(Blank)	60	-	-
Course Heading	61-63	64-65	Round whole degrees into tens of degrees.
Height of Eyes	64-66	66-68	Convert feet to meters (multiply by 0.3048, then round).
Platform Type	67-68	69	Convert from FWS to NODC code.
Sampling Technique	69	70	-
Ship Activity	70	71	Convert from FWS to NODC code.
O.B.S. Number	72-73	-	No NODC counterpart
O.B.S. Location	74	-	No NODC counterpart
Observation Conditions	-	75	Move from Col. 19 on FWS card Type 2.
Distance	-	76-79	No FWS counterpart
Watch Type	-	80	No FWS counterpart
Transect Width	-	83	No FWS counterpart
(Blank)	75-80	-	-
Card Type 2			
File Type	1-3	1-3	-
File ID	4-9	4-9	-
Station Number	10-14	11-15	-
Record Type	15	10	-
Weather	16-17	55-56	-
Cloud Type	-	57	No FWS counterpart
Cloud Amount	-	58	No FWS counterpart
Water Color	-	59-60	No FWS counterpart
Visibility	18	61	-
Observation Conditions	19	-	Move to Col. 75 on Card Type 1 for NODC.

Figure 5 (continued)

Field	FWS Cols.	NODC Cols	Special Processing
Card Type 2 (cont.)			
Wind Direction	20-22	45-46	Convert FWS degrees to NODC code (divide by 10, truncate, and add 1).
Wind Speed	23-24	47-48	-
Wave Height/Sea State	25-26	49	Convert from feet to NODC code.
Swell Direction	-	50-51	No FWS counterpart
Swell Height	27-28	52-54	Convert feet to tenths of meters (multiply by 3.048, then round).
Sea Surface Temp.	29-32	23-26	Move sign adjacent to first significant digit (embedded zeros or blanks removed).
XBT Temp.	33-36	-	No NODC counterpart
Wet Bulb Temp.	37-40	34-37	Same as Sea Surface Temp. above.
Dry Bulb Temp.	41-44	30-33	Same as Sea Surface Temp. above.
Relative Humidity	-	38-39	No NODC counterpart
Barometric Pressure	45-49	40-43	Truncate left digit.
Barometric Trend	50	44	-
Bottom Depth	51-54	16-19	Convert fathoms to meters (multiply by 1.829, then round).
Surface Salinity	55-57	27-29	-
Thermocline Depth	58-60	20-22	-
Sun Direction	-	62	No FWS counterpart
Glare Intensity	61	63	-
Glare Area	62	64	-
Turbidity Code	63	-	No NODC counterpart
Light Level	-	65-67	No FWS counterpart.
Moon Phase	-	68	No FWS counterpart.
Tide Height	-	69	No FWS counterpart.
Tide Rise/Fall	-	70	No FWS counterpart.
Distance to Shore	-	71-74	No FWS counterpart.
Distance to Shelf	-	75-77	No FWS counterpart.
SECCHI Depth	-	78-79	No FWS counterpart.
Debris Code	-	80	No FWS counterpart.
(Blank)	64-80	81-83	
Card Type 3			
File Type	1-3	1-3	-
File ID	4-9	4-9	-
Station Number	10-14	11-15	-
Record Type	15	10	-
Ice in Transect:			
Cover	16	16	-
Pattern	17	-	No NODC counterpart.
Type	18	17	-
Form	19	18	-
Relief	20	19	-
Thick	21	20	-
Melt	22	21	-
Ice Outside Transect:			
Cover	23	22	-
Pattern	24	-	No NODC counterpart.
Type	25	23	-
Form	26	24	-

Figure 5 (continued)

Field	FWS Cols	NODC Cols	Special Processing
Card Type 3 (cont.)			
Relief	27	25	-
Thickl	28	26	-
Melt	29	27	-
Open Water:			
Type	30	28	-
Direction	31	29	-
Distance	32	30	-
Lead/Polyna Widith	33	31	-
Visible Ice:			
Form	34	-	No NODC counterpart.
Cover	35	-	No NODC counterpart.
Description	-	32	No FWS counterpart.
Direction	36	33	Code groups not convertible.
Distance	37	34	Code groups not convertible.
Ship in Lead/Polyna:			
Location	38	-	No NODC counterpart.
Width	39	-	No NODC counterpart.
Distance	40	-	No NODC counterpart.
Miscellaneous:			
Arctic Code	41	35	Convert FWS to NODC code.
Excess Sediment	42	36	Code groups not convertible.
Ice Algae Layer	43	37	Code groups not convertible.
Mammal Trace	44	38	-
Other Features	45	39	Code groups not convertible.
Ice not coverable	46	-	No NODC counterpart.
(Blanks)	-	40-46	No FWS counterpart.
Water/Land Percent	-	47-48	No FWS counterpart.
Pond Size	-	49	No FWS counterpart.
(Blanks)	47-80	50-83	
Card Type 4			
File Type	1-3	1-3	-
File ID	4-9	4-9	-
Station Number	10-14	11-15	-
Record Type	15	10	-
Text	16-77	16-77	-
Sequence No.	78-80	78-80	-
(Blanks)	-	81-83	
Card Type 5			
File Type	1-3	1-3	-
File ID	4-9	4-9	-
Station Number	10-14	11-15	-
Record Type	15	10	-
Species Name	16-19	-	No NODC counterpart
Taxonomic Code	20-29	18-27	Blank out trailing zero doublets
Sub Species	30-31	28-29	-
Species Group	32-33	30-31	-
No. of Individuals	34-38	37-41	
Counting Method	-	42	No FWS counterpart
Reliability	-	43	No FWS counterpart
Distance Measurement Type	-	44	No FWS counterpart
Distance to birds	-	45-47	No FWS counterpart

Figure 5 (continued)

Field	FWS Cols	NODC Cols	Special Processing
Card Type 5 (cont.)			
Begin/Outside Zone	39-40	83	When coded 97-99 then convert to NODC Outside Zone Code, else ignore
End Zone	41-42	-	No NODC counterpart
Time into Transect	43-45	16-17	Round from minutes and tenths to whole minutes
Behavior	46-47	56-57	-
Flight Direction	48-49	48-49	Convert from clock position relative to the vessel to compass direction in tens of degrees (multiply by 30 and add rounded heading from card type 1).
Age	50	32	-
Sex	51	33	-
Color	52	34	-
Plumage	53	35	-
Molt	54	36	-
Association Type	55-56	50	Convert FWS code to NODC code.
Multi-species Link	57-59	51-53	-
No. os Species	60-61	54-55	-
Special Marks	62	58	-
Bird Condition	63	59	-
Food Source	-	60	No FWS counterpart.
Tax Code for Food	64-73	61-70	Same as Tax Code above.
Debris	74	71	-
Oil	-	72	No FWS counterpart
Distance from Breeding Colony	-	73-75	No FWS counterpart
Habitat	-	76-77	No FWS counterpart
O.B.S. Observer No.	75-76	-	No NODC counterpart
Text Flag Code	77	-	No NODC counterpart
Sequence Number	78-80	78-80	-
Substrate	-	81	No FWS counterpart
Cover	-	82	No FWS counterpart

The following fields will have either leading zeros or leading blanks inserted as necessary.

Leading Zeros	Leading Blanks
Station Number	Speed
Start Latitude	Height of Eyes
Start Longitude	Wind Speed
End Latitude	Sea Surface Temp
End Longitude	Wet Bulb Temp
Date	Dry Bulb Temp
Time	Bottom Depth
Course Heading	No. of Individuals
Multi-Species Link	Transect width
Flight Direction	
Sequence Number	

APPENDIX II.

Field Operation Status Report

***** FIELD OPERATION STATUS REPORT *****

AS OF 06/12/78

THE MARMAP INFORMATION SYSTEM — OCSEAP - GULF OF ALASKA PROJECT

COLUMN HEADING DEFINITIONS:

TAPE NUMBER - IDENTIFYING NUMBER ASSIGNED TO THE TAPE AS IT IS RECEIVED BY RU 527.

RESEARCH UNIT - RESEARCH UNIT NUMBER OF THE PRINCIPAL INVESTIGATOR.

DATE RECEIVED - DATE THE TAPE WAS RECEIVED BY RU 527.

FILE FORMAT - FORMAT IN WHICH THE DATA ON THE TAPE HAVE BEEN CODED.

CRUISE NAME - NAME ASSIGNED TO THE FIELD OPERATION BY THE PRINCIPAL INVESTIGATOR. "FW" CRUISES FROM DR. CALVIN LENSINK; "UCI" CRUISES FROM DR. GEORGE HUNT; "W" CRUISES FROM DR. JOHN WIENS; "UC" CRUISES FROM DR. JUAN GUZMAN.

CODEPULL MAILED - DATE THE OUTPUT FROM THE QUALITY CONTROL PROGRAM "CODEPULL" WAS MAILED TO THE PRINCIPAL INVESTIGATOR FOR CORRECTIONS.

LOGLIST MAILED - DATE THE OUTPUT FROM THE QUALITY CONTROL PROGRAM "LOGLIST" WAS MAILED TO THE PRINCIPAL INVESTIGATOR FOR CORRECTIONS.

CODEPULL RETURNED - DATE THE CORRECTED OUTPUT FROM "CODEPULL" WAS RECEIVED BY RU 527.

LOGLIST RETURNED - DATE THE CORRECTED OUTPUT FROM "LOGLIST" WAS RECEIVED BY RU 527.

EDITLOG COMPLETE - DATE THE CORRECTIONS WERE MADE TO THE CRUISE AT RU 527, THROUGH THE USE OF AN INTERACTIVE PROGRAM "EDITLOG".

FINAL CHECK - DATE THE CRUISE WAS READY FOR CONVERSION TO NODC FORMAT. OCCASIONALLY ADDITIONAL PROBLEMS ARISE WHEN "CODEPULL" AND "LOGLIST" ARE RERUN AFTER EDITING. IF THESE CANNOT BE RESOLVED OVER THE TELEPHONE THE LISTINGS ARE SENT BACK TO THE PI FOR FURTHER CORRECTIONS. THIS FIELD IS NOT FILLED IN UNTIL ALL CORRECTIONS HAVE BEEN MADE.

CONVERT TO NODC - DATE THE CRUISE WAS CONVERTED FROM FWS FORMAT TO NODC FORMAT. AN "NA" (NOT APPLICABLE) IS ENTERED HERE FOR CRUISES RECEIVED IN NODC FORMAT.

MAIL TO NODC - DATE THE CRUISE IN FINAL FORM WAS SUBMITTED TO NODC.

ENDNOTES - REFERENCE NUMBER TO ADDITIONAL COMMENTS FOLLOWING THE TABLE.

*** FIELD OPERATION STATUS REPORT ***

AS OF 06/12/78

THE MARMAP INFORMATION SYSTEM   OCSEAP - GULF OF ALASKA PROJECT

TAPE NUMBER	RESEARCH UNIT	DATE RECEIVED	FILE FORMAT	CRUISE NAME	CODEPULL MAILED	LOGLIST MAILED	CODEPULL RETURNED	LOGLIST RETURNED	EDITLOG COMPLETE	FINAL CHECK	CONVERT TO NODC	MAIL TO NODC	END NOTES
ALASKA1	337	03/12/77	FWS	FW5004	07/12/77	08/16/77	08/29/77	10/06/77	11/20/77	02/15/78			1A
ALASKA2	337	03/12/77	FWS	FW5009	07/12/77	08/16/77	10/06/77	10/06/77	11/28/77	01/30/78			1A
				FW5013	07/12/77	08/16/77	08/29/77	10/06/77	11/30/77	01/26/78			1A
				FW5018	07/12/77	08/16/77	08/29/77	10/06/77	12/06/77	02/01/78			1A
				FW5023	07/12/77	08/16/77	08/29/77	10/06/77	12/06/77	02/14/78			1A
				FW5024	07/12/77	08/16/77	08/29/77	10/06/77	11/30/77	02/15/78			1A
				FW5030	07/12/77	08/16/77	08/29/77	10/06/77	12/01/77	12/05/77	02/28/78		6
				FW5032	07/12/77	08/16/77	08/29/77	10/06/77	12/01/77	12/05/77	02/28/78		6
ALASKA3	337	05/27/77	FWS	FW5008	07/14/77	08/16/77	09/06/77	09/06/77	12/09/77	12/09/77			
				FW5016	07/14/77	08/16/77	09/06/77	09/06/77	12/12/77				1A
				FW5021	07/14/77	08/16/77	09/06/77	09/06/77	12/19/77				1B
				FW5026	07/14/77	08/16/77	09/06/77	09/06/77	01/31/78	02/01/78			
				FW5027	07/14/77	08/16/77	09/06/77	09/06/77	02/03/78	02/06/78			
				FW5033	07/14/77	08/16/77	09/06/77	09/06/77	01/30/78				1B
				FW5035	07/14/77	08/16/77	09/06/77	09/06/77	01/30/78	02/01/78			
				FW6008	12/12/77	12/12/77	01/10/78	01/10/78	02/06/78				1B
				FW6027	07/14/77	08/16/77	09/06/77	09/06/77	03/20/78				1C
				FW6050	07/14/77	08/16/77	09/06/77	09/06/77	03/22/78				1C
				FW6051	07/14/77	08/16/77	09/06/77	09/06/77	03/28/78				1C
				FW6074	07/14/77	08/16/77	09/06/77	09/06/77	03/02/78				1B
				FW6083	07/14/77	08/16/77	09/06/77	09/06/77	03/13/78				1B
ALASKA4	337	06/24/77	FWS	FW5011	08/16/77	08/16/77	11/01/77	11/01/77	03/20/78				1C
				FW5012	08/16/77	08/16/77	11/01/77	11/01/77	04/05/78				1C
				FW5020	08/16/77	08/16/77	11/01/77	11/01/77	04/05/78				1C
				FW5031	08/16/77	08/16/77	11/01/77	11/01/77	04/05/78				1C
				FW5034	08/16/77	08/16/77	11/01/77	11/01/77	04/17/78	04/19/78			
				FW6015	08/16/77	08/16/77	11/01/77	11/01/77	04/05/78	04/18/78			
				FW6018	08/16/77	08/16/77	11/01/77	11/01/77	04/12/78				1C
				FW6019	08/16/77	08/16/77	11/01/77	11/01/77	04/18/78				1C
				FW6067	08/16/77	08/16/77	11/01/77	11/01/77	04/12/78				1C
				FW6068	08/16/77	08/16/77	11/01/77	11/01/77	04/12/78				1C
				FW6088	09/29/77	09/29/77	10/20/77	10/20/77	04/17/78				1C
				FW6089	08/16/77	08/16/77	11/01/77	11/01/77	02/28/78				1B
				FW6094	08/16/77	08/16/77	11/01/77	11/01/77	03/01/78				1C
ALASKA5	337	07/01/77	FWS	FW5015	09/29/77	09/29/77	10/20/77	10/20/77	04/24/78				1E

*** FIELD OPERATION STATUS REPORT ***

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THE MARMAP INFORMATION SYSTEM   OCSEAP - GULF OF ALASKA PROJECT

TAPE NUMBER	RESEARCH UNIT	DATE RECEIVED	FILE FORMAT	CRUISE NAME	CODEPULL MAILED	LOGLIST MAILED	CODEPULL RETURNED	LOGLIST RETURNED	EDITLOG COMPLETE	FINAL CHECK	CONVERT TO NODC	MAIL TO NODC	END NOTES
ALASKA5	337	07/01/77	FWS	FW5025	09/29/77	09/29/77	10/20/77	10/20/77	04/20/78				1E
				FW6001	09/29/77	09/29/77	10/20/77	10/20/77	04/20/78	04/28/78			
				FW6002	09/29/77	09/29/77	10/20/77	10/20/77	04/20/78				1E
				FW6007	09/29/77	09/29/77	10/20/77	10/20/77	04/20/78				1E
				FW6009	09/29/77	09/29/77	10/20/77	10/20/77	04/24/78				1E
				FW6021	10/28/77	10/28/77	11/30/77	11/30/77	04/25/78				1E
				FW6026	09/29/77	09/29/77	10/20/77	10/20/77	04/26/78	04/28/78			
				FW6029	09/29/77	09/29/77	10/20/77	10/20/77	04/26/78	05/08/78			
				FW6057	09/29/77	09/29/77	10/20/77	10/20/77	05/31/78				1E
				FW6064	09/29/77	09/29/77	10/20/77	10/20/77	02/20/78				1B
				FW6066	09/29/77	09/29/77	10/20/77	10/20/77	02/22/78	02/24/78			
				FW6070	09/29/77	09/29/77	10/20/77	10/20/77	04/25/78				1E
				FW6095	09/29/77	09/29/77	10/20/77	10/20/77	05/09/78				1E
ALASKA6	337	07/07/77	FWS	FW5014	10/21/77	10/21/77	11/14/77	11/14/77	02/17/78	02/22/78			
				FW5022	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78				
				FW5029	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78				
				FW5036	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78	06/07/78			
				FW5037	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78	06/07/78			
				FW6004	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78				
				FW6005	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78				
				FW6010	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78				
				FW6011	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78				
				FW6012	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				
				FW6016	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				
				FW6028	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78	06/08/78			
				FW6052	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				
				FW6077	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				
				FW6078	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				
				FW6084	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				
				FW6085	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				
				FW6092	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78				
				FW7026	10/21/77	10/21/77	11/14/77	11/14/77					
				FW7027	10/21/77	10/21/77	11/14/77	11/14/77					
ALASKA7	083	07/07/77	FWS	UCI501	10/07/77	10/07/77							
				UCI601	10/07/77	10/07/77							
ALASKA8	337	07/28/77	FWS	FW5038	10/28/77	10/28/77	11/30/77	11/30/77					
				FW6013	10/28/77	10/28/77	11/30/77	11/30/77					
				FW6025	10/28/77	10/28/77	11/30/77	11/30/77					

*** FIELD OPERATION STATUS REPORT ***

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THE MARMAP INFORMATION SYSTEM   OCSEAP - GULF OF ALASKA PROJECT

TAPE NUMBER	RESEARCH UNIT	DATE RECEIVED	FILE FORMAT	CRUISE NAME	CODEPULL MAILED	LOGLIST MAILED	CODEPULL RETURNED	LOGLIST RETURNED	EDITLOG COMPLETE	FINAL CHECK	CONVERT TO NODC	MAIL TO NODC	END NOTES
ALASKA8	337	07/28/77	FWS	FW6082	10/28/77	10/28/77	11/30/77	11/30/77					
				FW6087	10/28/77	10/28/77	11/30/77	11/30/77					
ALASKA9	337	08/03/77	FWS	FW5003	10/28/77	10/28/77	11/30/77	11/30/77					2
				FW5006	10/28/77	10/28/77	11/30/77	11/30/77					
				FW5010	10/28/77	10/28/77	11/30/77	11/30/77					
				FW6006	10/28/77	10/28/77	11/30/77	11/30/77					
				FW6014	10/28/77	10/28/77	11/30/77	11/30/77					
ALASKA10	337	09/06/77	NODC	FW7032	10/07/77	10/07/77	11/03/77	11/03/77	11/22/77	11/30/77	/NA/	12/12/77	
				FW7033	10/07/77	10/07/77	11/03/77	11/03/77	11/22/77	11/30/77	/NA/	12/12/77	
ALASKA11	337	11/16/77	NODC	FW7034	11/30/77	11/30/77	01/04/78	01/04/78	01/09/78	01/10/78	/NA/	02/28/78	
				FW7035	11/30/77	11/30/77	01/04/78	01/04/78	01/06/78	01/17/78	/NA/	02/28/78	
				FW7042	11/30/77	11/30/77	01/04/78	01/04/78	01/09/78	01/16/78	/NA/	02/28/78	
				FW7046	11/30/77	11/30/77	01/04/78	01/04/78	01/09/78	01/16/78	/NA/	02/28/78	
ALASKA12	337	01/10/78	NODC	FW7028	01/18/78	01/18/78	01/30/78	01/30/78	01/31/78	02/01/78	/NA/	02/28/78	
				FW7031	01/18/78	01/18/78	01/30/78	01/30/78	02/01/78	02/02/78	/NA/	02/28/78	
				FW7036	01/18/78	01/18/78	01/30/78	01/30/78	01/31/78	02/01/78	/NA/	02/28/78	
				FW7045	01/18/78	01/18/78	01/30/78	01/30/78	02/01/78	02/01/78	/NA/	02/28/78	
ALASKA13	337	01/10/78	FWS	FW6086	01/18/78	01/18/78	01/30/78	01/30/78	02/17/78				1B
				FW6186	01/18/78	01/18/78	01/30/78	01/30/78	02/17/78	02/17/78			5
ALASKA14	083	04/10/78	NODC	UCI602	04/14/78	04/14/78	04/25/78	04/25/78	06/02/78	06/06/78	/NA/		
OREGON1	108	05/25/77	NODC	W05220	10/26/77	10/26/77	01/03/78	01/03/78	02/03/78	05/17/78	/NA/	05/24/78	
				W05221	10/26/77	10/26/77	01/03/78	01/03/78	02/16/78	05/17/78	/NA/	05/24/78	
				W05310	10/26/77	10/26/77	01/03/78	01/03/78	02/03/78	05/17/78	/NA/	05/24/78	
				W05311	10/26/77	10/26/77	01/03/78	01/03/78	02/03/78	05/17/78	/NA/	05/24/78	
				W05325	10/26/77	10/26/77	01/03/78	01/03/78	02/03/78	05/17/78	/NA/	05/24/78	
				W06211	10/26/77	10/26/77	01/03/78	01/03/78	02/03/78	05/17/78	/NA/	05/24/78	3
				W06221	10/26/77	10/26/77	01/03/78	01/03/78	02/17/78	05/17/78	/NA/	05/24/78	3
				W16140	10/26/77	10/26/77	01/03/78	01/03/78	03/27/78	05/17/78	/NA/	05/24/78	
				W16150	10/26/77	10/26/77	01/03/78	01/03/78	03/27/78	05/17/78	/NA/	05/24/78	
				W16161	10/26/77	10/26/77	01/03/78	01/03/78	03/27/78	05/17/78	/NA/	05/24/78	3

*** FIELD OPERATION STATUS REPORT ***

AS OF 06/12/78

THE MARMAP INFORMATION SYSTEM — OCSEAP - GULF OF ALASKA PROJECT

TAPE NUMBER	RESEARCH UNIT	DATE RECEIVED	FILE FORMAT	CRUISE NAME	CODEPULL MAILED	LOGLIST MAILED	CODEPULL RETURNED	LOGLIST RETURNED	EDITLOG COMPLETE	FINAL CHECK	CONVERT TO NODC	MAIL TO NODC	END NOTES
OREGON1	108	05/25/77	NODC	W26140	10/26/77	10/26/77	01/03/78	01/03/78	03/27/78	05/17/78	/NA/	05/24/78	
				W36070	10/26/77	10/26/77	01/03/78	01/03/78	03/27/78	05/17/78	/NA/	05/24/78	
CANADA1	239	03/30/78	NODC	C1UC75	04/17/78	04/17/78	05/08/78	05/08/78	05/11/78	05/15/78	/NA/	06/12/78	4
				02UC75	04/17/78	04/17/78	05/08/78	05/08/78	05/12/78	05/15/78	/NA/	06/12/78	4
				C3UC75	04/17/78	04/17/78	05/08/78	05/08/78	05/15/78	05/16/78	/NA/	06/12/78	4
				01UC76	04/17/78	04/17/78	05/08/78	05/08/78	05/15/78	06/09/78	/NA/	06/12/78	4,1D
				C2UC76	04/17/78	04/17/78	05/08/78	05/08/78	05/15/78	06/09/78	/NA/	06/12/78	4,1D
				C3UC76	04/17/78	04/17/78	05/08/78	05/08/78	05/15/78	05/16/78	/NA/	06/12/78	4
				04UC76	04/17/78	04/17/78	05/08/78	05/08/78	05/15/78	06/09/78	/NA/	06/12/78	4,1D
				C5UC76	04/17/78	04/17/78	05/08/78	05/08/78	05/15/78	06/09/78	/NA/	06/12/78	4,1D

ENDNOTES:

1. A. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (12/12/77), RETURNED TO RU 527 (01/10/78).
   B. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (03/16/78).
   C. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (04/26/78).
   D. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (05/18/78), RETURNED TO RU 527 (06/08/78).
   E. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (06/06/78).
2. TAPE WAS UNREADABLE, SENT BACK TO PI TO BE RE-GENERATED (08/31/77), RETURNED TO RU 527 (10/21/77).
3. UNAUTHORIZED LIGHT LEVEL AND WEATHER CODES USED BY PI, THESE WILL NOT BE INCLUDED IN SUBMISSION TO NODC.
4. TAPE RETURNED TO PI BECAUSE SEVEN OF THE EIGHT EXPECTED CRUISES COULD NOT BE FOUND (01/03/78).
   NEW TAPE WITH EIGHT CRUISES RECEIVED (03/30/78).
5. CRUISE FW6186 IS A CONTINUATION OF CRUISE FW6086 BECAUSE FW6086 NEEDED MORE THAN 999 STATIONS.
6. ONE OF FIRST CRUISES CONVERTED (02/28/78). FWS AND NODC FORMATS SENT TO PI FOR REVIEW.

*** FIELD OPERATION STATUS REPORT ***

AS OF 06/12/78

THE MARMAP INFORMATION SYSTEM   OCSEAP - GULF OF ALASKA PROJECT

SUMMARY:

TOTAL CRUISES RECEIVED BY RU 527	113
CODEPULLS MAILED TO INVESTIGATOR	113
LOGLISTS MAILED TO INVESTIGATOR	113
CODEPULLS RETURNED TO RU 527	111
LOGLISTS RETURNED TO RU 527	111
TOTAL CRUISES EDITED AT RU 527	99
CRUISES CONVERTED TO NODC	2
CRUISES MAILED TO NODC	30

APPENDIX III.

Draft Setup for File Type 038
Data Validation and Conversion

File Type 038 - Migratory Bird Sea Watch - Conversion Layout (DRAFT)

Fish and Wildlife Service: Field Definition	Columns	RT	RT	National Oceanic Data Center: Columns	Field Definition	Comments or Processing During Conversion
Data Type	1-3	1	1	1-3	File Type	-
Field Operation Number	4-9	1	1	4-9	File Identifier	-
Sea Watch Number	10-14	1	1	11-15	Station Number	Pad with leading zeros.
Record Type	15	1	1	10	Record Type	-
Latitude, degrees	16-17	1	1	16-17	Latitude, degrees	All latitude fields padded with leading zeros.
Latitude, min. to tenths	18-20	1	1	18-19	Latitude, minutes	Convert minutes and tenths
-				20-21	Latitude, seconds	to minutes and seconds.
-			1	22	Latitude, hemisphere	Add "N" by inspection.
Longitude, degrees	21-23	1	1	23-25	Longitude, degrees	All longitude fields padded with leading zeros.
Longitude, min. to tenths	24-26	1	1	26-27	Longitude, minutes	Convert all minutes and tenths
-			1	28-29	Longitude, seconds	to minutes and seconds.
Longitude, hemisphere	27	1	1	30	Longitude, hemisphere	-
Height Above Water	28-30	1	1	38-40	Height Above Water	Measured in whole feet.
Distance from Shore	31-35	1	1	31-35	Distance from Shore	Convert from meters to nautical miles and tenths.
Platform Type code	36	1	1	36	Platform Type code	See code sheets.
-			1	37	Sampling Technique code	No FWS counterpart.
Scope Bearing	37-39	1	1	41-43	Scope Bearing	Measured in degrees true north. Pad with leading zeros.
Blank	40-80		1	44-75	Blank	-
-			1	76-80	Sequence Number	No FWS counterpart.
-			2	1-3	File Type	No FWS counterpart.
-			2	4-9	File Identifier	No FWS counterpart.
-			2	11-15	Station Number	No FWS counterpart.
-			2	10	Record Type	No FWS counterpart.
-			2	16-75	Text	No FWS counterpart.
-			2	76-80	Sequence Number	No FWS counterpart.
Data Type	1-3	3	3	1-3	File Type	-
Field Operation Number	4-9	3	3	4-9	File Identifier	-
Sea Watch Number	10-14	3	3	11-15	Station Number	Pad with leading zeros.
Record Type	15	3	3	10	Record Type	-
-			3	16-17	Observation Start, year	All time fields padded with leading zeros. Measured in GMT. Number 78, etc. added to year field using column 3 of FWS Operation Number field
Start, day	16-17	3	3	20-21	Observation Start, day	-
Start, month	18-19	3	3	18-19	Observation Start, month	-
Start, hour	20-21	3	3	22-23	Observation Start, hour	-
Start, minute	22-23	3	3	24-25	Observation Start, minute	-
Elapsed Time, hours	24-25	3	3	26-27	Elapsed Sighting Time,	FWS datum is total transect

Elapsed Time, minutes	26-27	3	3	28-29	Elapsed Sighting Time, hours minutes	time, but NODC datum is elapsed sighting time - needs resolution.
Technique code	28	3	3	60	Watch type code	See code sheets.
Weather code	29-30	3			See Record Type 4	
Tide Trend code	31	3			See Record Type 4	
Tide Height code	32	3			See Record Type 4	
Sea State code	33	3			See Record Type 4	
Observing Conditions code	34	3	3	68	Observing Conditions code	See code sheets.
Species Abbreviation	35-38	3				No NODC counterpart.
Taxonomic code	39-48	3	3	30-39	Taxonomic code	Codes beginning with 88 were used and will not be converted, but trailing zero doublets will be removed.
Sub Species code	49-50	3	3	40-41	Sub Species code	(Bob Gill of FWS will advise on conversion).
-			3	44	Color Phase code	No FWS counterpart.
-			3	45	Plumage code	No FWS counterpart.
-			3	46	Molt code	No FWS counterpart.
SPP Group code	51-52	3	3	58-59	Species Group code	Acquired in NODC format. See code sheets.
Number of Individuals	53-57	3	3	47-52	Number of Individuals	-
-			3	53	Counting Method code	No FWS counterpart.
-			3	54	Reliability code	No FWS counterpart.
Behavior code	58-59	3	3	61-62	Behavior (Activity) code	(Bob Gill of FWS will advise on conversion).
Flight Direction code	60-61	3	3	55-57	Direction of Flight	Convert from clock position (reference position will be given by Bob Gill) to degrees from true north. Pad with leading zeros.
Age code	62	3	3	42	Age Class code	See code sheets.
Sex code	63	3	3	43	Sex code	See code sheets.
Linkage	64-66	3	3	65-67	Linkage	Pad with leading zeros.
Number of Species	67-68	3	3	63-64	Number of Species Participating	This is the number of species linked together, which can also be obtained from the "linkage" field, hence is left blank after conversion.
Optics Type code	69	3			-	No NODC counterpart.
Optics Power	70-71	3			-	No NODC counterpart.
Optics Angle	72-73	3			-	No NODC counterpart.
O.B.S. Observer Number	74-75	3			-	No NODC counterpart.
-			3	68-75	Blank	No FWS counterpart.
Sequence Number	76-80	3	3	76-80	Sequence Number	Pad with leading zeros.

-			4	1-3	File Type	Data in columns 1-15, inclusive, obtained from corresponding type 3 record.
-			4	4-9	File Identifier	
-			4	11-15	Station Number	Pad with leading zeros.

-			4	10	Record Type	-
Weather code	29-30	3	4	16-17	Weather code	See code sheets.
Tide Trend code	31	3	4	18	Tide Trend code	See code sheets.
Tide Height code	32	3	4	19	Tide Height code	See code sheets.
Sea State code	33	3	4	20	Sea State code	See code sheets.
-			4	21-34	Proposed addition of Observation Start and Elapsed Sighting Time to this record from corresponding type 3 record for unique identification of data.	
-			4	35-75	Blank	-
-			4	76-80	Sequence Number	Pad with leading zeros.

File Type 038 - Migratory Bird Sea Watch

Code Groups Validated
(FWS Format Citations)

Record Type 1	Column(s)	Comment
Platform Type	36	OK
Record Type 3		
Technique	28	Needs clarification
Weather	29-30	WMO Code 4677 used
Tide Trend	31	Same as NODC
Tide Height	32	Same as NODC
Sea State	33	WMO Code 3700 used
Observing Conditions	34	Needs clarification
Species Abbreviation	35-38	FWS int. code used
Sub Species	49-50	Needs clarification
SPP Group	51-52	Same as NODC
Behavior	58-59	Needs clarification
Age	62	Same as NODC
Sex	63	Same as NODC
Optics Type	69	OK

File Type 038

Migratory Bird Sea Watch

Platform Type Code

Format	Record Type	Column
FWS	3	36
NODC	3	36

FWS	FWS Definition	NODC Equivalent
11	Miller Freeman	1
12	Discoverer	1
13	Moana Wave	1
14	Surveyor	1
15	O.B.S. Research Vessel - Nordic Prince	1
20	Non-specialized ship	2
51	P2V	J
52	Goose	H
53	Otter, other 2 engine aircraft	5
54	Single engine aircraft	5
Fb	Shore Observer (b) means blank	F
Eb	Helicopter	E

File Type 038

Migratory Bird Sea Watch

Technique Code

Format	Record Type	Column
FWS	3	28
NODC	3	60

FWS	FWS Definition	NODC Equivalent
1	180 deg. infinity	
2	Fixed scope	
3	Lagoon count	
4	1 ± hour whole - mig. watch	

(Bob Gill - We don't have the equivalent NODC codes for this code group - do you have them? - Hal)

File Type 038

Migratory Bird Sea Watch

Weather Code

Format	Record Type	Columns
FWS	3	29-30
NODC	4	16-17

FWS	FWS Definition	NODC Equivalent
00	Clear to partly cloudy, less than 50% cover	
03	Cloudy to overcast, greater than 50% cover	S
41	Fog, patchy	A
43	Fog, solid	M
68	Rain, light	E
69	Rain, heavy	
87	Hail, light	
88	Hail, heavy	
71	Snow, light	
75	Snow, heavy	

File Type 038

Migratory Bird Sea Watch

Tide Trend Code

Format	Record Type	Column
FWS	3	31
NODC	4	18

FWS	FWS Definition	NOCC Equivalent
+	Rising	S
-	Falling	A
0	Ebb, full	M
		E

File Type 038

Migratory Bird Sea Watch

Tide Height Code

Format	Record Type	Column
FWS	3	32
NODC	4	19

FWS	FWS Definition	NODC Equivalent
1	High	S
2	3/4	A
3	1/2	M
4	1/4	E
5	Low	

File Type 038

Migratory Bird Sea Watch

Sea State Code

Format	Record Type	Column
FWS	3	33
NODC	4	20

FWS	FWS Definition	NODC Equivalent
0	Calm-glassy	
1	Calm-rippled	
2	0.1-0.5 m	
3	0.5-1.25 m	S
4	1.25-2.5 m	A
5	2.5-4 m	M
6	4-6 m	E
7	6-9 m	
8	9-14 m	
9	>14 m	

File Type 038

Migratory Bird Sea Watch

Observing Conditions Code

Format	Record Type	Column
FWS	3	34
NODC	3	68

FWS	FWS Definition	NODC Equivalent
1	Poor	1 - Terrible
2	Intermediate	2 - Marginal
3	degrees	3 - Poor
4	Moderate	4 - Average
5	Intermediate	5 - Fine
6	degrees	6 - Good
7	Excellent	7 (Excellent)

(Bob Gill - The only NODC code that matches exactly is number 7. FWS code number 1 matches NODC code number 3 as far as the word definition goes, but you might want to equate it with NODC code number 1. Please provide us with the set of equivalences you think best fits the use of your codes and the NODC definitions. - Hal)

File Type 038

Migratory Bird Sea Watch

Species Abbreviation Code

Format	Record Type	Columns
FWS	3	35-38
NODC	No counterpart	

FWS	FWS Definition
UNBI	Unidentified Bird
UNLO	Unidentified Loon
UNAL	Unidentified Albatross
BFAL	Black-footed Albatross
LAAL	Laysan Albatross
UNPR	Unidentified Procellarid
NOFU	Northern Fulmar
SOSH	Sooty Shearwater
SBSH	Slender-billed Shearwater
SCPT	Scaled Petrel
UNSP	Unidentified Storm Petrel
FTSP	Forked-tailed Storm Petrel
LESP	Leach's Storm Petrel
UNCO	Unidentified Cormorant
PECO	Pelagic Cormorant
RFCO	Red-faced Cormorant
UNCH	Unidentified Charadrid
UNSC	Unidentified Scolopacid
UNPH	Unidentified Phalarope
REPH	Red Phalarope
NOPH	Northern Phalarope
UNJA	Unidentified Jaeger
POJA	Pomarine Jaeger
PAJA	Parasitic Jaeger
UNGU	Unidentified Gull
GWGU	Glaucous-winged Gull
HEGU	Herring Gull
UNKI	Unidentified Kittiwake
BLKI	Black-legged Kittiwake
ARTE	Arctic Tern
ALTE	Aleutian Tern
UNAL	Unidentified Alcid
UNMU	Unidentified Murre
COMU	Common Murre
TBMU	Thick-billed Murre
PIGU	Pigeon Guillemot
MAMU	Marbled Murrelet
ANMU	Ancient Murrelet

CAAU	Cassin's Auklet
PAAU	Parakeet Auklet
CRAU	Crested Auklet
RHAU	Rhinoceros Auklet
HOPU	Horned Puffin
TUPU	Tufted Puffin
BLOY	Black Oystercatcher
PEFA	Peregrine Falcon
BAEA	Bald Eagle
DCCO	Double-crested Cormorant
HADU	Harlequin Duck
COEI	Common Eider
MEGU	Mew Gull
KIMU	
BOGU	
BRCO	
LEAU	
RBME	Red-breasted Merganser

File Type 038

Migratory Bird Sea Watch

Sub Species Code

Format	Record Type	Columns
FWS	3	49-50
NODC	3	40-41

FWS	FWS Definition	NODC Equivalent

(Bob Gill - This was one of the code groups for which you were going to provide us guidance. Please fill out this page with the correct entries. - Hal)

File Type 038

Migratory Bird Sea Watch

SPP Group Code

Format	Record Type	Columns
FWS	3	51-52
NODC	3	58-59

FWS	FWS Definition	NODC Equivalent

(These codes are used to extend the ten-digit taxonomic code assignments. Those established by NODC were used unchanged by FWS. No code verification is planned.)

File Type 038

Migratory Bird Sea Watch

Behavior Code

Format	Record Type	Columns
FWS	3	58-59
NODC	3	61-62

FWS	FWS Definition	NODC Equivalent
01	Sitting on surface	01
02	Sitting, diving at ship's approach	02
03	Sitting, flying off at ship's approach	03
07	Sitting on ice	14
10	Sitting on a floating object	10
20	Flying in a direct heading (travelling)	20
31	Flying, circling ship	31
32	Flying, following ship	32
35	Flying, milling about	35
48	Flying, meandering (foraging)	36
61	Feeding at the surface while flying	61
65	Feeding at the surface, scavenging on dead organisms,garbage	65
66	Feeding at the surface, not flying	66
70	Feeding below surface, diving	70
76	Probing	?
82	Feeding above surface, pirating	82
90	Courtship display	90
91	Bathing	91
92	Preening	92
93	Standing/sleeping	93
94	Copulating	94
95	Swimming	97
96	Feeding on mudflat / sandflat	?
97	At colony	?
99	Other (text card)	99

File Type 038

Migratory Bird Sea Watch

Age Code

Format	Record Type	Column
FWS	3	62
NODC	3	42

FWS	FWS Definition	NODC Equivalent
0	Indeterminable	
1	First year after hatching year - Jan. 1 to Dec. 31	
2	Hatching year - hatching date to Dec. 31. - Capable of sustained flight.	S A
4	Local - young bird incapable of sustained flight.	M
5	Second year	
6	After second year	E
7	Third year	
8	After third year (adult)	

File Type 038

Migratory Bird Sea Watch

Sex Code

Format	Record Type	Column
FWS	3	63
NODC	3	43

FWS	FWS Definition	NODC Equivalent
0	Indeterminable	S
1	Male	A
2	Female	M
		E

File Type 038

Migratory Bird Sea Watch

Optics Code

Format	Record Type	Column
FWS	3	69
NODC	No counterpart	

FWS	FWS Definition
1	Scope
2	Binoculars
3	Eyes
4	Scope/Binoculars
5	Scope/Eyes
6	Binoculars/Eyes
7	All of the above

File Type 038 - Migratory Bird Sea Watch

Limits and Relational Checks
(FWS Format Citations)

Record Type	Definition	Column(s)	Limits/Checks
1	Data Type	1-3	Must be "038".
	Field Operation Number	4-9	Must be identical to that of first record.
	Sea Watch Number	10-14	Must be increasing.
	Record Type	15	Must be "1".
	Latitude, degrees	16-17	Between 40 and 70.
	Latitude, min. to tenths	18-20	Between 0 and 599.
	Longitude, degrees	21-23	Between 120 and 180
	Longitude, min. to tenths	24-26	Between 0 and 599.
	Longitude, hemisphere	27	Must be "W"
	Height Above Water	28-30	Between 0 and 100.
	Distance from Shore	31-35	Between 0 and 100.
	Platform Type Code	36	Check code group.
	Scope Bearing	37-39	Between 0 and 359.
	Blank	40-80	Must be blank.
3	Data Type	1-3	Must be "038".
	Field Operation Number	4-9	Must be identical to that of first record.
	Sea Watch Number	10-14	Must be increasing.
	Record Type	15	Must be "3".
	Start, day (GMT)	16-17	Between 1 and 31.
	Start, month "	18-19	Between 1 and 12.
	Start, hour "	20-21	Between x and y. (Bob Gill - Please advise us as to appropriate daylight hours in GMT. - Hal)
	Start, minute "	22-23	Between 1 and 59.
	Elapsed Time, hours	24-25	(Bob Gill - Please advise us of appropriate range. - Hal)
	Elapsed Time, minutes	26-27	Between 0 and 59
	Technique Code	28	Check code group.
	Weather Code	29-30	"
	Tide Trend Code	31	"
	Tide Height Code	32	"
	Sea State Code	33	"
	Observing Conditions Code	34	"
	Species Abbreviation	35-38	"

Taxonomic Code	39-48	"
Sub Species Code	49-50	"
SPP Group Code	51-52	"
Number of individuals	53-57	Between 1 and 50.
Behavior Code	58-59	Check code group.
Flight Direction Code	60-61	Between 1 and 12.
Age Code	62	Check code group.
Sex Code	63	"
Linkage	64-66	Between 1 and 999.
Number of Species	67-68	Between 1 and 99.
Optics Type Code	69	Check code group.
Optics Power	70-71	Between 1 and 99.
Optics Angle	72-73	Between 0 and 90.
O.B.S. Observer Number	74-75	Bwtween 1 and 99.
Sequence Number	76-80	Between 1 and 99999.

Date: 6/26/78
Contract: 03-5-022-56
Task Order: #33
R.U. No.: 529
Proposal No.: OCS 79-4

Renewal Proposal FY '79

to

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

SOURCES, TRANSPORT PATHWAYS, DEPOSITIONAL SITES AND DYNAMICS OF SEDIMENTS IN THE LAGOON AND ADJACENT SHALLOW MARINE REGION NORTHERN ARCTIC ALASKA

R.U. No.:	529
Total Costs:	$64,370
Lease Area:	Beaufort Sea, 100%

Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

A. S. Naidu, Principal Investigator
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7032

J. R. Moore, Director
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7531

A. B. Frol, Director
Administrative Services
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7340

Keith B. Mather
Vice Chancellor for Research and
Advanced Study
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7282

3. TECHNICAL PROPOSAL

I. TITLE:

Sources, transport pathways, depositional sites and dynamics of sediments in the lagoon and adjacent shallow-marine region, northern arctic Alaska.

Research Unit Number: OCSEAP R.U. 529-77

Contract Number: 03-5-022-56

Proposed Dates of Contract: October 1, 1978 to September 30, 1979

II. PRINCIPAL INVESTIGATOR:

Dr. A. S. Naidu, Assistant Professor of Marine Science, Institute of Marine Science, University of Alaska, Fairbanks, Alaska 99701.

III. COST OF PROPOSAL (for FY 1979)

A. Science: $64,370

B. P.I. Provided Logistics: None

C. Total: $64,370

D. Distribution of Effort by Lease Area: Beaufort Sea - 100%

IV. BACKGROUND

The impact of the activities related to exploration and exploitation of petroleum on the nearshore ecosystem of north arctic Alaska are unknown. Recognizing this important data gap the BLM-NOAA-OCSEAP Office initiated a comprehensive ecosystem process-response research in the barrier island-lagoon regime of north arctic Alaska. A consolidated research plan was outlined in June 1976, by the LGL Limited, U.S., Inc. who were awarded with the prime contract. Preliminary results of the first year interdisciplinary study, are now becoming available (refer to the 1978 Annual Reports submitted by various principal investigators to the OCSEAP Office).

It has become increasingly evident from deliberations at several LGL-sponsored ecosystem modeling workshops, held over the last year at the University of British Columbia (Vancouver), that the carbon input to the lagoon ecosystem of north arctic Alaska is influenced by terrigenous organic detritus. Seasonal studies in the lagoon regime conducted over a few years by Schell and Alexander (in Alexander *et al.*, 1975), have indicated that the net carbon input in the North Slope lagoon by under-ice and pelagic photosynthesis is low, and that terrestrial peat detritus derived from fluvial discharge and/or coastal bluff erosion would seem to be a relatively more important carbon source for epibenthic invertebrate sustenance. Supporting this view is the concentration of epibenthic organisms in and on the organic detritus that blankets the Simpson Lagoon bottom. It is of further interest to note that the primary food sources of higher trophic organisms (e.g. fishes and birds) in the above lagoon are the epibenthic invertebrates such as mysids, amphipods, isopods etc. (Truett, 1978). However, the importance of carbon in the terrigenous organic detritus to the lagoon invertebrates, and by implication to the birds and fishes, would seem to depend on several factors, the more critical being the length of time the detritus is exposed to heterotrophic bacterial degradation and to detrivore scavenging. High rate of particulate sedimentation would, of course, preclude the usefulness of the organic detritus as a major carbon source, and vice versa. Consequently, at the April 1978 LGL ecosystem modeling workshop in Vancouver it was surmised that in order to understand the overall nutrient dynamics in the north Alaskan arctic lagoons it would be imperative to quantify data on the terrigenous organic detritus. It was also decided that the data to be collected should include pertinent information on the sources, transport pathways, sites and rates of sedimentation, as well as the physical factors (waves, currents, wind etc.) that regulate the deposition-resuspension rates of terrigenous organic detritus. This proposal in essence will address the above task, fulfilling the recently identified critical needs of those concerned with lagoon ecosystem modeling in the Alaskan Beaufort Sea.

In addition to the above, one of the questions that was repeatedly raised at the 1977 and 1978 Beaufort Sea Synthesis meeting in Barrow related to the understanding of overall sediment dynamics (including both organic and inorganic particles) in the nearshore area of north arctic Alaska. It was concluded that without an adequate knowledge of the sediment fluxes which would encompass considerations of sources, transport directions, and depositional sites of fine-grained terrigenous particles it would be almost impossible to forecast the fate of soluble and particulate pollutants in the lagoon and shallow marine Alaskan arctic. The importance of clay-sized sediment particles as potential vehicles to transport pollutants is universally well recognized. Additionally, it was concluded at the two meetings that hydrodynamic factors that govern the threshold (minimum current velocity) of coastal sediment movements must also be understood, because of the implication of it in quantitative assessment of changes in sediment budgets resulting from anthropogenic activities (e.g. drilling pad and causeway construction, dredging etc.). We have no knowledge what the fluxes and mean rate of sedimentation is in the North Slope lagoon and what physicochemical factors can alter that rate. A conceivable concern has been that any significant disturbance of the contemporary sediment budgets in the shallow lagoons may eventually lead to the destruction of the lagoon ecosystem of the North Slope area.

Although considerable baseline data on the lithological composition of sediments have been collected for the continental margin of north arctic Alaska - especially under the auspices of the ongoing OCSEAP studies - no serious process-response sedimentological investigations involving extensive data base have ever been undertaken for the above region. A few sediment dynamics studies of a preliminary nature have been conducted along the beaches of the Simpson Lagoon and the Pingok Island by Wiseman *et al.* (1973) and Dygas and Burrell (1976a, 1976b). However, to assume that results of these surf-zone studies may be extrapolated to the adjacent relatively deeper and protected lagoons would seem quite inappropriate. The above investigators made no direct *in situ* measurements of threshold sediment movements. In fact the first system studies on sediment dynamics, involving time-series concomitant wind-wave-current data, in Alaskan waters are those of Cacchione and Drake (1977). It is, therefore, proposed that sediment dynamics studies in the north Alaskan arctic lagoon be initiated. Such studies will have to include *in situ* concurrent documentation of wind-wave-current parameters, nature of bed and suspended loads, as well as bed forms. It is believed that understanding of contemporary sediment dynamics will be of immense use to geomorphologists such as Dr. Jan Cannon (RU 530) who are concerned with the stability of barrier chain of islands and the adjacent coastal features of north arctic Alaska.

Intrinsic to the sediment dynamics studies is the understanding of the sources and depositional sites of terrigenous inorganic particles in north arctic nearshore environment. Considerable research has been accomplished in this direction relative to fine-grained particles, *via* very detailed analysis of clay minerals (Naidu and Mowatt, 1975; Naidu, 1978). However, relatively little effort has been expended to firmly establish the provenance and net long-term transport directions of sand-sized sediment particles. Several lines of indirect evidence demonstrate that the net along shore sand drift is towards the west. More recently Hopkins (1977) has concluded that the major passes within the Beaufort Sea island chains act as effective obstacles to continous littoral sediment transport between different island groups. Additionally Hopkins (1977) has suggested that both sand and gravel laterally migrate from one island to another only within individual island groups. Although these observations on sediment transport are interesting, Hopkins' (1977) conclusions need to be substantiated because his data were based chiefly on the lithologic composition of pebbles rather than both pebbles and sand grain mineralogy. Therefore, in order to elucidate the sources, transport pathways and depositional sites of sand, investigations restricted to sand size particles must be conducted. It is proposed to fill this critical gap by completing the ongoing mineralogical studies on sands which can be used as "natural tracers" (refer to the original OCSEAP proposal under RU 529-77, submitted by A. S. Naidu).

V. OBJECTIVES

The overall objectives of this research unit will be to understand the sediment dynamics and correlate the transport, resuspension and deposition of sediments as functions of wind-wave-current actions in the lagoon environment of north arctic Alaska. The specific objectives of the study will be:

(i) to define the sources, migratory pathways and depositional sites of terrigenous organic particles, using the assumption that the hydraulic behavior of both fine inorganic particles (e.g. clay minerals) and organic particles are similar.

(ii) to develop understanding of sediment dynamics in the lagoon environment of north arctic Alaska, considering the Simpson Lagoon as a type area. This objective would include initiating of a study that would eventually lead to the establishment of correlations between wind-wave-current parameters and water turbidity, resuspension and movement of organic and inorganic particles;

determination of the critical value of near-bed shear stress for incipient motion of cohesionless sediments under oscillatory wave action.

(iii) To estimate the contemporary rate of sedimentation in the Simpson Lagoon.

(iv) To elucidate the sources, transport directions, and depositional sites of sand and clay-size inorganic terrigenous particles.

(v) To collaborate with Dr. J. Cannon (RU 530) in establishing criteria based on ground truth and LANDSAT images (obtained by remote sensing techniques), for mapping distributional pattern of suspended particle concentrations in the lagoons of north arctic Alaska.

Relevance of the proposal objectives for decision making prior and during leasing and development.

The exploitation of the petroleum reserves in the North Slope of Alaska has commenced with the recent flow of oil through the trans-Alaska pipeline. The present trend is towards exploration in the adjacent continental shelf of the Beaufort Sea. As a consequence of the OCS petroleum and gas development activities, the nearshore and the open shelf ecosystem of the Beaufort Sea is bound to be subjected to some degree of anthropogenic perturbations. The industrial activities which most likely will be introduced in this area include the construction of artificial islands and causeways for the use of drilling operations and docking facilities, dredging for maintaining navigations, and the exploitation of gravel and sand deposits from several possible sources as construction and fill materials. The impact of these activities on the nearshore sediment budgets and the implication of the latter on the nearshore ecosystem are unknown. However, several attempts have been made postulating the possible socio-economic scenario and environmental perturbations that might result during the exploration and exploitation of petroleum reserves from the OCS lease areas of the Beaufort Sea (Arnold, 1975; Weller *et al.*, 1977). It is of interest to note that significant changes in the size distributions, benthic and chemical attributes of bottom sediments, as well as on the nearshore bathymetry have already been recognized in the vicinity of Prudhoe Bay, consequent to the building of the new ARCO causeway (Feder *et al.*, 1976; Barnes *et al.*, 1977; Grider *et al.*, 1977).

If the response of the physical environment and biological resources of the area to such changes can be properly assessed, or even predicted, it is quite possible that effective measures can be developed to protect or enhance existing resources. Few environmental studies of arctic barrier islands, lagoons, and the contiguous shallow marine regime of north arctic Alaska have been carried out (Alexander *et al.*, 1975; Truett, 1978). The existing data gaps for this area were identified in two recent OCSEAP meetings held at Barrow to synthesize the current state of knowledge on the Beaufort Sea. It was the unanimous opinion of the meeting participants that unless satisfactory answers are available to account for the sediment fluxes, and sources, transport pathways and depositional sites of sediments, and without an adequate knowledge developed to understand threshold of sediment movements (as functions of wave-current parameters), it would not be possible to quantitatively assess - or even speculate - the possible impacts of petroleum exploration and development activities on the Beaufort Sea nearshore ecosystem.

The proposed geological studies under the current RU 529 will be addressing the OCSEAP subtasks C-5, D-4, and D-5. This study will be an integral part of the barrier island-lagoon ecosystem process studies in which LGL (RU 467) plays the lead role.

VI. GENERAL STRATEGY AND APPROACH:

As mentioned earlier, the terrigenous vegetal particulate matter appears to be a major source of carbon to sustain biological productivity in the Simpson Lagoon. However, the fate of these particles and their potential usefulness as a carbon source would naturally depend on the ready availability of them to biota, either in the water column or at the substrate sediment-water interface of the lagoon. Rapid deposition of the organic particles would of course limit the chances of being scavenged by the epibenthic invertebrates and vice versa. There can be several physicochemical factors which would regulate the concentrations of the particles in the readily available form. The more obvious physical factor is the amount of turbulence in the lagoon, which in turn can be related to wind-wave-current actions. Our approach would be to determine the correlation between the concentrations of suspended particles and the organic carbon content in it and the wind-wave-current parameters in the Simpson Lagoon. The ultimate purpose of such a study would be to establish the critical near-bed shear stresses, translated in terms of threshold oscillatory wave motions, which are necessary to resuspend organic particles from the lagoon bottom and keep these particles in suspension for significant periods of time.

In attempting to establish the above correlations our strategy would be to concomitantly document on a two-month continuous time series basis the wave-current parameters, wind directions and velocities, the concentrations of total suspended particles and the organic carbon and nitrogen contents in them, and the lagoon bed form. The sensitive parameters of the Simpson Lagoon waves we will record (*via* pressure sensors) will be the period T and the amplitude of the oscillatory, horizontal excursion R of the water at the floor level of the lagoon (or alternatively the peak value of the horizontal oscillatory wave velocity U (refer to e.g., Bagnold, 1946; Taylor, 1946; Sternberg and Larsen, 1975). Concomitant with the wave data the turbidity of the Simpson Lagoon water will be continuously monitored *via* a nephelometer. To calibrate the nephelometer readings in terms of suspended organic particulate matter (and by implication organic carbon), we will collect frequent water samples, measure the total suspensates in definite aliquots of it and finally quantify the organic carbon contents in those water samples. As we will be concerned with surface gravity waves it would be relevant for us to have complementary time-series data on the directions and velocites of wind. Hopefully the wind data will be available to us from meteorologists working in the Simpson Lagoon vicinity during 1978 and 1979 (R.U. 519). The current measurements would include both directions and velocities of the bottom waters. As characteristic surficial bed forms on the lagoon bottom are developed in response to definite wave energy we will photographically monitor on a continous time lapse basis (typically once every 15 minutes) the lagoon substrate form. As discussed in detail later the current-wave characteristics, time lapse photographs and the turbidity of waters will be obtained directly or indirectly from parameters to be measured *via* a tripod instrumented package - the Sediment Dynamics Sphere (SDS) - which will be deployed in the lagoon for almost two months in each of the summers of 1978 and 1979.

Once the above basic data on waves have been established, contour plots of the organic carbon contents in the suspended particles of water will be drawn in TR plane and TU plane. Since the other parameters of hydrodynamic importance are steady current speed and wind strength which are also expected to control the suspended carbon quantity, contour plots will be likewise made piecewise for different domain of current speeds and wind velocities.

The above contour plots will be provided to the ecosystem modelers. The latter would then be able to assess the effects of anthropogenic barriers in the lagoon system and/or natural driving forces (e.g., wind) which would modify the U and T values and thereby the quantity of suspended matter and by implication the content of organic carbon suspensates.

Concomitant to the above research, we will initiate a study to develop our understanding of sediment dynamics and fluxes in the Simpson and adjacent lagoons. The strategy to achieve this objective would be delineated into three phases:

(1) The sources, transport pathways and major sinks of terrigenous clay and sand-sized particles along the nearshore area of north Alaskan arctic will be elucidated by means of detailed clay minerals and heavy minerals studies of fine and sand-sized particles respectively on a regional scale. The mineralogy of different size sediment particles from various major rivers of the North Slope of Alaska will be discriminated and used as "natural" tracers to understand the primary sources, net transport directions and accumulating places of terrigenous inorganic debris. This approach has been quite successfully used in the case of fine-sized sediment particles (<2μm and <1μm size), as shown by results of our studies (Naidu and Mowatt, 1975; Naidu, 1978). However, we need to fill in small data gaps for the lagoon area between Milne Point and Prudhoe Bay. We have already initiated heavy minerals studies on sands separated from samples from all the major rivers as well as barrier islands of the north Alaskan arctic. The work will be continued and completed in FY 1979.

(2) The second phase of the sediment dynamics study will be to estimate the contemporary rate of sediment deposition in the Simpson Lagoon. This data will be an important baseline to assess physical impact of anthropogenic activities on sediment budgets in the lagoons. The rate of sedimentation will be assessed by collecting a few gravity core samples and getting the samples dated by the ^{210}Pb method. On the basis of this data it would be possible to determine in the future whether the lagoon is shoaling or deepening as a response to changes in sediment budgets, and whether these changes do affect the ecosystem in any way.

(3) The third phase of the sediment dynamics study will be addressed to developing understanding of the correlations existing between sediment resuspension and oscillatory wave motion, as well as the threshold of sediment movement. The strategy would be to test how rigidly some of the empirical relations developed in the laboratory on fluid-sediment equations of motions (refer to Shields, 1936; Bagnold, 1946; Taylor, 1946; Einstein, 1950; Manohar, 1955; Komar and Inman, 1970; Madsen and Grant, 1976) can be extrapolated to the field (e.g. Simpson Lagoon in north Alaskan arctic). In attempting to do so we will obtain the critical shearing stresses, as applicable to the Simpson Lagoon, that will initiate resuspension of sediment particles, and the minimum current velocity that will keep the particles in motion. The basic laboratory equations to be tested have been elaborately discussed in Komar and Miller (1973) and Sternberg and Larsen (1975).

Briefly, our ultimate goal would be to determine in the field the critical entrainment function and boundary shear stress to entrain the size (or mean size) of sediment grain in the Simpson Lagoon bottom, considering the following relationship postulated by Shields (1936),

$$\Theta = \frac{T_o}{(\rho_s - \rho)\ gD} \tag{1}$$

where Θ is the critical entrainment function, T_o is the boundary (or near-bottom bed) shear stress to entrain a sediment particle of diameter D, $(\rho_s - \rho)$ is the difference in the densities of the sediment grain and the fluid, and g is the acceleration of gravity. The value of Θ for the Simpson Lagoon sediments can be estimated by assuming $\rho U_m^2 = T_o$ and using the relationship developed by Komar and Miller (1973) for oscillatory wave conditions, which is:

$$\Theta = \frac{\rho U_m^2}{(\rho_s - \rho)\ gD} \tag{2}$$

where U_m is the maximum bottom oscillatory velocity of a fluid parcel at the sediment-water interface, whereas ρ_s, ρ, g and D values connote the same as in equation (1). We will obtain the U values for the Simpson Lagoon from wave parameters obtained on a time series basis, as suggested by Sternberg and Larsen (1975), using pressure sensors of a Sediment Dynamics Sphere (SDS) for two months. To solve equations (1) and (2) we will assume the specific gravity of sediment particles to be 2·56 (similar to quartz and clay mineral grains) and acceleration of gravity to be 980 cm/sec^2. The density of the Simpson Lagoon water will be provided to us by physical oceanographers involved in the project (RU 526 and 531), while the mean size of the bottom sediment particles will be analyzed in the Fairbanks laboratory on sediment samples retrieved periodically for the lagoon bottom.

Our data founded on field observations will enable us to finally establish the U_m-Θ, U_m-D, Θ-D and To-D relationships. The above relationships then can be compared with those established by Bagnold (1946, 1963), Manohar (1955) and Komar and Miller (1973), on the basis of laboratory experiments.

In addition to the above, we plan to conduct field tests to varify the Karman-Prandtl equation (Koman, 1976). To achieve this it would be necessary to document time series data on current speeds at a particular water depth, T_0, ρ, and D values for the Simpson Lagoon. We will take the values of the latter three parameters from equations (1) and (2), whereas the steady state current speeds will be documented on a time series basis from the Simpson Lagoon, using the current meter of the SDS unit.

For the purposes of our field tests it will be assumed that unidirectional, turbulent, nonlinear oscillatory flow conditions exist in Simpson Lagoon, and that the Simpson Lagoon is characterized essentially by cohesionless substrate. This would seem to be a valid assumption taking into consideration the commonly observed net movement of water masses in the summer to be from the east to the west, presence of surface to bottom turbid water, and the existence of soft substrate sediments, and occasionally of oscillation ripples in the lagoon bottom.

Our field experiments will be conducted in the Simpson Lagoon at a site to be determined later in consultation with biologists and physical oceanographers. However, the minimum depth of water in which the instrumented tripod SDS unit can be emplaced would necessarily be restricted by the navigational limit of the R/V *Alumiak*. The current plans are to install the SDS in Point Barrow and transport it to the Simpson Lagoon experimental site on the R/V *Alumiak*. The feasibility of deploying the SDS in more than one location in the lagoon will have to be taken into consideration, because of the possible existence of spatially non-uniform sediment and flow conditions.

VII. SAMPLING METHODS:

The basic wave (*via* pressure sensors), current, temperature, and turbidity data for the Simpson Lagoon water column, as well as the time-lapse photographs of the lagoon substrate and water column will be collected by the Sediment Dynamics Sphere (SDS). This instrumented tripod package will be emplaced in the Simpson Lagoon and the above data monitored on a continuous time series basis during the summers of 1978 and 1979, extending from August 1 to about mid-September - a few days before sea ice starts forming in the lagoon. A subcontract will be issued by A. S. Naidu to Dr. L. Larsen from the University of Washington, Seattle, to install, check, transport, operate, and retrieve the SDS, as well as to provide A. S. Naidu the basic data. A request to issue such a subcontract from A. S. Naidu's ongoing (RU 529) grant has been approved by the OCSEAP, Boulder office to cover 1978 summer work. Details of this subcontract, as well as the Operational Manual, together with the Sediment Dynamics Data Acquisition System of the SDS (Lahore *et al.*, 1977) have already been submitted to the OCSEAP office and, therefore, will not be repeated in this proposal. However, it is pertinent to state that we intend to substitute for the transmissometer of the SDS unit a SeaMarTec nephelometer to obtain a measure of the water turbidity and concentrations of particulate suspension on a continous time series basis.

To document the size distributions of substrate sediment samples of the Simpson Lagoon, replicate surficial bottom samples will be collected once daily at the experimental site, using a small gravity core unit. This unit will be manually operated from a zodiac boat.

The concentrations of organic carbon and nitrogen will be estimated from samples of suspended particulate matter collected on the Nuclepore filter pads. In order to minimize bacterial degradation, the filter pads with samples will be stored in a frozen state until analysis. Replicate samples of bottom and suspended sediments will be used to determine the sampling precision. A few gravity core samples in the immediate vicinity of the SDS experimental site and also from a few widely-spaced location in the Simpson Lagoon will be retrieved for determining the mean rates of sediment depositon in the lagoon. These samples will be collected from the *Alumiak*, using a 1000-lb gravity coring unit. The sediment cores thus collected will be preserved in the original plastic liners in an upright position, and sent to a laboratory in the lower 48 for ^{210}Pb dating. The ^{210}Pb date should provide us with the net depositional rate at least over several decades. However, in order to elucidate the rates of sedimentation on one or two summer basis we plan to use a sediment trap. This trap will be emplaced in the Simpson Lagoon for the entire summers of 1978 and 1979, and the amount of sediment accumulated in the trap will be quantified. We plan to use a trap similar to one being used by Drs. Cline and Feely of the PMEL, Seattle.

We already have a sufficient number of sediment samples from the major rivers of the North Slope of Alaska, the lagoon region extending from Oliktok Point to Prudhoe Bay, and from the major islands of north arctic Alaska for mineralogical studies. These samples were collected on the on-going OCSEAP study (RU 529) in 1977 (see Naidu, 1978), and analysis of clay minerals and heavy minerals on these samples are in progress.

In order to understand the sediment fluxes in and out of the lagoon, we have plans to collect a suite of suspended particulate samples from the adjacent shallow marine region, using the support provided by the U.S. Coast Guard ice breaker *Northwind*. We have been invited to participate in a cruise for about 10 days, starting from August 10, 1978. Samples of suspended particles will be collected from the shelf waters, off the Colville Delta and the Simpson and adjacent lagoon areas. These samples will be analyzed for total particulate matter, organic carbon and nitrogen contents, following procedures mentioned earlier.

It is understood that two satellites will be passing over the North Slope area alternately once in 9 days during the period of our field study. LANDSAT images documented by these satellites over various bands will be available to us and Dr. Cannon for our joint investigations relating to sediment plume distributional studies. We will make sure that samples of suspended particles will be collected from as many sites as possible from the Simpson Lagoon during the passage of the satellites over the area, to ensure that meaningful criteria can be developed to quantitatively interpret the distributional pattern of turbid water as depicted in LANDSAT images.

VIII. ANALYTICAL METHODS

Laboratory analysis

The analytical methods to be adopted have been elaborately described in the current (FY 1978) OCSEAP R.U. #529-77. Briefly, the sediment size distribution analysis will be performed by the usual sieve-pipetting method, and calculation of the conventional statistical grain size parameters will be after Folk and Ward (1957). The clay mineral composition of the <2 μm of sediments will be accomplished according to the methods elaborated by Naidu *et al.*, (1971) and Naidu and Mowatt (1975) using X-ray diffraction technique. A variety of chemical and heat treatments will be adopted to assist in the clay mineral identification.

Heavy mineral analysis will be performed on medium and fine size grades of sands. The heavy mineral crops will be separated in heavy liquid media, the quantitative assesments of the relative concentrations of the various heavy minerals will be accomplished using a petrographic microscope.

Organic carbon will be calculated from the difference between total carbon and carbonate carbon. The total carbon will be analyzed either in a a LECO, TC-12 automatic carbon determinator or by using a disperse-beam infrared analyzer, depending on the concentration range of the total carbon in the suspended particles. The carbonate contents in the suspensates will be estimated manometrically (Hülsemann, 1969). Total nitrogen in the sediments will be measured in a Coleman Model 29B nitrogen analyzer. Replicate laboratory analyses will be run for a few samples to determine the analytical precision.

The methods elaborated by Burbank (1974) will be followed for the analysis of LANDSAT images as obtained by remote sensing techniques. It is presumed, however, that this actual analysis of the images at different bands will be the responsibility of Dr. Cannon, and A. S. Naidu will collaborate with Dr. Cannon in providing him with time-series data on suspended loads collected for the Simpson Lagoon.

IX. DELIVERABLE PRODUCTS

A.1. All data products forthcoming from this study will be submitted to the OCSEAP Data Management Group in the accepted format. In addition, we hope to provide the OCSEAP office with the following data:

a) All basic data pertaining to grain size distributions, heavy minerals and clay minerals, organic carbon, and nitrogen contents, on substrate and suspended sediments will be provided in tabulated form. The concentrations of suspended particulate matter, collected on a time-series basis will be tabulated also, and corresponding nephelometer readings will be appended with this table. Efforts will be concentrated to consolidate all published and unpublished data available with us in a manner best suited for coastal management purposes. This would obviously incur vigorous statistical analysis of all data.

b) Lateral variations in the clay mineralogy, and heavy minerals concentrations will be depicted on standard OCSEAP Beaufort Sea maps for the purpose of ready graphical reference. Sediment transport trajectories for sand and clay-sized particles will be mapped for different sections of the investigated coastlines.

c) A geological report will be prepared that will include chapters on the sources and the inferred sediment transport vectors in the barrier island-lagoon complex. The above report will also include a section predicting possible perturbations on the barrier island-lagoon ecosystem that may directly or indirectly result from various oil-related industrial activities in the North Slope of Alaska.

d) A copy of the computer print out, showing all basic and correlative data, as obtained from the Sediment Dynamics Sphere, including calcomp plots of time series data will be submitted. This data will pertain to values of a rotor counter, direction vane, pressure sensor, nephelometer, time-lapse photography, and temperature of water (refer to details enumerated in the User's Guide to the SDS Data Aquisition System (Lahore *et al.*, 1977), submitted to the OCSEAP office in June 1978).

e) All data acquired on critical shearing stresses, entrainment functions, and horizontal oscillation velocities corresponding to various sediment particle diameters of the Simpson Lagoon will be tabulated. Scatter plots, showing the graphical relationships between the above values will be drawn and the trend in the variances will be statistically established.

f) The rate of contemporary sedimentation in the Simpson Lagoon, as established on the basis of ^{210}Pb dating of a few gravity core samples will be provided.

g) All attempts will be made to interface the sedimentological studies with other disciplines of the overall OCSEAP barrier island-lagoon ecosystem modeling study, which is headed by the LGL, Limited, Inc.

A.2. List of Digital products:

a) Sediment size distribution data (e.g., weight percentages of various fractions, percentiles, mean and median size, sorting, skewness, and kurtosis of size distributions.

b) Weighed peak area percents of the various clay mineral types, and the number percentages of various heavy minerals.

c) Concentrations of total suspended particulate matter, and the contents of organic carbon and nitrogen in the above matter, in mg/g values. We would need additional funds to cover the cost of recording this data on magnetic tapes. However, we have no idea how much this would cost.

d) As in case of above, additional funds would be needed to record the SDS data on magnetic tapes.

B. Narrative Reports: None

C. Visual Data:

Refer to A.1. for details.

D. Other:

Calcomp plots of all time-series data relating to the SDS unit will be available on computer strip charts. For details please refer to proposal submitted by Dr. Larsen under subcontract to A. S. Naidu (RU 529) to the OCSEAP office in June 1978 and the SDS User's Guide (Lahore *et al.*, 1977).

X. QUALITY ASSURANCE PLAN

Calculation of the percentage coefficient of variations based on results of replicate analyses of individual sediment parameters will provide the analytical precision. Likewise, sampling precision will be obtained on the basis of replicate samples. Representative splits of at least 5% of all sediment samples collected by us will be submitted, if required, to the National Bureau of Standards for interlaboratory calibration.

We intend to use a nephelometer rather than a transmissometer as mentioned in the SDS User's Guide for monitoring the suspended loads on a continuous time series basis. The nephelometer can be calibrated either in the laboratory or in the field. In the laboratory the calibration can be achieved against known concentrations of suspended particles (by weight) of a particular size distribution range, using either a settling tube or a flume chamber. However, for the purposes of our studies it would seem more meaningful to calibrate the nephelometer readings directly with the *in situ* concentrations of suspended particles (by weight) at precisely the same water depth at which the nephelometer probe is emplaced. For estimating the amounts of suspended loads, 1-litre water samples will be collected *via* a small Niskin bottle at the above probe level, filtered using a Millipore (0.45 μm pore size Nuclepore filter pads) unit, and weighing the particulate solids thus collected. It is planned to take several replicate water samples, at least twice daily (as far as possible matching with varying wind conditions). The replicate samples will provide the sampling precision. Thus, by the complementary use of the direct and indirect methods we will be able to establish a workable calibration curve for the nephelometer, and which would be applicable only locally for Simpson and adjacent lagoons.

We are well aware of the complexities involved in attempting to calibrate a nephelometer more precisely. Sediment grain parameters such as size and shape, as well as nature and state of particle aggregation (as controlled by electrochemical properties, mineralogy, organic-inorganic binding etc.) can independently or jointly affect the scattering properties of particles and thus the calibration curves of nephelometers. However, these are beyond the practical scope of our present study, and therefore will not be taken into account.

The nephelometer we would like to purchase would be the SeaMarTec *in situ* unit manufactured by SeaMarTec, Seattle. This unit seems to work satifactorily in Alaskan waters and meaningful calibration curves have been obtained on a similar instrument owned by Dr. J. Colonell of our institute (personal communication).

The current meter and pressure sensors in the SDS unit will be calibrated as suggested in the units User's Guide (Lahore *et al.*, 1977).

XI. SPECIAL SAMPLE AND VOUCHER SPECIMEN ARCHIVAL PLANS

Splits of all sediment samples analyzed will be stored for future reference. In order to minimize biodegration and post-sampling changes in sediment phases, all samples for chemical analysis will be stored in a frozen state. There is adequate freezer space at Dr. Naidu's laboratories at the Institute of Marine Science. No annual cost of archiving the samples are anticipated.

XII. LOGISTIC REQUIREMENT

As mentioned earlier, our logistic requirements in the field for the collection of sediment samples, transport and installation of the SDS unit will be arranged by the OCSEAP Arctic Project Office. A possible convenient way would be to coordinate our field logistics with the LGL Limited, U.S., Inc., who presumably would be again the major contractor of the OCSEAP Beaufort Sea barrier island-lagoon ecosystem modeling study. Our coordination with the LGL has been excellent up to now and we wish to continue the present logistic arrangements with them. However, the logistic and ice-breaker ship requirements for the offshore sampling work, and the sediment coring program in the Simpson Lagoon will have to be provided by the U.S. Coast Guard and the Arctic Project Office, respectively, as per the April 1978 preliminary planning meeting held in Seattle.

Please refer to the standard attached form for further details.

XIII. ANTICIPATED PROBLEMS

At this point in time we do not anticipate any problems. However, we would like to emphasize that the recently approved subcontract to Dr. Larsen of the University of Washington, Seattle, from Dr. Naidu's FY 1978 contract be processed as soon as possible by the OCSEAP Office. This must be considered critical if the SDS unit is to be deployed in the Simpson Lagoon in summer 1978.

XIV. INFORMATION REQUIRED FROM OTHER INVESTIGATORS

We would be requiring time-series data on the water density at the SDS experimental site, from August 1 to about September 15 in 1978 and 1979, on a daily basis. It is hoped that this data will be provided to us by the biologists and/or physical oceanographers involved in the OCSEAP lagoon ecosystem studies (RU 526, 531, and 467). If this is not possible then we will have to gather this data, which will involve additional cost to the project. Daily time-series data on the direction and velocity of wind will be needed from meteorologists (RU 519) working in the area. We have been asked by the OCSEAP Office, Boulder (refer to Dr. Doug Wolfe's telefax of June 20, 1978 to Dr. G. Weller) to look into the feasibility of deploying the SDS in more than one location in Simpson Lagoon to obtain a wider data base. This is possible, but would need sanction of additional funds.

XV. MANAGEMENT PLAN

Dr. A. S. Naidu will serve as the Principal Investigator of this project. His responsibilities will include analyses and interpretation of all sedimentological data, meeting delivery milestones for data submission, as well as the deadlines for reports as required by the OCSEAP Arctic Project Office. Mr. R. Parthasarathy, Professor in Physics at the Geophysical Institute, University of Alaska, will be an Associate Investigator in this study at no cost to this project. His prime responsibility will be to help Dr. Naidu in developing the empirical relationships on sediment grain size and bed shearing stress and the sediment entrainment function.

A Student Aide will help Dr. Naidu in the mechanical analysis of the sediment parameters. Mr. Mike Sweeney, a graduate student presently working with Dr. Naidu and funded by the USGS, will also be involved in the chemical analysis of sediment samples. The outcome of part of the sediment dynamics work will be included by Sweeney in a M.S. thesis dissertation.

The OCSEAP Office recently approved a subcontract from Dr. Naidu's ongoing contract (RU 529-78) to Dr. L. Larsen, University of Washington, Seattle. In the budget of the FY 1979 renewal proposal issue of a similar subcontract has been stipulated. Under the two subcontracts (1978 and 1979) it would be the responsibility of Dr. Larsen to transport to and assemble the SDS unit at Simpson Lagoon experimental site, gather all basic SDS data for the August and September months, and provide all data reduced from the SDS to Dr. Naidu in a consolidated tabloid form. Details of this subcontract will be spelled out in two separate purchase orders, when the approval of the requested subcontracts have been notified to Dr. Naidu by OCSEAP.

Dr. Naidu will participate in the ecosystem modeling workshops to be held at the University of British Columbia, Vancouver from time to time.

As mentioned earlier, most of this study will be conducted in conjunction with the geomorphic studies of Dr. J. Cannon (RU 530), and the physical oceanographic and biological investigations to be pursued, respectively, by Drs. B. Matthews (RU 526) and C. Mungall (RU 531) and the LGL Limited, U.S., Inc. (RU 467), and by Dr. Schell (RU 537) on nutrient chemistry as part of the overall OCSEAP program on the barrier island-lagoon ecosystem model of north arctic Alaska.

Target dates, for field sampling, sample analysis, processing, data submission, and final reports are outlined in a chart appended separately.

XVI. OUTLOOK

1. The nature of the final results and data products: The ultimate long-term goal of this study will be to understand and quantify the processes and physical and chemical products of sedimentation in the continental margin and shelf areas of the Beaufort Sea. This knowledge would be of fundamental use to any individual or group concerned with management of the renewal and nonrenewal resources of arctic Alaska, with least ecological perturbations.

2. Significant milestones: It would seem that at least a decade of concerted effort may be involved before any quantitative understanding of sediment dynamics can be expected. Lack of proper logistics has been a traditional hurdle in the way of achieving knowledge in this area. However, primarily through the efforts during the past six years and the ongoing interests, it is believed that adequate basic data would be available by the end of 1979. It would seem that for the next decade efforts should be concentrated on process response studies.

3. Cost by fiscal year: It would seem that continuous funding in the order of $300,000/year for the next 5-10 years would be considered a marginal amount to achieve understanding of the gross depositional processes in arctic continental margin. However, the most likely way to achieve this goal would be to initiate a long-term, multidisciplinary "mission-oriented" study under one organization. We have most of the expertise and facilities to carry on this program at the Institute of Marine Science.

4. Additional major equipment required: Some of the major equipment that we would like to acquire would include a side-scan sonar unit, a SDS, and a portable vibrocorer. We would also like to update our X-ray diffraction unit, by adding to it a monochromator, controlled humidity chamber and an automatic sample changer.

5. Location of future field efforts: We would like to continue concentrating our efforts in the continental margin and shelf areas of the Beaufort Sea. However, presently our investigations as in the past have been focussed on the central Beaufort Sea coast in the vicinity of the Colville and adjacent deltas. In the future we would like to extend laterally as far as Point Barrow in the west and the Demarcation Point in the east.

6. Logistic requirements: Collection of sediment samples from the lagoons adjacent to the North Slope has been a matter of constant concern for us, primarily because of a lack of proper large boat and navigational facilities to locate sample stations. We have traditionally depended either on the USGS or our own limited logistic support for samples. Presumably, an ideal boat for this area would be a 30-foot arctic cruiser or a vessel similar to NARL's R/V *Natchik*. It would seem only appropriate that some Federal or State agency maintain a permanent boat in the North Slope coastal area specifically for scientific research.

The introduction of *Alumiak* is certainly an encouraging feature and we hope to make use of it in 1978 and 1979 summers. However, through small boat operations it would seem possible to accomplish, as in the past, considerable amount of our sampling providing proper facilities are provided to locate sample stations. The latter could be partly accomplished by setting up identifiable landmarks on the coast and buoys in the water.

XVII. 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 XI 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 policy.

4. See Section XV 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.

5. Data will be provided in the form and format agreed to by the University 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 sorting 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 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."

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NONDIGITAL 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 size distributions (in tabulated form)	–	Roughly for 100 samples, total of 9 parameters	N/A	Yes	October 1978 to June 1978	July 1979
Heavy mineral number % (in tabulated form)		Roughly 30 samples, a total of possible 20 parameters	"	"	January 1979 to July 1979	August 1979
Clay mineral weighed peak area % (in tabulated form)	–	About 30 samples, 10 parameters	"	"	October 1978 to March 1979	May 1979
Organic carbon and nitrogen (μg/g, in tabulated form		About 120 samples - total 3 parameters	"	"	October 1978 to May 1979	June 1979
Concentrations of suspended particles (mg/ℓ, in tabulated form)		About 120 samples - total one parameter	"	"	October 1978 to February 1979	March 1979
Wave-current-turbidity -temperature data as obtained from the SDS unit, and tabulated		Time series data averaged to 15 mins. input for almost 2 months-total of 8 parameters	"	"	October 1978 to January 1979	February 1979

* For digital data submissions, see XVII Standard Contractual Statements, #'s 1,5,6,7.
All digital data processed onto tape by R.U. 350.

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 Institute of Marine Science PRINCIPAL INVESTIGATOR A. S. Naidu

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.
   Beaufort Sea Continental Shelf, between Cape Halkett and Prudhoe 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. At each station 1 to 2 liter water samples will be collected for measurement of suspended loads. Occasionally grab sediments will be taken.

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.)

   One cruise only; 10-15 days in the first two weeks of August 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.)

   10-15 days (to participate in one leg)

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback? My investigation will be part of a round-the-clock multidisciplinary investigation.
   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.
   A total of 3 hrs/day on a 24-hr basis. Between 1/2 to 1 hr. will be the sampling time at each station

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

   Trained MST help and two 2-5 litre Niskin water samplers will be needed.

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

   Maximum 500 lbs.

8. Will your data or equipment require special handling? Yes If yes, please describe. Operation of a heavy wind may be necessary for sediment sampling.

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. Yes, a U.S. Coast Guard ice-breaker ship is the only acceptable, because of possible heavy pack ice conditions.

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? As in the past, the U.S. Coast Guard could come up with the ship time at no cost to OCSEAP.

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 or two. Dr. Naidu and his student (TBN) will participate. Dr. Naidu is a citizen of India, with permanent resident status in the U.S.A.

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.)

   Airlifting of personnel and equipment from Pt. Barrow or Deadhorse and back. Helicopter support will be needed to collect samples, and possibly to emplace the SDS unit in the Simpson Lagoon.

2. Describe types of observations to be made.

   None

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.)

   None

4. How many days of flight operations are required and how many flight hours per day?
   2 hrs/day for 6 days.

   Total flight hours?
   10 hrs.

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?

   My investigations will be the principal one.

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. The SDS unit will weigh about 1000 lbs. If necessary, it needs to be lifted from the lagoon shore and gradually unhooked in the lagoon.

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

   Maximum 1000 lbs.

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

   Don't know

9. Do you recommend a source for the aircraft? N/A
   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)?

    Between 2 to 3

12. Where do you recommend that flights be staged from? Deadhorse, Point Barrow, Oliktok Point, Milne Point or Helmerick's place in Colville Delta.

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).

   Helmerick's place on Colville Delta: Between July 26 and August 10th, 1978; for two scientists on discontinuous basis; 10 days.

   Deadhorse: August 1st week and September 2nd week; 3 days each time for two scientists.

   Milne Point: Between August 1 to September 25th, 1978 on a discontinuous basis; total of one month; three scientists.

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

   OCSEAP Arctic Project Office, Fairbanks.

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

   Between $40-50/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?

   Reasonable guesses based on current rates.

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?

It is most critical that the SDS unit consisting of an instrumented tripod package be transported with utmost care to the experimental site in the Simpson Lagoon by August 1, and retrieved before icing forms in the lagoon (say around 2nd week of September). Presumably the transport of the SDS can be handled satisfactorily either on the deck of the *Alumiak* or by helicopters from the Simpson Lagoon shore. In the latter case, the SDS unit will be transferred from Deadhorse by OCSEAP truck. Delays in the transportation of the SDS will adversely effect the Sediment Dynamics program.

MILESTONE CHART

O - Planned Completion Date
X - Actual Completion Date

R.U. # 529 P.I. A. S. Naidu

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
Report on the field work and participation in the Beaufort Sea cruise	X												X		
Size distribution data on sediments							O			X					O
Heavy mineral contents in sands										X					
Clay mineral contents in clays		O			X										
Organic carbon contents in suspensates						O	X							O	
Nitrogen contents in suspensates					O	X								O	
Sand transport directions and sources										X					
Clay transport directions and sources		O			X										
Threshold of sediment movements							O			X					O
Sediment Dynamics Sphere basic data		O		X											
First Quarterly Report				X											
Second Quarterly Report							X								
Third Quarterly Report										X					
Final Report*															X

*Submission of the Final Report will have to be extended well beyond September 30, 197~~8~~9 when the funding closes, to incorporate 1979 Summer data.

Date: 6/26/78
Contract: 03-5-022-56
Task Order: 34
R.U. No.: 530
Proposal No. OCS 79-5

Renewal Proposal FY '79

to

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

THE ENVIRONMENTAL GEOLOGY AND GEOMORPHOLOGY OF THE BARRIER ISLAND-LAGOON SYSTEM ALONG THE BEAUFORT SEA COASTAL PLAIN

R.U.:	530
Total Cost:	$36,622
Lease Area:	Beaufort Sea 100%

College of Environmental Sciences
University of Alska
Fairbanks, Alaska 99701

P. J. Cannon, Principal Investigator
Department of Geology
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7809

V. Alexander, Dean
College of Environmental Sciences
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7941

A. B. Frol, Director
Administrative Services
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7340

Keith B. Mather
Vice Chancellor for Research and Advanced Study
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7282

FY 79 RENEWAL PROPOSAL

I. Title: The Environmental Geology and Geomorphology of the Barrier Island-Lagoon System Along the Beaufort Sea Coastal Plain

Research Unit Number: #530

Contract Number: #03-5-022-56

Proposed Dates of Contract: October 1, 1978 thru September 30, 1979

II. Principal Investigator: Dr. P. Jan Cannon

III. Cost of Proposal for FY 79:

A. $36,622

B. None

C. $36,622

D. 100% Beaufort Sea

IV. Background:

The stability of various landforms which comprise the natural habitat is extremely important to the ecology. The stability of the various landforms is directly related to the natural geomorphic processes which occur in the area. The natural geomorphic processes must first be identified and second, their magnitude and intensity determined. This is done in order to establish a reference of the natural conditions. The reference is needed so that the effects of lack of environmental control or (just as harmful) the effects of unnecessary environmental control can be assessed. The natural conditions must be known before they can be maintained for the sake of the ecology.

Previous research indicates that there are two types of islands: gravel islands and tundra islands. However, the materials which make up the islands have a common source, the coastal plain. Previous research also indicates that the lagoons are created by the enlargement of coastal plain lakes. The direction of future research is dictated by the previous research. Since the lakes on the coastal plain are important to barrier island-lagoon development, the rates of natural change and the processes involved are important factors to be studied. The previous research has further indicated that the streams which enter the lagoons are important to the geomorphology and the ecology of the system. These streams and their importance can be best studied by looking closely at the deltas at their mouths. Deltas are very delicate landforms which respond easily to natural processes and record the intensity and magnitude of the natural geomorphic processes which are occurring in the system. Therefore, future research will include a very close look at the deltas, both qualitative and quantitative.

Previous investigations have indicated that there is apparently a corresponding vertical drop in land surface with the horizontal retreat of shorelines. The magnitude and rate of the vertical change is unknown. Future study will look at this change because if it is large enough, it could play a very important part in maintaining the natural ecological conditions.

V. Objectives:

1. To determine the origin and stability of the barrier island-lagoon system.
2. To identify the natural geomorphic processes involved in creating and maintaining the natural physical environment.
3. To determine the rates of natural change in features due to natural processes.
4. To provide baseline information that can be used to predict and assess environmental impact in an unbiased manner.

5. To provide geomorphic information that can be used to establish guidelines for land use and resource management.
6. To compile information that can be used to construct a model which can be manipulated to indicate long and short term changes both naturally or as the result of development.

The purpose of the scientific objectives is to establish information which will be displayed or discussed in the products. The objectives specifically approach areas of unknown data and parameters needed to make an environmental assessment of the Beaufort Sea Continental Shelf. The products, reports, maps and tables provide information about the scientific objectives which can be drawn on as needed to help in decision-making prior and during leasing and development.

VI. Strategy and Approach:

There are two basic aspects behind the strategy of this proposal: 1) expand information learned in the Simpson Lagoon area to the rest of the lease area, and 2) fill in the presently existing information gaps about geomorphic processes and the rates of natural change. The following is a list of the basic methodology:

1. Interpretation of aerial photographs, radar imagery, landsat imagery, thermal infrared imagery and other satellite and aircraft data.
2. Ground reconnaissance on foot and boat.
3. Low altitude aerial reconnaissance. This is a very important part of the ground truth measurements and map verification.
4. Literature evaluation.
5. Exchange of data with Dr. A.S. Naidu. This has been very helpful in previous research.

6. Quantitative and qualitative analysis of the deltas in the area.
7. Comparison of sequential data.
8. Compilation of a landforms map of the region.
9. Analysis of the geomorphic setting of the lease area.
10. Compilation of shoreline erosion maps for the rest of the islands, the coast, and the important lakes.
11. Analysis of the future results of natural processes and man-induced effects.
12. Construction of an environmental process map.
13. Make an evaluation of the remote sensing techniques best suited for various aspects of the project.

The natural changes in the barrier island-lagoon system and the coastal plain will be determined using aerial photographs taken over a 25-year period, sequention landsat imagery and other satellite and aircraft remote sensing data. Field studies of geomorphic processes and the interpretation of remote sensing data will provide information concerning the origin and stability of the barrier island-lagoon system and the importance of the adjacent coastal plain. Information generated by this project will be interfaced with the work done by other research units in order to expand the usefulness of the information and to verify interpretations. Interpretations will be based on the information collected and analyzed, therefore, it is expected that interpretations will evolve as new data is acquired. The direction of research will be continually focused towards the objectives necessary for the environmental assessment of the Beaufort Sea Continental Shelf.

A. Sampling Methods: Not applicable, see above.

B. Analytical Methods: Not applicable, see above.

VII. Deliverable Products:

A. Digital Data: None

B. Narrative Reports

Special report topics will include the rates and processes behind the natural retreat of the shorelines. Also a special section in the annual report will present the quantitative and qualitative study of the deltas. A special report is planned concerning the applicability of various remote sensing techniques to the research problems in the lease area.

C. Visual Data

Maps showing landforms, erosion rates and processes will be constructed. It is expected that several photographs and tables of information will be used to help convey the magnitude of various processes. The physical size of the maps will be kept to page-size in order to aid in reproduction. The scale of some of the maps will be large, therefore, the areas will be broken into segments that can be shown on page-size maps.

D. Other: None

E. No digital data will be produced by this R.U. (see Milestones)

VII. Quality Assurance Plan:

The principal investigator always uses prior planning in all aspects of research. The principal investigator is a multi-rated pilot and an experienced arctic field geologist, therefore, no reason exists for other than quality and timeliness in the investigation.

IX. Specimen Archival: Not applicable

X. Logistics Requirements: See attached forms

XI. Anticipated Problems: Contingency Plan

In the event that field information suffers from the effects of weather, a heavy reliance will be placed on information from remote sensing techniques and data from other research units. An unexpected lack of remote sensing data will be compensated with increased field work. This project does not rely on any instrumentation used in the field so those types of problems will not occur.

XII. Information Required from other Investigators:

Information from other investigators has been a tremendous help in previous investigations. The type of information from other investigators which is useful is quite diverse. Information about water and weather from the biologists is useful to the process studies. Physical parameters from the oceanography group provides data which can be used to determine rates of change. Observational and sedimentation information from Dr. A.S. Naidu, R.U. # 529, will be used to verify processes and to supplement information problem areas such as sediment volumes.

XIII. Management Plan:

See milestones chart. At the close of the summer the amount of data to be analyzed is at its peak. Remote sensing data is collected by various sources throughout the summer. A major fall project is finding and acquiring all the various types of remote sensing data that was taken. Throughout the winter the remote sensing data is carefully studied and measured. The quantitative and qualitative studies are completed for use in the annual report. In the spring the field work for the summer is planned. Field work must be carefully planned for optimum use of time and resources. Field work in the summer is used to fill in information gaps and to verify previous interpretations.

XIV. Outlook:

The final products will be information sources for environmental assessment of the study area. The information will indicate the present natural conditions and indicate what is to be expected as a result of natural changes. The final products will contain the information needed to determine the impact on the natural conditions as a result of the lack of environmental controls and adverse accidents related to development. Significant results will be the rates of horizontal and vertical changes, and a method to predict the future of these changes. Future efforts should include a lagoon by lagoon study along the Beaufort Sea coast. The previous work indicates that the Simpson Lagoon is not representative of the other lagoons. A closer look at the effects of ground water flow on the lagoons should be considered in the future. A future problem would be to integrate the geomorphic data collected with long range weather information, both past and future.

One significant problem is the reason for actual barrier island chain location. Additional equipment is not needed but additional photographic data would have to be acquired. The cost for these projects beyond FY 79 would be on the order of $80,000 per year. A considerable portion of the funding would be spent on detailed field work.

XVII. 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 IX 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 XIII 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 this R.U. 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 Plan. 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 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 sorting or other laboratory procedure." NODC Taxonomic Code will be used where appropriate for FY '79 data submission.

g. 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.

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.

B. AIRCRAFT SUPPORT - FIXED WING

P. Jan Cannon

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.)

One flight from Deadhorse to Flaxman Island and return

2. Describe types of observations to be made.

Low-altitude photo-recon

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.)

Anytime coast is ice-free

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

Total flight hours?

One flight operation/8 flight hours/one day--8 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?

No--can be piggybacked

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.

N/A

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

Cameras and film - less than 20 kilograms

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

Large single engine

9. Do you recommend a source for the aircraft? No
If "yes", please name the source and the reason for your recommendation.

N/A

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

Unknown

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? Deadhorse

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).

Deadhorse to Flaxman Island

2. Describe types of observations to be made.

Close observations of processes on islands

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

Anytime that the islands are ice-free

4. How many days of helicopter operations are required and how many flight hours per day? Two days of operation/5 hours per day

Total flight hours?

Total of 10 flight hours

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?

Less than 20 kilograms

7. What type of helicopter do you reommend for your operations and why?

Two engine for safety

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?

Unknown

10. Where do you reommend that flights be staged from?

Deadhorse

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) Deadhorse
   b) July and August
   c) 2 persons/day - total of 12 days

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?

   $50.00/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?

   Based on previous field experience in the Arctic

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?

   Special logistics problems concern the acquisition of remote sensing data. These problems will be handled mostly by the P.I.

MILESTONE CHART

0 - Planned Completion Date

X - Actual Completion Date

RU # ___________ PI: P. Jan Cannon

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
Analyze summer field data	0														
Complete collection of previous summer and fall remote sensing data		0													
Complete measurement of island erosion rates			0												
Complete measurement of coastal erosion rates					0										
Compile annual report on previous summer's field data analysis & calculated erosion rates						0									
Complete study on river deltas concerning impact and natural processes							0								
Complete study on the evolution of the lagoons and the coastal plain lakes								0							
Plan field documentation program for July and August									0						
Field documentation of geomorphic processes and rates of change										0					
Field documentation of unstable zones and verification of map units											0				
Review of summer field work												0			
Complete drafting of maps												0			
Complete final report on stability of islands and coastal plain													0		

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

Proposal Date: 26 June 1978
Contract #: 03-7-022-35182
Task Order #:
NOAA Project #:
Institution ID#:

FY 1979 RENEWAL PROPOSAL

Research Unit Number #531

TITLE: Oceanic Processes in a Beaufort Sea Barrier Island-Lagoon System and its Surroundings: Numerical Modeling and Current Measurements

Cost of Proposal: $ 69,884 Lease Area: Beaufort Sea 100%

Period of Proposal: 1 March 1979 to 28 February 1980

Principal Investigator

Christian Mungall

J.C.H. Mungall, Ph.D.
Principal
Kinnetic Laboratories, Inc.
One Potrero St.
Santa Cruz, CA 95060
(408) 423-6830

22 June 1978

Required Organizational Approval

Philip D. Carpenter

Philip D. Carpenter, Ph.D.
Vice President
Kinnetic Laboratories, Inc.
One Potrero St.
Santa Cruz, CA 95060
(408) 423-6830

22 June 1978

Organization Financial Officer

Marylee Kinney

Mary Lee Kinney
Controller
Kinnetic Laboratories, Inc.
One Potrero St.
Santa Cruz, CA 95060
(408) 423-6830

22 June 1978

IV. Background

The work proposed here is of relevance to two principal groups. First, as specified by the NOAA OCSEAP Arctic Project Office, the prime responsibility of the Physical Oceanography Research Units is to support the Biological Studies by providing the appropriate physical data. Secondly, the Physical Oceanography Research Units must, through interaction, be responsive to the needs of the Bureau of Land Management. Accordingly, the research undertaken to date commenced with studies limited to Simpson Lagoon and its immediate surroundings. The studies are currently being expanded in the spatial sense to include areas outside Simpson Lagoon both by numerical modeling and by field investigations. Specifically, numerical models have been written that cover the region from the west of Harrison Bay to near Flaxman Island --- a distance of some 200 km. During the 1978 field season, besides assisting the biological party with both hydrographic surveys and with providing a continuous readout of lagoon wave heights, currents and water quality, efforts are being directed towards conducting drifter tracking experiments both inside and outside of Simpson Lagoon. This latter effort should provide much needed information concerning the current field between Prudhoe Bay, the mouth of the Colville River, and the west side of Harrison Bay.

The research proposed for 1979 represents a direct extension of the above work. It appears that the biological research is being faced with two questions: 1) what is the source of the water that flows into Simpson Lagoon, and 2) is Simpson Lagoon typical of the Beaufort Sea nearshore environment? The first of these questions is the subject of our present work. The second question requires several short-term investigations of selected atypical nearshore sites. The latter mobile approach requires that our Physical Oceanography Research Unit 531 follow, as much as possible, the movement of the biological group.

The proposed research addresses not only the problems of the biological group, but also includes work of perhaps of more direct interest to the Bureau of Land Management---the estimation of surface currents and of horizontal eddy diffusivities. Several groups have pointed out the lack of knowledge concerning the variability of long shore currents (Beaufort Sea Synthesis Report [Draft], 1977, page 41; Comments on Draft Beaufort Sea Synthesis, 1977; Beaufort Sea Synthesis Report, 1978: Physical Oceanography and Meteorology [Draft], 1978, page 49). It is interesting to note that in all three of the above reports mention is made of the need for more information concerning cross-shelf variations and concerning cross diffusion. Obviously such knowledge is of prime importance when estimating the spread of a pollutant.

A summary of the proposed research is given in the section that follows.

V. Objectives

The direct objectives of this project are:

1. The support of the biological group in their physical oceanographic data needs, and
2. The provision of certain key items of physical oceanographic knowledge as needed by the Bureau of Land Management.

The indirect objectives --- the subject of this proposal --- are as follows:

1. Field investigations in the vicinity of those sites (yet to be determined) selected by the biological group for study,
2. Drifter tracking in both the Beaufort Sea lease area (Flaxman Island to the west end of Simpson Lagoon and in that part of Harrison Bay off the mouth of the biologically-important Colville River),
3. A concurrent precision drifter tracking experiment to be conducted over smaller special scales than above and over a period of several days with the objective of obtaining the local horizontal lagrangian eddy-diffusivities as needed for realistic dispersion modeling,
4. Offshore hydrographic measurements, using the R/V Alumiak or equivalent, as needed to support both our drifter measurement and the eulerian current measurements of J.B. Matthews and K. Aagaard,
5. The establishment of one nearshore structure, at a site or sites yet to be specified, with the capability of providing continuous readouts of currents, wave height, and water quality, and
6. Numerical modeling will be used to assimilate previously obtained measurements. The development of the four (4) available numerical models (2- and 3-dimensional models applied to both Simpson Lagoon and the entire lease area) will be frozen, and all funds will be directed towards model verification and to mission-oriented investigations.

The relevance of the above goals is as follows:

1. The presence of a physical oceanographer with the biology group will serve to assist the biologists with meteorological and physical oceanographic data measurements, or in interpreting (so far as is possible) any phenomena of a physical origin.
2. Drifter tracking will provide expressive data concerning the current regime in the Beaufort Sea lease area. Such

information when combined with the current measurements of other research units and with numerical modeling results, should significantly increase our knowledge of the variation of currents with distance offshore. Such knowledge will greatly assist those concerned with navigation and with the movement of sediment, contaminants, and plankton.

3. A realistic assessment of horizontal eddy-diffusivities for the lease area is vital if meaningful dispersion modeling is to be performed. All too frequently the modeling of contaminant dispersion looses much credibility on account of the guesswork involved in the eddy-diffusivities. A series of measurements, even if only conducted over several days --- and their not necessarily fully representative of all typical conditions --- will represent a positive step towards more realistic modeling.

4. Hydrographic measurements are essential for helping the interpretation of the various current measurements. It is hoped that research unit 526 will assist in this important task.

5. The instruments to be used on the proposed portable structure have already been purchased under the NOAA contract. Use will be made of these instruments, either to support the mobile biological group, or, if deemed appropriate, to support those involved in sediment transport investigations.

6. To this date, due to the limited availability of data, efforts have primarily been directed towards developing a suite of numerical models for Simpson Lagoon and the lease area. (An exception has been the calculation of the likely, but unverified, volume exchange rates and the trajectories for Simpson Lagoon). At the commencement of FY 79 in March 1979, we will be in a position where we can start making use of the data gathered over 2 years (and to be gathered in 1979) to calibrate the 4 models and to commence using these as tools. We expect that the Bureau of Land Management will wish to avail themselves of these models by making requests for certain studies--- trajectory modeling, diffusion modeling, etc. Not only can the Bureau of Land Management thus play a direct part in making use of its previous research monies, it can also participate in providing contingency models as may be needed by other agencies.

VI. General Strategy and Approach

The need for one party of physical oceanographers to support the mobile biological group while drifter tracking is to be carried out is a tough but not insurmountable problem. We see close co-operation between the selection and, particularly, timing of the biological site visits, and between the orderly release of drifters as being crucial. At this point a brief discussion of drifter tracking is desirable.

Drifter tracking, as mentioned in section XVI (Outlook) of the 1978 proposal of research unit 531, could be accomplished by satellite-tracked buoy at around $3,000 to $5,000 each. While still maintaining the importance of such an approach, we suggest that a more conservative approach would be to use radio-beacon equipped drifters, at a cost of some $200 each, to be tracked by 2 radio direction finding (RDF) stations. Drifter deployment would be simplified, a larger number of drifters could be deployed, and the consequences of the grounding or "ice-trapping" of drifters would not be so serious.

A useful summary of the technique for RDF tracking of radio-beacon equipped drifters is to be found in Murray et al (1975). Use of beacons with 4 to 6 MHz frequencies permits over-the-horizon tracking from two bases equipped with RDF sets, each consisting of a loop antenna, receiver, and digital output of bearing and frequency. For safety in remote locations, the mobile stations require 2 persons. The stations should be located so as to produce bearings whose intersections are as close to being perpendicular as possible --- requiring thus logistical support by float plant, helicopter, or boat.

The manufacturer of the drifters, W. Whelan of Telecommunications Enterprises, Inc., is currently working on the design of an air-droppable radio-beacon equipped drifter scheduled for production in 1979. We feel, however, that in order to ensure a large enough subsurface to surface drag ratio (to eliminate wind caused errors) we must ensure the use of large vanes. This requirement seems to indicate the need for deployment from the sea surface. Since the drifters may have to be released some 10 miles from shore, use of a vessel such as the R/V Alumiak seems mandatory. The availability of such a vessel for 3 weeks will furthermore permit study of the prevailing hydrography and (with high-precision navigation relying on shore-based transponders) will permit lagrangian dispersion studies to be performed.

We therefore envisage the following:

1. For a period of 2 months, two RDF groups will be in the field between Harrison Bay and Flaxman Island. The base RDF group will be with the biological camp, while the mobile RDF group will be sited, using OCSEAP logistics support, so as to produce suitable bearing intercepts. Drifter deployment will be from the R/V Alumiak for a

period of 3 out of the 9 weeks. Other means (probably air) will be used for the remaining 6 weeks. Obviously considerable attention must be paid to coordination between the biological group, the Research Vessel, the OCSEAP air logistics group, and the RDF groups. Adequate radio communication is essential.

2. For a period of 3 weeks, hydrographic data will be taken from the R/V Alumiak.

3. During the 3 week period during which the R/V Alumiak is available, 5 days will be devoted to a precision drifter tracking experiment for the purposes of ultimately computing lagrangian eddy-diffusivities. The ship will locate each of 10 beacon-equipped drifters using RDF information provided from the shore. Each drifter will have to be visited in turn. As a drifter is passed, the ships position will be ascertained by the KLI range-range Motorola Miniranger III. It is possible that the transponders may have to be relocated periodically to ensure adequate spatial coverage. Necessary height for the mobile antenna is achieved by use of a tethered balloon.

Numerical modeling --- consisting primarily of production runs using 4 previously-developed computer programs --- will be conducted. The four models are:

1. 2-dimensional Simpson Lagoon model
2. 3-dimensional Simpson Lagoon model
3. 2-dimensional Lease Area model
4. 3-dimensional Lease Area model (with or without 'rigid lid')

We will bring together, as desired, R.E. Whitaker (from Texas A & M), J.B. Matthews and R. Callaway for the purpose of integrating the data in and around Simpson Lagoon with the model. Experiments will be conducted as requested by NOAA and the Bureau of Land Management. Diffusion coefficients as computed during the tests above will be used to study any desired scenarios. We see this as the logical conclusion to the first three years of the project.

VII. Sampling Methods

Sampling methods are described in the above sections and are designed to provide input to numerical hydrodynamic models as part of this project.

VIII. Analytical Methods

Besides general oceanographic interpretations, the data will be used as input to hydrodynamic models as part of this project.

IX. Deliverable Products

1. Narrative Reports: As required of all OCSEAP projects. Methods and results of measurements and modeling of the circulation regime inside and outside Simpson Lagoon; particularly flow rates through various sections in the lagoon system and between barrier islands. Drift paths from buoys and wave measurements.

2. Digital Data: Current, conductivity, temperature, wind and wave data collected during summer.

3. Visual Data:

   a. Computer displays of currents at various depths inside and outside Simpson Lagoon under different wind and river discharge conditions.

   b. Displays of surface and bottom salinities under various environmental conditions.

   c. Displays of particle tracks at different depths under various environmental conditions.

   d. Plots of current, conductivity and temperature data.

X. Quality Assurance

All instruments will be calibrated and all data checked according to professional standards of the principal investigators and of NOAA.

XI. Archival Plans

No samples are to be taken that require archiving.

XII. Logistic 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)
Physical Oceanography--hydrographic; waves; drogue tracks; computer simulations.	TAPES	-	-	no	1 Mar 79 to 28 Feb 1980	1 Mar 80

1. Narrative Reports: As required of all OCSEAP projects. Methods and results of measurements and modeling of the circulation regime inside and outside Simpson Lagoon; particularly flow rates through various sections in the lagoon system and between barrier islands. Drift paths from buoys and wave measurements.

2. Digital Data: Current, conductivity, temperature, wind and wave data collected during summer.

3. Visual Data:

   a. Computer displays of currents at various depths inside and outside Simpson Lagoon under different wind and river discharge conditions.

   b. Displays of surface and bottom salinities under various environmental conditions.

   c. Displays of particle tracks at different depths under various environmental conditions.

   d. Plots of current, conductivity, and temperature data.

XII. 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 Kinnetic Laboratories, Inc. PRINCIPAL INVESTIGATOR Dr. J.C.H. Mungall

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.

R.V. Alumiak; Harrison Bay to Flaxman Island (to about 10 mi. offshore)

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. -- Launch, tracking and recovery of current drogues with RDF beacons. Hydrographic casts with self-contained STD system.

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.)

3 weeks out of 8-9 week period during July and August 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.)

Daily trips, 5 days of this 3 week period may require night (24 hr) operations.

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback? Principal, due to requirement to move with drogues for the 5 day period. Can be coordinated with other programs rest of 3 weeks
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.

12 normally

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

Ship operator.

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

350 lb; 18 ft^3 in pieces.

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.

R.V. Alumiak or equivalent

---

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?

Not known at present

---

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, no foreign nationals

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.)

Harrison Bay to Flaxman Island (inshore)

2. Describe types of observations to be made.

Transportation of field crews; drop off current drogues in areas of quieter water.

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.)

Periodically (about 1 trip/week of about ½ day), 8 weeks July and August 1979.

4. How many days of flight operations are required and how many flight hours per day?
approx. 8 days
Total flight hours?
4 hrs/day = approx. 32 hrs.

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?

Cooperative work can be arranged.

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.

NONE - float plane must land.

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

150 lbs, 4 ft. lengths maximum

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

180 on floats or equivalent

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

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

$90/hour

11. How many people are required on board for each flight (exclusive of flight crew)?
2

12. Where do you recommend that flights be staged from?
As convenient to OCSEAP logistics

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).

   Harrison Bay to Flaxman Island (inshore)

2. Describe types of observations to be made.

   Transportation of field crews; drop off current drogues offshore (up to 10 mi.)

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

   Periodically about four 3 hr trips during July & August 1979.

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

   Total flight hours?
   2 hrs/day = 8 hrs

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

   One for drogue drop off. Two for crew relocation. = Three total.

6. What are the weights and dimensions of equipment or supplies to be transported?

   150 lbs., 4 ft. maximum length.

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.

   OCSEAP; logistic and coordination ease.

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

   $550/hour

10. Where do you reommend that flights be staged from?

    As convenient to OCSEAP logistics.

11. Will special navigation and communications be required?

    NONE

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).

4 people for 8-9 weeks split between biological field camp and mobile camp using OCSEAP logistics. Field scheduling of drogue drops and of subsequent mobile tracking camp location can be somewhat flexible depending upon OCSEAP logistic restraints.

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

OCSEAP

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

$20/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?

Ref: Ted Flesker

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?

Coordination and communications between shore based RDF units and the R/V Alumiak will be required for the 3 week period that the ship is being utilized. Periodic movement of the mobile RDF team by available OCSEAP logistics (the ship, float plane, or helicopter) will be necessary.

Other means (probably air) will be needed periodically during the other 5-6 weeks (about 1/week) to drop drogues off (helicopter use for outside lagoon placement), and to periodically move the mobile camp. Communication and coordination between the biological group, the OCSEAP air logistics group, and the RDF groups will thus be necessary to work around the expected weather complications.

XIII. Anticipated Problems

Coordination and communications problems as discussed above under special logistic problems will occur to some extent. The flexible schedule for field operations should prevent these, and associated weather problems, from seriously reducing field results.

XIV. Information Required from Other Investigators

Current meter data being obtained by Dr. Matthews and Dr. Aagaard will be used to check modeling. Contacts are made to obtain these needed data in time.

XV. Management Plan

This project will be managed by Dr. Mungall. Fiscal responsibility will be with Kinnetic Laboratories, Inc. A milestone chart is attached.

XVI. Outlook

The final result is to be an understanding of the physical oceanographic processes within the nearshore area of the Beaufort Sea along the Alaskan coast. This knowledge is to be embodied in a useful form for management purposes. This form is to be as numerical hydrodynamic models, verified by actual field data, and capable of simulating the physical oceanographic processes in the region.

As of this coming project year, these models will have been constructed and have been verified by some actual data.

It is anticipated that remaining efforts will involve the use of the models to simulate specific cases in order to solve applied problems or guide management decisions. In addition to model improvements or additions, the addition of an oil spill subroutine is anticipated.

Future field work should be aimed toward further verification, with particular emphasis upon measurements of turbulent diffusivities and the wind response of the very surface layer. A next year fiscal year cost of $70,000 would be anticipated.

0 – Planned Completion Date

X – Actual Completion Date

RU # 531 PI: Dr. J.C.H. Mungall

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
Start Project						✓											
Field Work										0	0						
Reports (Quarterly and Annual)								0			0			0			0

XVII. Standard Conditions

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 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." 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."

Date: 6/26/78
Contract: 03-5-022-56
Task Order: #32
R.U. No.: 537
Proposal No.: OCS 79-3

Renewal Proposal FY '79

to

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

NUTRIENT DYNAMICS AND TROPHIC SYSTEM ENERGETICS IN NEARSHORE BEAUFORT SEA WATERS

R.U. No.: 537
Total Costs: $56,691
Lease Area: Beaufort Sea, 100%

Institute of Water Resources
University of Alaska
Fairbanks, Alaska 99701

D. M. Schell, Principal Investigator
Institute of Water Resources
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7709

for Robert Carlson, Director
Institute of Water Resources
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7775

A. B. Frol, Director
Administrative Services
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7340

Keith B. Mather
Vice Chancellor for Research and Advanced Study
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7282

3. TECHNICAL PROPOSAL

I. TITLE

Nutrient Dynamics and Trophic System Energetics in Nearshore Beaufort Sea Waters.

Research Unit Number: OCSEAP RU #537
Contract Unit Number: 03-5-022-56
Proposed Dates of Contract: 1 October 1978 to 30 September 1979

II. PRINCIPAL INVESTIGATOR

Dr. Donald M. Schell, Assistant Professor, Temporary, Institute of Water Resources, University of Alaska, Fairbanks, Alaska 99701, (907) 479-7709.

III. COST OF PROPOSAL (for FY 1979)

A. Science: $56,691

B. P. I. Provided Logistics: None

C. Total: $56,691

D. Distribution of Effort by Lease Area: Beaufort Sea - 100%

IV. BACKGROUND

This proposal outlines work to be performed in direct conjunction and cooperation with OCS Research Unit 467, LGL Limited's Ecological Process Studies in the Beaufort Sea Barrier Island-Lagoon system. The proposed work below will be completely integrated with the LGL Limited-US proposal for 1978-1979 and will be a cooperative study with personnel of LGL and Dr. Don Schell of the Institute of Water Resources, University of Alaska. As such, the principal investigator will utilize LGL logistic facilities in the field and will participate in LGL sponsored workshops.

The primary goal for this research unit is to provide data on the coastal marine ecosystem energetics and nutrient cycles and identify critical aspects which directly or indirectly may be impacted by OCS development. The data acquired will be synthesized to relate directly to OCS development and will also be utilized in LGL modeling workshops to attain integration of the ecosystem process studies. As such, a degree of flexibility is incorporated to allow extension or site specific intensification of study effort as deemed desirable by the overall requirements of the LGL team. This coherency of effort has worked very well in the past year and has resulted in considerable evolution of this research unit. Thus, although this study was originally proposed to examine a specific aspect of primary production in nearshore under-ice waters, namely ice algae productivity, the emphasis has shifted toward the elucidation of the role of terrestrially derived organic carbon as an energy source to marine biota. The data summarized and presented below represent current "best estimates" of the relative magnitude of the energy sources driving the nearshore ecosystem and are being refined as more data are acquired.

V. OBJECTIVES

The overall objective of RU 537 is to describe the principal processes supplying energy (i.e. fixed carbon) to the biota of the Beaufort Sea coastal zone and to relate the various nutrient chemistry regimes observed to this production of energy. Both terrestrially derived and offshore derived nutrient sources are considered. The information obtained is for integration into the overall structure of the LGL Barrier Island study group, RU 467. Their modeling effort will relate this information to: 1) description of the overall ecosystem, 2) possible OCS direct impacts on the nearshore biota by offshore oil and gas development and 3) possible impacts on the nearshore biota caused by "upstream effects" on land which would change the character of terrestrial input of nutrients and/or carbon to the marine ecosystem via erosional processes or runoff.

Specific Objectives

The specific objectives of this research unit are as follows:

1. Establish mass balance relationships for particulate and dissolved nitrogenous nutrients beneath the winter ice cover in the nearshore Beaufort Sea.
2. Compare standing stocks of epontic algae in relation to under-ice water circulation.
3. Collect data delineating temporal and spatial variability in ice algae blooms in the nearshore Beaufort Sea.

The data requirements of the LGL-Barrier Island study group have identified and necessitated the inclusion of the following objectives relating to the nutrient and energy inputs to the coastal marine ecosystem:

4. Determine the total inputs of energy to the coastal ecosystem including allochthonous carbon and nitrogen entering the system *via* terrestrial runoff and coastal erosion.
5. Relate the observed patterns in nutrient availability over the annual cycle to the heterotrophic utilization of detrital carbon within the coastal ecosystem.
6. Determine to what extent the detrital carbon is passed up the food chain and the relative significance of the various energy inputs to specific higher organisms in the coastal Beaufort Sea.

VI. GENERAL STRATEGY AND APPROACH

Introduction

Photosynthetic primary production in the nearshore Beaufort Sea, as elsewhere in the biosphere, is the principal source of energy and incorporated nitrogen and phosphorus for higher trophic levels. However, unlike coastal waters in more temperate latitudes, primary production in the Arctic Ocean is rigorously controlled by extreme seasonal variations in light intensity and to a lesser extent by the physical and chemical structure of the water column. In addition, the mechanisms of algal productivity in the coastal Beaufort Sea are unlike temperate waters where water column stability is critical to the onset of the spring bloom. In the Arctic, the spring bloom commences when winter conditions are greatest as typified by maximum ice thickness and minimum water temperatures. The primary production does not begin in the water column but instead occurs as a layer of epontic algae on the underside of the ice. Studies by Alexander *et al.* (1974) documented the ice algae layer and concluded that the appearance of ice algae populations is triggered by the attainment of critical light intensities in the spring, usually in mid-April. Little is known, however, of the extent to which ice algae cover the bottom of the nearshore ice sheet other than patchiness results from variable light attenuation caused by snow drifts on the surface of the ice. Epontic ice algae production reaches a maximum in mid-May and estimates by Clasby *et al.* (1976) based on a single sampling site off the Naval Arctic Research Laboratory at Point Barrow, indicate that the annual production at that location was approximately 5 g C/m^2-yr. Although this is a low amount by temperate standards, it represents a significant fraction of productivity in the nearshore Arctic. Ice algae production essentially ceases as the bottom of the ice sheet erodes in early June with the onset of melt. For the remainder of the summer, primary production by phytoplankton assumes the major role with additional production occurring in gravelly shallows by benthic algal communities. Instantaneous rates of production by benthic algal mats off Barrow were found to exceed the highest rates measured on ice algae or phytoplankton at the same location (Matheke and Horner, 1974) but the apparent need for a suitable substrate and critical light requirements probably relegate benthic production to a minor role in the overall annual primary production in these waters. Further quantification of benthic production in the shallows is desirable, however, to validate projections of productivity.

The nutrients required to support the annual cycle of primary production in the shallow bays and estuaries are derived from a combination of deep-water and terrestrial sources plus *in situ* regeneration. The relatively high organic and inorganic nitrogen concentration in the run-off waters of the Colville River during summer are believed to complement the high phosphate concentrations of the Harrison Bay-Simpson Lagoon areas and contribute toward balancing an apparent nitrogen deficiency in the nearshore Beaufort Sea waters (Schell, 1975; Alexander *et al.*, 1975). *In situ* regeneration of ammonia has been measured by Alexander *et al.* (1975) in summer and Schell (1975) has measured rates of under-ice ammonification in Simpson Lagoon waters. Schell (1974) has also measured nitrification and heterotrophic utilization of dissolved organic N with consequent release of ammonia in the under-ice saline waters of the Colville River.

Thermohaline Convection

The past work of Schell (1975) on Dease Inlet near Point Barrow has let to the formulation of a hypothesis that the spring epontic algal bloom may derive a large fraction of its nutrient requirements through a mechanism of thermohaline convection which serves as a "nutrient pump" into shallow waters. As the ice freezes on the bottom side of the ice sheet, the salt is excluded causing a localized increase in salinity and density at the interface. This denser water drains away and is replaced by fresher water. On a macro scale, the thickening ice sheet causes an increase in the salinity beneath the ice that is most pronounced in shallow bays such as Harrison Bay or Dease Inlet and the lagoon systems.

If communication is possible with offshore water, the hypersaline water drains out of the shallows along the bottom and is replaced by onshore flow beneath the ice. This onshore flow brings a fresh nutrient supply which is readily assimilated by the epontic algal community on the underside of the ice. Since ice accretion occurs until mid-May, this "nutrient pumping" process may be biologically beneficial for up to two months during the spring and the accumulated algal biomass may contain nitrogen and phosphorus in excess of that which would have been available in the water column beneath the ice had "nutrient pumping" not occurred. Recent work to delineate the extent of these processes has resulted in the complication of the simplistic model described above. Spring sampling in 1978 in Simpson Lagoon has revealed that sediment entrainment in the ice column may render the ice opaque to incoming radiation and prevent algal growth on the under-ice surface. Although full processing of samples is not complete, cores cut in late May 1978 contained large amounts of detrital material in the ice column at depths corresponding to October-November freezing. Only cores taken outside of Simpson Lagoon were clear ice top to bottom and had high concentrations of algae on the ice-water interface which may indicate that variability in autumn weather and consequent sediment suspension during storms may have a controlling effect on the following spring epontic algal blooms. Previous work in Simpson Lagoon and Elson Lagoon yielded high densities of ice algae and cores of clear ice which may indicate that this entrainemnt of detrital material is atypical. However, the addition of 1979 ice core data will be required to help establish the pattern of autumn ice accretion in these shallow waters. Thus the sampling effort to delineate ice algae spatial distribution will be extended into the 1979 spring season.

Detrital Based Production

The enhancement of biological activity in the proximity of land has been long recognized and attributed to various factors among which are the provision of suitable habitat for both benthic flora and fauna, substrate for macrophytes and input of terrigenous nitrogen, phosphorus and carbon via runoff from land. The arctic coastline provides very limited habitat for macrophytes or benthic infauna due to the 2-m freeze depth which effectively eliminates the shallow nearshore zone as a year-round environment for marine organisms. Again, in the deeper water, ice scouring creates sufficient habitat disturbance to account for the paucity of observed infauna. Below the 2-m contour in the bays and lagoons, however, large standing stocks of invertebrates - amphipods, mysids and isopods - are common and estimates by the LGS-Barrier Island Study (RU 467) personnel place the biomass at approximately 20 g/m^2 dry weight in Simpson Lagoon. These invertebrates are commonly found in close association with eroded organic material from the shoreline and studies by Broad (RU 356) have shown that certain gammarid amphipods and saduria do ingest and degrade the peat. This ingestion is probably accompanied by the removal and digestion of heterotrophic microflora and microfauna that are attached to the peat particles. Although it is known that the detrital material is ingested and that large number of invertebrates are associated with the organic material, as yet no conclusive evidence has been found indicating that the peat carbon is being assimilated either directly or indirectly by invertebrates or is being carried up the food chain to higher organisms such as fish or birds. Techniques by which we are currently investigating trophic dynamics are included in Section VII of this proposal.

Estimation of erosional input of nitrogen to Simpson Lagoon was first attempted by Schell (1975) using data obtained by Lewellen (1973). Coastal erosion rates were determined through the use of coastline aerial photography made in 1955 and again in 1972. Coastline retreat was utilized with field data on average shoreline relief and soil types to calculate total organic matter and nitrogen being eroded on an annual basis. This technique has been expanded by Rawlinson (RU 530) and the results are shown in Figure 1A which gives the relative carbon inputs to Simpson Lagoon. Approximately 80% of the carbon input to the lagoon system is from terrestrial runoff and 75% is derived from peat eroded from the shorelines. This material, which has an average C:N atom ratio of about 18.8 also represents an input of approximately 730 metric tons of fixed nitrogen to the lagoon system.

When extending these calculations to include the entire Alaskan Beaufort Sea coast, a mean erosional rate of 1.75 m/year and a coastal relief of 1.5 m was assumed, of which 1.0 m was peat materials. From the data available on the Elson Lagoon coastline near Barrow, and the Simpson Lagoon area, the estimates are felt to be about representative. The carbon budget for the nearshore zone as a whole is shown in Figure 1B. As in Simpson Lagoon, over 75% of the carbon input is from terrigenous material with 22% derived from marine primary production. Coastline erosion is responsible for approximately half of the total carbon input.

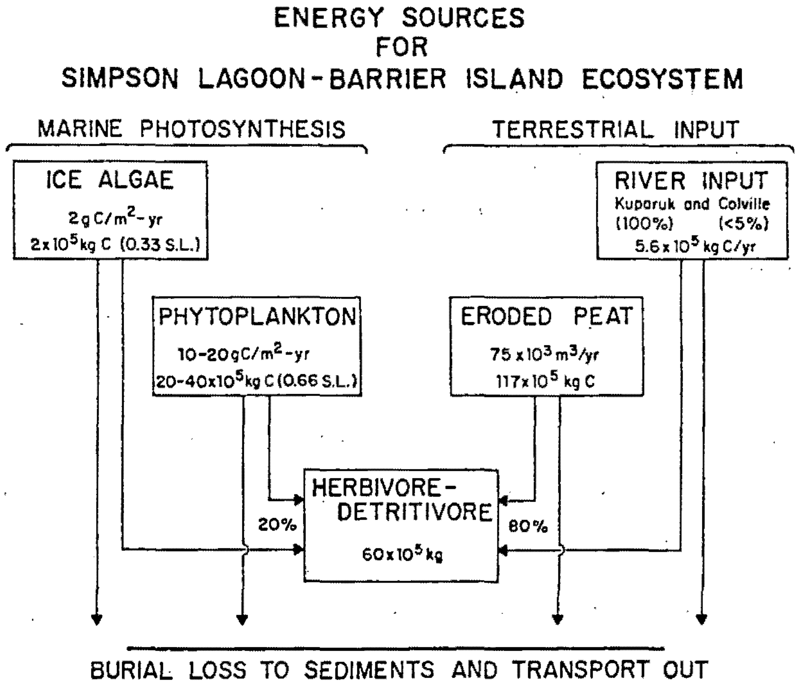

Figure 1A. Carbon input to Simpson Lagoon.

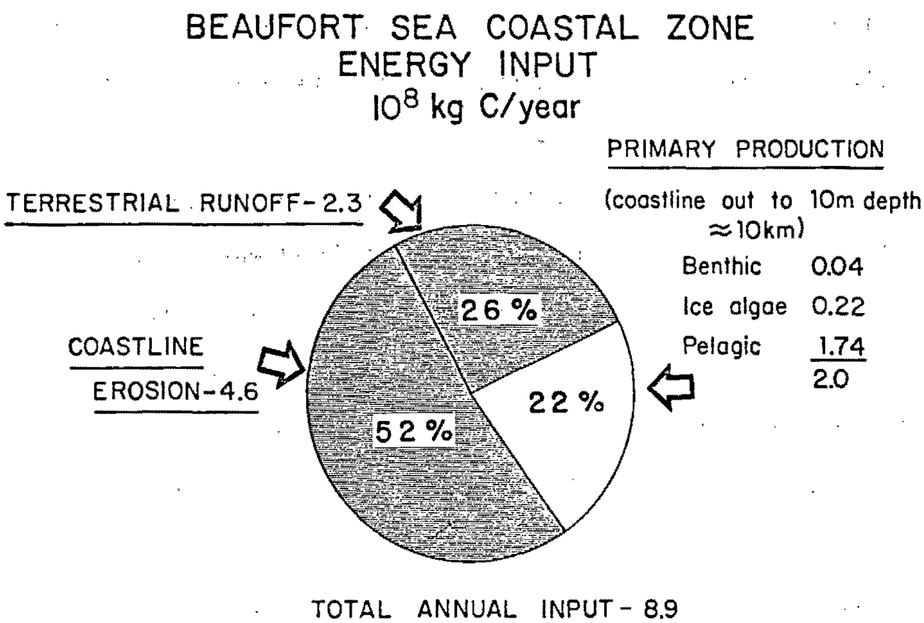

Figure 1B. Carbon sources of the nearshore Alaskan Beaufort Sea.

Accompanying this approximately 4.5×10^6 tons of carbon is an estimated 2.7×10^4 tons of nitrogen which, after mineralization by heterotrophic oxidation of the carbon, should supply a large fraction of the nitrogen requirements of the nearshore primary producers. The refinement of these estimates of input quantities and nitrogen content will be a major concern during 1979.

Phosphorus Uptake and Recycling

Although Schell (1975) has shown the nearshore Beaufort Sea to be apparently nitrogen limited, the high input of organic material in the estuarine zone with the consequent potential for heterotrophic activity has given evidence of a reversal of the typical offshore conditions in the shallow bays and lagoons next to eroding shorelines. Figure 2 shows the nitrogen/phosphorus ratios present in the water beneath the ice in Dease Inlet during April 1973 (Schell, 1975). The water column throughout the inlet and up the delta channels of the Meade River was saline as all freshwater inflow ceases by late fall. A pronounced phosphate depletion is apparent as the stations progress toward the head of the inlet without a corresponding depletion in nitrogen. The author believes that this phosphate consumption is due to intense heterotrophic activity in the detritus and since thermohaline convective processes are active throughout the winter, the eroded terrestrial material must act as sink for phosphorus. The fate of this phosphorus is unknown. If incorporation into the sediments does not occur, then at some period of the year, as yet unknown, regeneration and transport outward must be active.

Dr. Edward Brown of the Institute of Water Resources is collaborating with this part of the study and would continue to assist in the

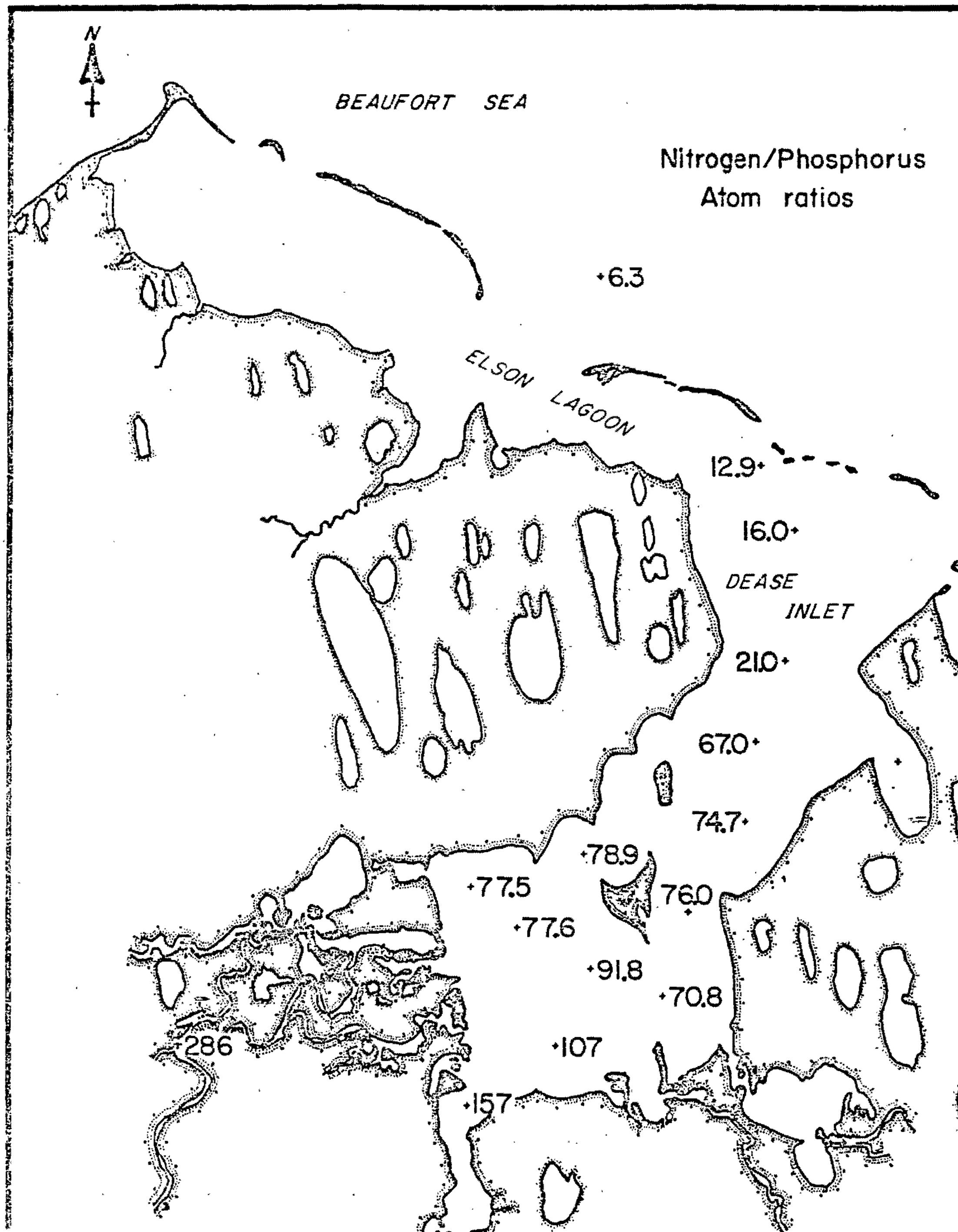

Figure 2. Dease Inlet nitrogen/phosphorus atom ratios in under-ice water, April 1973. Saline waters had intruded to the head of the Meade River delta (lower left) (from Schell, 1975).

phosphorus uptake and recycling studies. Through the use of carrier free radiolabeled phosphate it will be possible to follow the movement of phosphorus from the water column into the particulate phase and to quantitate the rates of transfer. Through the use of a combination of *in situ* and laboratory experiments in controlled environments, it should be possible to relate the pronounced changes observed in the natural system to the interactions of thermally convected offshore water with the detrital organic material. This information can then be utilized in assessing potential OCS impacts which would alter the nearshore circulation regimes or the input of terrestrial material to the coastal marine environment.

Winter Sampling

To acquire the necessary data on salinities and standing stocks of inorganic nutrients beneath the winter ice cover it is planned to conduct two winter sampling trips. The basic salinity-nutrient data will be collected in November by helicopter flights into the Harrison Bay-Simpson Lagoon area. Ice cores and water samples will be taken and analysed to acquire nitrogen, phosphorus and salinity budgets for the water column at that time. In April, the stations will be repeated to enable calculation of the extent of thermohaline convective exchange and changes between compartments of the inorganic nitrogen pools. Due to the severe weather prevailing during this period, all sampling will be designed for minimum time requirements on the ice. Furthermore, all efforts will be coordinated with LGL personnel and other OCS investigators seeking winter sampling opportunities.

VII. SAMPLING METHODS

Nutrient Chemistry and Ice Algae Production

The sampling program for ice algal production and spatial distribution occurs during the spring months and involves sampling the ice-water interface before and after the ice algae bloom. The first sampling period is during early April and yields the water chemistry data representing the maximum nutrient concentrations and salinities of the annual cycle. Ice cores and water samples are taken as logistics and weather allow. Samples are filtered and analyzed for inorganic nutrients and particulate nitrogen to yield a total nitrogen budget for the water column. Sample locations are located to give spatial data yielding densities and distribution of ice algae. Stations occupied to date have corroborated the contention that logistic restraints prevent site specificity in listing times and quantities of samples. The April 1978 sampling trip fortuitously occurred in ideal flying weather and all desired stations were occupied and the coverage extended beyond the original bounds. In May, however, whiteout conditions prevailed for several days and severely restricted flying over the ice. Approximately 70% of the desired stations were occupied although these had been prioritized and thus the essential sampling was completed. Projecting to Spring 1979, it is envisioned that the Simpson Lagoon-Harrison Bay area will be sampled on two occasions - April, prior to algal growth and late May during maximum ice algae production. On station, ice cores will be collected in duplicate or triplicate if deemed necessary due to heterogeneities in the ice column. Water samples will be collected from beneath the ice and at intervals in the water column when deep enough (>3 m) to warrant.

Stations will be selected from within the lagoon, outside the barrier islands and westward into Harrison Bay in the same locations as occupied this spring. Other stations will be included if flying conditions permit. To allow a much faster and more sensitive means of chlorophyll determination, we are requesting the purchase of a Turner Design Fluorometer in this proposal. This will allow rapid estimation of *in vivo* chlorophyll and *via* the simple expedience of collecting water samples and running them in the field or at base camp, a much more detailed description of phytoplankton distribution and ice algae densities will be possible. Although other Turner Design Fluorometers have been purchased on other OCS projects within the University of Alaska, the high demand on these instruments necessitates the purchase of this instrument for dedication to arctic work.

VIII. ANALYTICAL METHODS

Analytical methods employed for nitrate, ammonia and phosphate analyses are similar to those utilized by Alexander *et al.* (1974) for their ice algae studies. Dissolved organic nitrogen was run using the ultraviolet photooxidation technique employed by Schell (1974). Particulate nitrogen analyses were run on glass fiber filters containing aliquots of the melted ice cores or underlying water. The filtered samples were burned and the evolved nitrogen gas measured using a Coleman Nitrogen Analyzer.

By establishing detailed nitrogen budgets for the water column and ice column before and after the epontic algal bloom it is possible to determine two important facets of the nearshore productivity regime.

First, the total standing stocks of ice algae (and assimilated nitrogen) can be quantitatively described for the nearshore zone and the validity of extrapolating primary production measurements obtained by Clasby *et al.* (1976) at Point Barrow to include other areas of the Beaufort Sea coast can be determined. Second, by establishing budgets of nitrogen in the dissolved and particulate phase, the importance of thermohaline convective flow as a nutrient input in the nearshore zone can be estimated.

Utilization of Detrital Carbon and Transfer of Detrital Carbon in the Food Web

The magnitude of carbon input to the nearshore zone of Simpson Lagoon (Fig. 1) required that the effects of this energy source be evaluated in respect to the inputs of primary production. Detrital input occurs through essentially two sources - coastal erosion and runoff from the tundra. Thus assessment of these inputs becomes a geomorphological problem for the former source and a hydrological problem for the second. Chemical data on the eroded tundra have been previously obtained by Schell (1975) and new erosional data are being determined by Cannon and Rawlinson (RU 530). Total organic carbon data for the Colville River waters have been kindly provided by the US Geological Survey (Charles Sloan, personal communication) and flow data are available from the literature (Arnborg *et al.*, 1967; Walker, 1974). Nitrogen data has been collected by Schell (RU 537) and will be incorporated with the above to yield quantitative inputs of nitrogen and carbon by the Colville River to the nearshore zone.

The utilization of detrital organic carbon by heterotrophs and the further transfer of this carbon into the food web is being investigated through the use of carbon isotope ratios in the various coastal marine living and non-living organic materials. Figure 3A shows the three fractions that would comprise the organic carbon of a detritivore or the predators of detritivores. The analytical techniques used to identify these fractions are shown in Figure 3B. If the carbon in the eroded peat materials of the shoreline is incorporated to a significant extent in the food web of heterotrophic microorganisms and these are then consumed and assimilated by benthic invertebrates such as amphipods, isopods and mysid shrimp, the isotopic abundances in the higher organisms should generally reflect the food source. Some species of these benthic invertebrates are known to comprise a large fraction of the diets of higher organisms found in the coastal Beaufort Sea and thus the potential exists for detrital carbon to constitute a large fraction of the energy supply to the ecosystem.

Radiocarbon dating is being used to delineate the fraction of peat carbon in the organisms. Eroded peat in Simpson Lagoon has a mean radiocarbon age of about 4000-5000 years B.P. if the radiocarbon dates given by Lewellen (1973) are representative of the basal peat layer in the Simpson Lagoon area. It is assumed that the peat has been accumulating at a constant rate to present. As yet no age has been obtained for carbon transported by the Colville River but the surficial nature of runoff in a permafrost environment such as the North Slope would suggest a modern date somewhat tempered by peat addition via riverbank erosion and collapse.

Stable isotope techniques allow the discrimination of food sources in ecosystems where the source materials (primary producers) have significantly different $^{12}C/^{13}C$ ratios. By comparing $^{12}C/^{13}C$ ratios of organisms

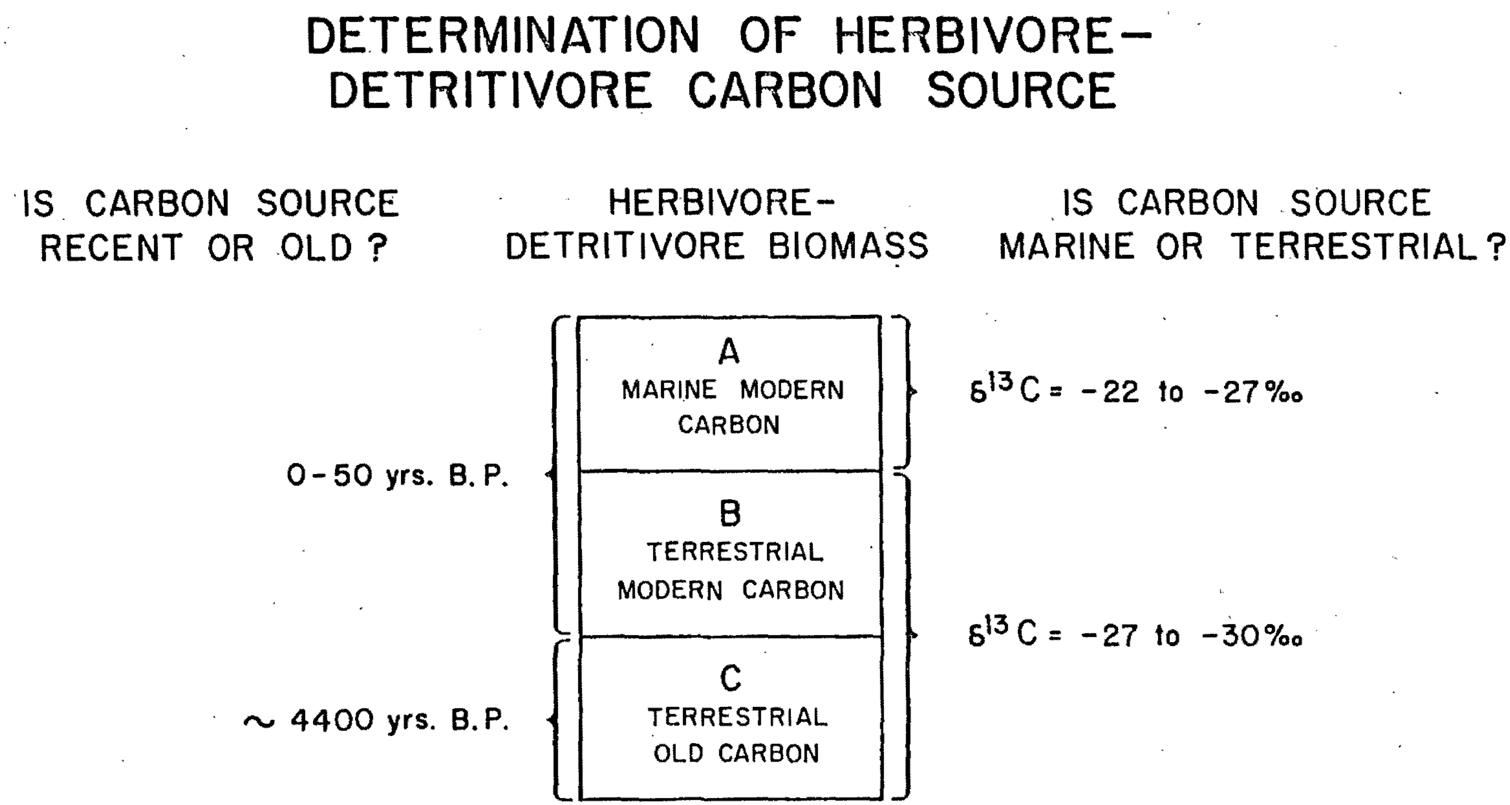

Figure 3A. Fractionation of carbon in nearshore Beaufort Sea fauna and characteristics of carbon isotopes from each source.

RADIOCARBON DATING

$$\%C = \left[\frac{\text{Mean peat age} - \text{Sample age}}{\text{Mean peat age}}\right] \times 100$$

$$\begin{aligned}\%\,A+B &= 100 - C\\ &= \text{percent modern carbon (marine and terrestrial)}\end{aligned}$$

STABLE ISOTOPE RATIOS

$$\%A = \frac{{}^{12}C/{}^{13}C(\text{terr.}) - {}^{12}C/{}^{13}C(\text{sample})}{{}^{12}C/{}^{13}C(\text{terr.}) - {}^{12}C/{}^{13}C(\text{marine})} \times 100$$

$$\%B = 100 - (A+C)$$

= carbon derived from modern terrestrial sources.

Figure 3B. Techniques for quantitation of carbon input sources shown in Figure 2A.

at different trophic levels the food sources of the higher organisms can be apportioned. This technique has been used by McConnaughey (1978) to study the detrital input of eelgrass beds in Izembek Lagoon to the fauna of the lagoon and nearshore Bering Sea. Application of this technique is shown in Figure 3B and will be investigated as a method to separate terrestrial and marine contributions to the nearshore fauna. Although the method is acknowledged to be less sensitive than ^{14}C dating, the applicability to modern carbon sources increases its desirability. Analytical cost is low compared to ^{14}C dating.

The radiocarbon and ^{13}C analyses will be performed by private laboratories specializing in this service. Modern standards related to the NBS Oxalic Acid are used and dates will be corrected for fractionation by using $^{12}C/^{13}C$ ratios determined on the same sample.

Phosphate Uptake and Regeneration Studies

Movement and incorporation of phosphate into the detritus pool and subsequent partitioning will be measured with the use of carrier free ^{32}P radiolabeled phosphate. The high specific activity and low cost of this label will allow field and laboratory studies to be conducted on the interactions of the eroded peat materials and the relatively phosphate rich seawater. Aliquots of the various inorganic and organic fractions will be taken at intervals during the experiments and counted using routine liquid scintillation techniques. The reapportionment of the radiolabel from the inorganic seawater solution into the particulate fraction, when coupled with simultaneous colorimetric determination of total pool size, will offer a quantitative measure of phosphorus uptake by meiofauna and microflora associated with the detrital matter.

Chlorophyll Determinations

Although originally it was hoped that quantitation and calibration of ice algae recoverv in coring would be accomplished by divers, this was not feasible this spring. The large quantities of detrital material incorporated in the ice structure so severely attenuated the light penetrating the ice that no ice algae were present on the underside of the ice where the diving hole had been cut for current meter installation by other investigators. Therefore, losses of algae during coring operations will be approximated by using data regarding this technique obtained by Matheke and Horner (1974) at Point Barrow. Chlorophyll determinations are made using the procedures of Strickland and Parsons (1972) adapted to the Turner Design Fluorometer. The extreme sensitivity of this instrument allows a smaller sample size and thus improved ease and coverage in the field. Cross calibration with spectrophotometric methods allows quantitation of chlorophyll measurements in the presence of phacopigments.

IX. DELIVERABLE PRODUCTS

All data forthcoming from this study will be submitted to OCSEAP data management group in the accepted format. Efforts will be made to consolidate all published and unpublished data available in a manner best suited for coastal management purposes. These data will include digital products. See also Data Products Schedule.

Nutrient concentrations - nitrate + nitrite -N, ammonia, phosphate, dissolved organic nitrogen

Particulate material - particulate nitrogen

Salinities - water samples and ice core samples

Pigment concentrations - chlorophyll data

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)	Submissic (Month/Ye
Primary Productivity	Tapes	?	029	Yes	11/78	3/79
"	"	"	"	"	3/79 - 4/79	9/79
"	"	"	"	"	5/79	9/79
"	"	"	"	"	7/79 - 8/79	12/79

File Type 029 - Primary Productivity

Common to all records
- File Type
- File Identifier
- Record Types
- Station Number (Records Types 1, 3 and 4)

Record Type '0' - Header
- Vessel Name - Cruise Number
- Cruise Dates
- Senior Scientist/Investigator/Institution

Record Type '1' - Master
- Geographic Position
- Date/Time
- Water Depth
- Chlorophyll a - Integrated
- Phaeopigments - "
- Carbon Assimilation - "
- One Percent Light Depth
- Phospate PO_4- P Reactive Time
- pH Scale & pH Corrections (codes)
- Secchi Depth
- Mixed Layer Depth
- Light Level (Platform)

Record Type '3' - Detail
- Depth of Sample
- Chlorophyll a Concentration
- Phaeopigment - "
- Carbon ASsimilation "
- Elapsed Time of Incubation
- Oxygen
- Phosphate-PO_4-P (Inorganic)
- Ammonia - NH_3-N
- Nitrate-NO_3-N
- Nitrate-NO_2-N
- Silicate-SiO_3-Si
- PH
- Total Alkalinity
- Temperature and Salinity
- Sequence Number

Record Type '4' - Text
- Text

A. Narrative reports:

None anticipated other than Quarterly and Annual Reports.

B. Visual data:

Nutrient data and ice algae density will be presented on maps where sufficient sampling density allows.

C. Other non-digital data:

None anticipated

X. QUALITY ASSURANCE

The Institute of Water Resources and the Institute of Marine Science employ well standardized and calibrated analytical equipment for routine nutrient and pigment analyses. Internal standards will be used to insure no deviation from normal processing has occurred in samples acquired in OCSEAP programs. Field replication of samples will ascertain precision in sampling methods. All analytical procedures used are in routine use and have been summarized above. Specific nutrient analysis procedures are from Strickland and Parsons, 1972. Field handling of samples, including the maintenance of frozen samples will be accomplished through close coordination with LGL logistic support programs. The airlines servicing Prudhoe Bay offer "Keep Frozen" capabilities and these have been successfully employed to date.

Processing and analysis techniques used in developing output products are completely integrated and structured within the framework of the LGL data management program. LGL Limited maintains oversight and responsibility for data product development through its workshop program.

XI. SPECIAL SAMPLE AND VOUCHER SPECIMEN ARCHIVAL PLANS

No special sample or voucher specimen archival plans apply to this project.

XII. LOGISTICS REQUIREMENTS

See attached forms.

XIII. ANTICIPATED PROBLEMS

Within the framework of sampling and analytical chemistry, no major problems are anticipated. Logistic considerations are all-important, however, in establishing the spatial and temporal framework of the water and ice sampling program. Persistent fog and overcast can curtail ice sampling and heavy weather precludes small boat operations. A degree of flexibility will be maintained to allow an opportunistic approach toward sample station locations and density.

XIV. INFORMATION REQUIRED FROM OTHER INVESTIGATORS

This project is an integrated part of the LGL-Barrier Island study group and as such will interact continuously in data exchange and redirect to address the requirements of overall program needs. The trophic system studies will require information from LGL on the food preferences of different higher organisms and information on erosion rates from Dr. J. Cannon (RU 530). This research unit will provide nutrient data and primary productivity information to other researchers and to modeling efforts at the LGL workshops.

XV. DATA MANAGEMENT PLAN

Overall management of logistics and field operations will be the responsibility of the LGL Limited staff. The principal investigator of this project will be responsible for the field research program described above. Dr. Schell will be responsible for the nutrient, pigment, and ^{14}C-primary productivity analyses and data reduction. LGL Limited will be responsible for data synthesis and incorporation of information into the final report.

XVI. OUTLOOK

The conclusion of field work and data analysis in 1980 should have provided enough survey data to allow a reasonable prediction of OCS impacts regarding possible perturbations of the physical-chemical nature in the Beaufort Sea lease area. As yet, however, it is impossible to predict the outcome of the carbon isotope studies and the implications that may arise regarding the movement of detrital carbon in this ecosystem. These data plus information on process studies regarding phosphorus and nitrogen cycling in the immediate nearshore zone can be projected to assume more importance in future efforts. Objectives for a FY 1980 proposal would lead to results describing:

1. Carbon transfer mechanisms in higher organisms based upon isotopic distributions determined in FY 1979.

2. Refinement of terrestrial input of carbon from North Slope rivers. Current effort is based primarily upon erosional inputs (RU 530) and these will need to be extended to include water transported detritus.

3. Extend nitrogen and phosphate budgets in the nearshore to include the entire coastline in order to overcome limitations currently imposed by the strong lateral transport of water along the shore.

The above tasks should complete the basis for establishing the lower trophic level dynamics in the Beaufort Sea. The extent of the research is envisioned at approximately the same magnitude as current operations and the overall budget would be approximately $65,000. Logistic requirements would increase somewhat to reflect sampling drainages east and west of Simpson Lagoon.

XVII. 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 XI 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. See Section XV of this proposal. The University of Alaska agrees that the Principal Investigator 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 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 sorting of 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 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."

B. AIRCRAFT SUPPORT - FIXED WING

1. Delineate proposed flight lines on a chart of the area. Indicate designed 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.)

Charter flights from Deadhorse to Milne Point.

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.)

At intervals during summer field season

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

6 total, 2 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?

Could piggyback

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.

Approximately 700 pounds miscellaneous scientific equipment

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?

Single engine bush aircraft

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

No

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

Not available

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

2

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

Deadhorse

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).

   Simpson Lagoon - Harrison Bay - Deadhorse

2. Describe types of observations to be made.

   Ice and water sampling

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 1 $\pm$ 10 days; May 25 $\pm$ 5 days; November 10 $\pm$ 5 days

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

   Total flight hours?

   20 hours @ 5/day

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?

   Approximately 400 pounds scientific equipment

7. What type of helicopter do you recommend for your operations and why?

   Bell 206 - has worked well 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.

   ERA Helicopters - Deadhorse. Good service in the past.

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

   Approximately $400.00

10. Where do you recommend that flights be staged from?

    Deadhorse

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).

   Deadhorse - April, May, November - approximately 2-5 days each period for two people

   Milne Point - June, July, August - approximately 20 man-days total - two people in camp each period for 3-4 days

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

   No. - Assume facilities similar to past Prudhoe Bay camp.

3. What is your estimated per man day cost for this support at each location?
   Not available.

   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).

   Winter sampling (November) will be difficult due to poor daylight and severe weather conditions. We plan on using helicopter support - probably from ERA, Deadhorse. We anticipate handling requirements through LGL Limited. Poor flying weather will be a problem during other seasons but less so than winter. Waiting on weather could conceivably increase time and costs of field trips by 2-3 fold.

MILESTONE CHART

0 – Planned Completion Date
X – Actual Completion Date

R.U. # 357 P.I. Donald M. Schell

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
Quarterly reports			0			0			0			0			
Date submission	0	0				0					0	0			
Winter field work		0				0									
Spring ice coring (field)								0							
Open water sampling										0--	-0				
Modeling and integration workshop	0			0			0					0			
Completion of analytical work											0				
Final report															0

Date: 15 September 1978
Contract: 03-5-022-56
Task Order: #32
R.U. No.: 537W
Proposal No. OCS 79-12

Proposal for Winter Work, FY 79
Additional Work for R.U. 537

to

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

NUTRIENT DYNAMICS AND TROPHIC SYSTEM ENERGETICS IN NEARSHORE BEAUFORT SEA WATERS

R. U. No.: 537W
Total Cost: $30,537
Lease Area: Beaufort Sea, 100%

Institute of Water Resources
University of Alaska
Fairbanks, Alaska 99701

D. M. Schell
Principal Investigator
Institute of Water Resources
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7115

R. F. Carlson
Director
Institute of Water Resources
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7775

A. B. Frol
Director
Administrative Services
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7340

K. B. Mather
Vice Chancellor for Research
and Advanced Study
University of Alaska
Fairbanks, Alaska 99701
(907) 479-7282

I. BACKGROUND

This proposal is in response to the meeting of OCSEAP personnel and OCS principal investigators on 31 July 1978 in which the desirability and necessity of winter work in the Beaufort Sea was discussed.

Research Unit 537 has been investigating trophic system dynamics in the nearshore Beaufort Sea. Primary production by ice algae and phytoplankton has been measured and is currently being compared with the magnitude of secondary production derived from detrital food webs, resulting from the large inputs of terrestrial organic matter in the nearshore zone. Critical data toward understanding these systems are nutrient concentrations (i.e., ammonia, nitrate and phosphate) occurring beneath the winter ice cover when photosynthetic processes are negligible.

Observations to date seem to indicate that most nutrient regeneration processes occur in the autumn and continue throughout the winter, in spite of the low under-ice temperatures. The regenerated nutrients, however, are subject to transport out of the coastal zone by the thermohaline convective processes that result from the accretion of winter ice cover. To understand the nutrient cycles of the nearshore Beaufort Sea, it is essential that the relationship of nutrient regeneration processes to thermohaline convection be studied simultaneously. This research unit has kept this perspective since beginning this study. Since this study began approximately 18 months behind the work of R. U. 467, no fall or early winter field work has been accomplished yet. To date, due to funding constraints and the need for spring and summer sample collection, winter field work has been necessarily given low priority. This proposal addresses this information gap and is applicable to the specific area selected for leasing.

Applicability to BLM-OCS data requirements.

This study will seek to answer basic questions regarding the winter regime in the nearshore marine environment. For example, if drilling mud suspensions, sanitary waste effluents, or other aqueous pollutants were discharged beneath the ice, are there possible dispersion mechanisms which, depending on the density of the effluent, would carry the plume onshore or offshore? Is there evidence of sufficient microbial activity to present problems with excessive biological oxygen demand beneath the ice, if effluents with high organic loading were discharged? Are under-ice circulation patterns the controlling mechanisms of nutrient concentrations, and hence primary production in the spring? How would the nutrient regime be affected in the lease area if a lagoon entrance were restricted by causeway construction? This study does not propose definitive answers to these questions but seeks data necessary for intelligent evaluation of the environmental risks involved.

II. OBJECTIVES

The overall objective of this proposal is to study the nutrient regeneration processes of the nearshore Beaufort Sea, and their relationship to the thermohaline convection of under-ice water resulting from salt exclusion during ice formation. Specifically, I propose to address the following objectives:

(1) Extend the areal survey of ice algae standing stocks to the specific areas included in the projected Beaufort Sea lease sale.

(2) Determine spatial and temporal variation in under-ice water salinities during winter and apply this data to estimating circulation.

(3) Measure under-ice nutrient regeneration rates through the use of isotopic tracer techniques.

(4) Measure seasonal variation in under-ice nutrient concentrations to determine the periods of most intense nutrient regeneration.

III. GENERAL STRATEGY AND APPROACH

The sampling techniques employed have been described in proposal OCS 79-3 and will only be summarized herein. The work will consist of two phases: spatial survey of nutrient-salinity relationships to ice algae standing stocks will rely upon helicopter sampling of several sites within the lagoon and outside of the barrier islands off Prudhoe Bay and Foggy Island Bay; and process studies measuring ammonia regeneration rates in under-ice waters. The latter will utilize N-15 isotope dilution techniques with incubation *in situ* at the location, where a heated hut will be deployed. This location has not been established as yet, although the "boulder patch" south of Narwhal Island is the likely choice.

Estimation of water circulation can be made after two (or more) sampling trips have been accomplished during periods of rapid ice formation. Planimetry of bottom contours at depths corresponding to ice thickness will allow estimation of ice volumes formed and from measured ice core salinities, the salt excluded into the water column. Measured water salinities can then be compared to calculated salinities and the required water-exchange rates estimated. From these estimates, the transport rates of nutrients offshore can be determined. The production rates of ammonia and nitrate, from the heterotrophic consumption of organic material followed by nitrification, will be estimated by the incubation experiments. These data will be incorporated into the water-exchange estimates to determine net nutrient removal or addition to the nearshore zone. The current-salinity data obtained by Matthews (R.U. 526) will be of value to this study for corroboration of transport efficiencies across the very shallow bays and lagoons.

This study does not propose to conduct *in situ* ice algae primary production measurements. The extremely high cost in personnel time and logistics is not felt to be as valuable, at this stage of the environmental assessment, as a determination of spatial variation in ice algae stocks. The great spatial variability on a relatively small scale that has become evident to this investigator over the past years requires that the areal coverage receive the primary emphasis of the study. However, if opportunities arise in conjunction with other work at the Stefansson Sound intensive study site, *in situ* primary production measurements will be undertaken. Such data would be useful in expanding the literature data base by which standing stocks are used to estimate seasonal production.

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 541
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

Principal Investigator

Co-Principal Investigator

Associate Principal Investigator

George C. Anderson
Associate Chairman for Research
Department of Oceanography

Joe S. Creager, Associate Dean
College of Arts & Sciences

Official Authorized To Give University Approval:

Donald R. Baldwin, Director
Grant & Contract Services
1 Administration Building, AD-24

Ref: P78-71

Proposal/Revision Date: 15 June 1978

To: Juneau Project Office

Contract #: 03-5-022-67, TO 14

NOAA Project #: ____________

Institution ID#: ____________

FY 1979 RENEWAL PROPOSAL

Research Unit Number 541

TITLE: Norton Sound/Chukchi Sea Oceanographic Processes

Cost of Proposal: $50,000 Lease Areas Chukchi Sea 25 %

Norton Sound 75 %

(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 (L. K. Coachman) Date 15 June 1978

Signature [signature]

Address ____________

Telephone Number ____________ FTS: ____________

INSTITUTION (include Department, if appropriate)

____

REQUIRED ORGANIZATION APPROVAL:

Name ____________ Date ____________

Signature ____________

Position ____________

Address ____________

Telephone Number ____________

ORGANIZATION FINANCIAL OFFICER:

Name ____________ Date ____________

Signature ____________

Position ____________

Address ____________

Telephone Number ____________

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

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
Mooring NC-24A (24m) (40m)	Tape		015 015	Yes	9/77 to 7/78	11/78
Mooring NC-24B (24m) (40m)	"		015 015		7/78 to 9/78	1/79
Mooring LD-5 (15m) (21m)	"		015 017		7/78 to 9/78	
Mooring FX-1A (18m) (40m)	"		015 015		7/78 to 9/78	1/79
Mooring FX-2A (18m) (43m)	"		015 017		7/78 to 9/78	1/79
Mooring FX-3A (18m) (40m)	"		015 015		7/78 to 9/78	1/79

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	O	N (1978)	D	J	F	M	A (1979)	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

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

Department of Oceanography
Cable Address: UNWADO

15 September 1978

Dr. Herbert E. Bruce
Project Manager
NOAA/OCSEAP
P.O. Box 1808
Juneau, AK 99802

Dear Dr. Bruce:

I am responding to your letter RFx41-541-855 dated 11 September 1978 concerning Mylar overlays for Research Unit 541. I missed the 15 September deadline because your letter was not received until 14 September; Tom Kinder telephoned preliminary information to Mauri Pelto of your office on 15 September.

We will provide Mylar overlays of the circulation where we judge adequate data exists, and also overlays of mean measured currents, where we judge the means significant. As you know circulation schemes inferred from hydrography alone are often erroneous, as are means inferred from non-stationary time series. We realize the value of a valid circulation pattern to OCSEAP goals, but we also realize the dangers inherent with incorrect schemes. A good example is the Bristol Bay region: compare circulation schemes inferred from hydrography published just a few years ago with the picture that is emerging in our reports.

Similarly, we find it difficult to provide maps of temperature and salinity in some areas (e.g. Norton Sound) because of high variability. Where appropriate, we can provide maps of salinity and temperature, and in other regions we can indicate something of the hydrographic structure, water masses, or variability, as the data warrant.

In summary, we agree to provide Mylar overlays that depict circulation and hydrographic conditions, and we will choose a method that we judge provides maximum information with high confidence levels. We want to provide the best information in the spirit of your letter, but avoid statistically insignificant depictions.

We plan to provide these overlays by 30 September 1979.

Sincerely,

Lawrence K. Coachman

LKC:THK:af
cc: OCSEAP Project Office, Boulder, Co.
R.B. Tripp
J.D. Schumacher
R.L. Charnell

TO: NOAA
OCSEAP
Bering Sea-Gulf of Alaska Project Office
P. O. Box 1808
Juneau, Alaska 99802

Proposal Date : 15 Oct 1978
Contract No. : ______
NOAA Project No. : ______
Institution ID No: ______

FY 1979 RENEWAL PROPOSAL

Research Unit Number: RU 551

Title: Seasonal composition and food web relationships of marine organisms in the nearshore zone--including components of the ichthyoplankton, meroplankton, and holoplankton

Cost of Proposal: $176,000[1/] Lease Areas: Kodiak 100%

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

1/ Sorting costs of ca $60,000 included under RU 553

I. Title: Seasonal composition and food web relationships of marine organisms in the nearshore zone--including components of the ichthyoplankton, meroplankton, and holoplankton

II. Principal Investigators:

Jean R. Dunn

Arthur W. Kendall, Jr., PhD

Robert J. Wolotira

III. Cost of Proposal for Federal Fiscal Year (October 1, 1978 through September 30, 1979):

A. Science: $176,000

B. PI-provided logistics: none

C. Total: $176,000[1/]

D. Distribution of effort by Lease Area: Kodiak Island, 100%

IV. Background:

Significant gaps in biological information in the Kodiak Island shelf area include knowledge of the temporal and spatial changes in the composition of planktonic organisms of ecological or economic importance. Such information is needed to determine critical species or stages and will provide important data for use in evaluating the possible impact which oil and gas development may have.

Of critical need in attempts to evaluate the potential impact of oil contamination on larval stages of important components of the ecosystem is the evaluation of what species are where, in what abundance, and at what time of the year. Evaluation of the food web, through coordination with marine mammal and bird studies under RUs 341, 337, 243, 229, and other

1/ Sample sorting will be done by contract (approximately $60K for RU 551) included under RU 553.

relevant programs, may well indicate critical life history stages or areas which could be severely impacted by oil contamination.

Studies of the seasonal composition, distribution, and relative abundance of marine organisms in the nearshore zone of Kodiak Island in FY 78 included one reconnaissance cruise (October-November 1977) and two assessment cruises (March-April and June-July 1978). Although limitations on vessel time and restrictions on vessel scheduling in FY 78 precluded seasonal coverage of the Kodiak Island shelf, the data available from these cruises should depict the distribution and relative abundance of dominant ichthyoplankton taxa and selected zooplankton taxa (including shrimp and crab larvae and euphausiids). Field research efforts in FY 79 would extend data collection in the fall of 1978 and spring of 1979 to provide information for a complete annual cycle. Primary efforts in FY 79, however, would be directed toward analysis, synthesis, and reporting of data collected in FY 78 and 79.

Data collected in FY 78 and 79 will provide necessary information for other research units participating in the Kodiak Food Web study, including RUs involved in feeding habits of sea birds, stomach analyses of juvenile and adult fishes, and assessment of plankton in bays and estuaries.

V. Objectives:

The overall objectives of RU 551, as indicated in the FY 78 proposal, are to determine the seasonal composition, distribution, and apparent abundance of marine organisms of ecological or economic importance and to investigate relations among these parameters and environmental conditions. Emphasis is on ichthyoplankton and meroplankton.

Specifically, the objectives are: (1) determine seasonal composition, distribution, and apparent abundance of major life-stages of selected planktonic taxa, including fish eggs and larvae, larvae of shrimp and crab, and euphausiids; (2) examine observed biological distributions in relation to bathymetry and available hydrographic data; and (3) compare the distribution of planktonic organisms in nearshore, mid-shelf and slope waters.

VI. Strategy and Approach:

The general approach to the stated objectives is to sample plankton in Kodiak Island shelf waters using a centric-systematic sampling grid during seasonal cruises. Biological sampling at each station will include surface ichthyoneuston tows, integrated oblique tows from near bottom to the surface and, at selected stations, discrete depth Tucker tows. Such sampling will enable us to identify dominant taxa, their distribution in time and space, relations between nearshore, mid-shelf and slope fauna and to assess the influence of bathymetric and oceanographic features of the region on the distribution of organisms.

Associated environmental data will be collected. Analysis of data will focus on assessing the distribution and relative abundance of taxa by season. Details are included below.

This work will be accomplished under the administrative supervision of Dr. Felix Favorite, Resource Ecology Task. All field work, identification of ichthyoplankton, and data analyses will be supervised by the co-principal investigators. The identification and analysis of shrimp and crab larvae will be conducted by John Bowerman, Kodiak Laboratory, NWAFC.

A. Sampling Methods

1. Sampling scheme. A centric-systematic sampling grid (Figure 1) consisting of 88 stations will be used. Such a design may be treated as a random sample (Milne, 1959; Elliott, 1977). The entire grid can be covered

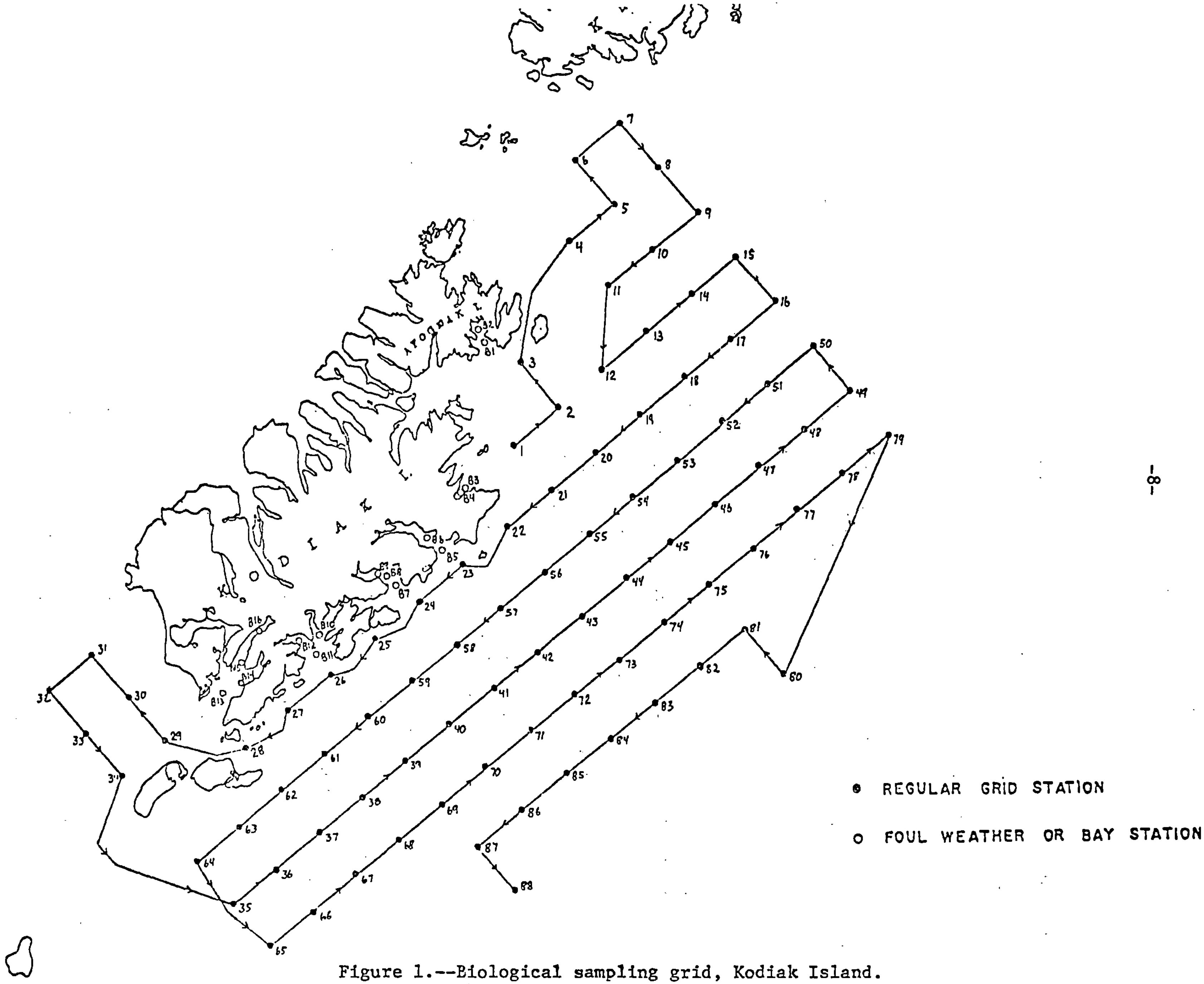

Figure 1.--Biological sampling grid, Kodiak Island.

in approximately 14 days, given good weather, allowing sufficient time for diel studies, investigation of anomalous conditions, and repetitive sampling of certain stations.

The use of neuston samplers will allow identification of the components of ichthyoplankton which are near surface components. The use of an integrated tow (Bongo nets) allows estimation of biomass and determination of distribution of organisms. Discrete sampling (Tucker trawl) will enable identification of which strata organisms are in and will enable investigation of diel migrations. Replicate tows will be made at selected stations to assess sampling variability.

Field sampling will be conducted in accordance with standard MARMAP procedures (Smith and Richardson, 1977). Flowmeters will be calibrated before and after each cruise. Common stations have been selected to overlap transect lines of the inshore intensive survey (RU 553) for direct comparison of survey results. Research Units 551 and 553 will use essentially the same sampling gear mix.

2. Sample Collection

At each station a CTD cast will be made to determine the vertical profile of temperature and salinity. A surface neuston tow utilizing a 30 by 50 cm Sameoto sampler will be made (10-minute tow filtering ca 50 m^3 water) to sample ichthyoneuston. A double-oblique tow of Bongo nets (60 cm diameter, 0.505 and 0.333 mm mesh) from near bottom to the surface will be made to sample ichthyo- and zooplankton. Minimum amounts of water filtered will be ca 100 m^3. At selected stations a one-meter multiple net Tucker trawl (0.505 mm mesh) will be used for discrete depth sampling.

Diel studies will be made at locations where large catches of ichthyoplankton are made. At those stations, a surface neuston tow and multiple Tucker trawl towswill be made every other hour for at least 24 hours, Approximately 400 plankton samples will be collected during each three-week cruise (Table 1).

Plankton samples collected at sea will be placed in one-liter Nalgene jars and preserved in 10% buffered (sodium acetate) formaldehyde. Samples will be stored in metal containers holding 60 such one-liter jars. Samples will be sorted by contract.

B. Analytical Methods

1. Sample processing. Samples will be shipped from Kodiak to Seattle via Sea-Land barge and thence by air freight to the sorting contractor (Texas Instruments, Inc., Dallas, Texas).

The NWAFC will pre-sort a portion of the plankton samples for fish eggs and larvae, return them to the original plankton, and ship them to the sorting contractor along with the remaining plankton samples. The sorting contractor will not know which samples are pre-sorted. Upon completion of sorting, a listing of the number of fish eggs and larvae in the sorted samples will be sent to NWAFC. If the numbers of fish eggs and larvae found in the pre-sorted samples do not agree closely with the counts obtained by the contractor, then all plankton samples must be re-sorted at contractor's expense. This procedure will be repeated until the contractor and NWAFC counts agree closely.

The sorting contractor will first take a settled volume of each sample (Kramer et al., 1972). All fish eggs and larvae (i.e., samples are not split) will be sorted out of the neuston, 0.505 mm Bongo, one-meter Tucker trawl. The fish eggs and larvae (or juveniles) will be bottled separately by the sorting contractor according to station, gear, etc., and returned to NWAFC for identification.

At NWAFC, fish eggs and larvae will be identified to lowest taxa, counted (some taxa will be measured), and life history stage noted. Identification of fish eggs (based on diameter of eggs, perivitelline space,

Table 1.--Estimated number of plankton samples to be collected by RU 551 in FY 79, according to cruise period and gear type, and associated sorting costs.

	Gear									
Cruise period	Neuston	$	Bongo (0.505)	$	Bongo (0.333)	$	Tucker	$	Total	$
October-November, 1978	88	3,696	88	3,960	88	9,152	136	13,056	400	29,600
February-March, 1979	88	3,696	88	3,960	88	9,152	136	13,056	400	29,600

developmental stage, pigment patterns, oil globules, myomere counts, etc.) and fish larvae (based on developmental stage, myomere counts, pigment patterns, etc.) are based on standards developed by Dr. E. H. Ahlstrom, NMFS, La Jolla, CA, and used at NWAFC since 1970. The reference collection of fish eggs and larvae at NWAFC is the third largest on the west coast. Published and unpublished keys to larvae and juvenile fishes available at NWAFC will be used as appropriate.

Zooplankton from the 0.333 mm Bongo nets, after volumes are determined, will be sorted to major categories (e.g., class, phyla, or order--see Appendix I) from an aliquot of the total (ca 500 organisms) and enumerated. As necessary, an additional subsample will be taken by the Kodiak laboratory, NWAFC, to obtain adequate numbers of shrimp and crab larvae (ca 200 each). Eight major taxa (Euphausiacea, Chaetognatha, Copepods, Amphipods, Decapoda (Natantia), Decapoda (Reptantia), and Pisces eggs and larvae will be placed in separate labeled vials and returned to NWAFC.

A separate subsample will be taken to yield an aliquot containing approximately 200 adult euphausiids which will be identified to species, enumerated, lengths measured and wet weights (Weibe et al., 1975) determined. The euphausiid species will be placed in separate vials and returned to NWAFC.

Samples from the 0.505 mm Tucker trawl will be subsampled for ca 200 euphausiids which will be handled as above. An additional subsample of about 500 organisms will be taken for separation of shrimp (Natantia) and decapod crab (Reptantia) larvae. If this aliquot yields insufficient numbers of decapod larvae, then additional subsampling as necessary will be conducted by the Kodiak Laboratory, NWAFC.

Zooplankton data (numbers per aliquot) and samples will be returned by the contractor to NWAFC for analysis. The shrimp and crab samples will be sent to the Kodiak Laboratory, NMFS, for identification to species and life history stage by John Bowerman, according to keys developed by Evan Haynes (Haynes, 1976, 1978a, 1978b).

Samples of fish eggs and larvae will be archived at NWAFC, and crab and shrimp larvae will be stored at the Kodiak Laboratory. Other invertebrates will be stored at NWAFC for one year or forwarded to any archiving center designated by OCSEAP. Voucher specimens will be deposited at California Academy of Sciences.

2. Data Analysis. All data will be recorded on forms designed to facilitate subsequent processing by ADP methods. Computer programs will be used to convert observed data to numbers or biomass per standard unit, either per 1000 cubic meters of water filtered or under 10 square meters of sea surface, as appropriate (Kramer, et al., 1972).

Standard methods of analyses will be used. Samples of such analyses for ichthyoplankton may be found in Kendall (1975), Richardson and Pearcy (1977), Houde (1977 a, b, c), Smith, et al. (1978), and Richardson and Stephenson (1978); for zooplankton in Haynes (1974), Angel and Fasham (1973), Angel and Fasham (1975), Pearcy, et al. (1977), and Colebrook (1977).

Similar analyses will be performed on all of the taxonomic groups investigated under this RU (ichthyoplankton, shrimp and crab larvae, and euphausiids) as abundances, distributions, and time permit. Priority will be given to thorough analysis of ichthyoplankton and shrimp and crab larval data.

Geographic analysis will consist of plotting species distribution on charts of the area. Isolines of abundance for species of interest on a logarithmic scale will be plotted on the charts. Biomass will be expressed as numbers per 10 m^2 of surface area for each station. For abundant species of interest, biomass estimates for entire cruises or portions thereof can be derived by calculating the areas represented by each station and summing the biomasses at the stations of interest. Variances of the biomass estimates for the cruises can be calculated as in Houde (1977a).

Visual comparisons of charts of biomass with bathymetric charts of the area will show if further analysis of the relation between depth and bottom topography to plankton distribution is warranted. If such be the case, graphical analysis will be employed.

As hydrographic data become available, their distribution will be plotted and compared with that of biomass plots of plankton species. Further analysis may include investigating correlation between temperature, salinity, and plankton abundance.

Comparisons of the geographic, bathymetric and hydrographic distribution of plankton biomass on a seasonal basis will be possible by comparing the several cruises with each other. Species lists, rank orders of abundance, and size or stage distributions can be compared. The importance of each season to the reproduction of economically and ecologically important species in the area can be evaluated by examining the abundance of their larval stages on a seasonal basis.

If the data justify it, an analysis of the community structure of the area can be attempted using a variety of numerical classification techniques. These will allow statements concerning the co-occurrence of species which may in some way (e.g., competition for food) influence the distribution and survival of each other.

Discrete depth tows with the neuston net and the Tucker trawl will allow comparisons of densities at various depths on a diel cycle. For these analyses, data will be converted to numbers per 1000 m^3, since density rather than biomass is to be investigated. Experiments are designed so that, with transformation (e.g., $\log_{10}[x + 1]$), a factorial analysis of variance can be performed---the factors being depth, time of day, species, and replicates.

VII. Deliverable Products

A. Digital Data

1. No new parameters are proposed for FY 79

2. The minimum and maximum values of zooplankton parameters are listed in Table 2.

Table 2.--Digital data to be submitted to OCSEAP and estimated minimum and maximum values of parameters.

File Type 024-Zooplankton

Record type	Range of values
Common to all records	
File Type	024
File Identified	1
Record Type	2
Station Number (except 1)	1-200
Record type 1 - File Header	
Vessel	DISCO, FREEMAN, or WECOMA
Cruise/Cruise Dates	1-6, 78-79, 1-12, 1-31
Area/Project	Kodiak Plankton 551
Investigator/Institution	Dunn et al, NWAFC
Record type 2 - Location	
Latitude/Longitude	55.00.00-60.00.00N/148°00.00-157°00.00W
Date in GMT/Time in GMT	78-79, 01-12, 1-31/0000-2400
Depth to bottom	10-6000 m
Sample interval	0-1000 m
Ship speed	1.0 - 5.0 knots
Surface water temperature	-1.0 to 15.0°C
Record type 3 - Total Haul Data	
Gear Code/Mesh Size	04, 09, 16, 17/165-505u
Duration Haul/Length	0.1-2.0/100-2000 m
Total settled volume	1 ml-1,000 ml
Volume of water filtered	40 m^3-1500 m^3
Duration of tow	5 min - 90 min
Haul type code	Surface/oblique
Record type 4 - Subsample Data	
Sample number/taxonomic code	1-200/zooplankton-fishes
Life history code	0, 1, 2, 3, 4, 5, 6, 7, 8
Size of subsample	0.1 - 100
Number of adults	0-1000
Number of juveniles	0-5000
Number of eggs	0-100,000
Number of larvae	0-10,000
Record type 5	
N/A	
Record type 6 - Subsample Data 2	
Sample number/taxonomic code	1-200/zooplankton-fishes
Life history code	0, 1, 2, 3, 4, 5, 6, 7, 8
Size of subsample	0.1 - 100
Number of adults	0-1000
Number of juveniles	0-5000
Number of eggs	0-100,000
Number of larvae	0-10,000

3. Standard ADP quality control checks will be made, including range-checking computer programs, following procedures described for RU 175 (Demersal Fish and Shellfish Resources of the Eastern Bering Sea in the Baseline Year 1975; Data Appendices, Appendix A: Data Processing Quality Control, pp. 1-3).

B. Narrative Reports

Interim products will be included as appropriate in quarterly and annual reports. These products will consist essentially of tables, charts, and figures of available data (see Waldron and Favorite, MS 1977; Waldron and Vinter, MS 1978).

A final report, synthesizing data collected in FY 78 and FY 79 will be submitted by December 31, 1979.

C. Visual Data

Standardized OCSEAP maps and mylar overlays will be used.

D. Other

N/A

E. Data Products

Data products will include the following:

(1) Tables, charts, and figures depicting the relative abundance of ichthyoplankton and zooplankton taxa by station, cruise, and season.

(2) Rank order of abundance of ichthyoplankton and zooplankton by area, region, coastal, and offshore regimes, or other appropriate analyses.

(3) Distribution of ichthyoplankton and zooplankton taxa by depth strata and results of diel variation studies.

(4) Contour charts of distribution of various ichthyoplankton and zooplankton taxa as appropriate.

(5) Distribution and abundance of dominant taxa in relation to physical-chemical parameters.

(6) Size composition data and/or life history stage data, as appropriate.

Digital data products are described in Table 3. Processing and formatting of digital data into OCSEAP format will be done by the project or by subcontract.

Table 3.--Data Products Schedule, RU 551.

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)	Submissi (Month/Y
Ichthyoplankton	tape	2,000 cards	024	Yes	Oct 1977-Nov 1977	Nov 1978
Zooplankton	tape	3,000 cards	024	Yes	Oct 1977-Nov 1977	Jan 1979
Ichthyoplankton	tape	3,000 cards	024	Yes	Mar 1978-Apr 1978	Jan 1979
Zooplankton	tape	5,000 cards	024	Yes	Mar 1978-Apr 1978	Apr 1979
Ichthyoplankton	tape	3,000 cards	024	Yes	Jun 1978-Jul 1978	Mar 1979
Zooplankton	tape	5,000 cards	024	Yes	Jun 1978-Jul 1978	Jun 1979
Ichthyoplankton	tape	2,500 cards	024	Yes	Oct 1978-Nov 1978	Mar 1979
Zooplankton	tape	5,000 cards	024	Yes	Oct 1978-Nov 1978	Jun 1979
Ichthyoplankton	tape	2,500 cards	024	Yes	Feb 1979-Mar 1979	Sep 1979
Zooplankton	tape	5,000 cards	024	Yes	Feb 1979-Mar 1979	Oct 1979

VIII. Special Samples and Voucher Specimen Archival Plans:

All samples of fish eggs and larvae (estimated to be ca 1,200 samples for FY 78 and 800 for FY 79) will be permanently archived at the NWAFC, and crab and shrimp larvae will be stored at the Kodiak Laboratory, NWAFC. Other invertebrates will be stored at NWAFC for one year or forwarded to any archiving center designated by OCSEAP.

Voucher specimens will be deposited at the California Academy of Sciences.

IX. Logistics Requirements:

Logistics are detailed in Table 4.

X. Anticipated Problems:

Based on our experience in FY 78, the two major problems will be winch and CTD failures aboard NOAA vessels. Such failures have been the subject of numerous memoranda to the Juneau Project Office, and resolution of these problems cannot be made at the investigation level.

If winch failures occur, repairs will be needed at sea or in the nearest port. At least two CTD fish should be on each vessel. In the event of long term inclement weather, special stations have been assigned to overlap those sampled by RU 553.

Samples of decapod larvae sorted from ichthyoplankton and zooplankton samples by the sorting contractor may be inadequate to supply statistically significant data on crab and shrimp larvae. If so, it will be necessary to sort additional larvae from the parent samples from which the aliquots were taken. Only a limited number of such samples can be processed within the budget proposed.

XI. Information Required from Other Investigators:

Environmental data from 1978 and 1979 cruises in the area of investigation would be helpful in conducting field studies. Although preferably in the form of maps showing horizontal distribution of properties, particularly flow, such data on tape would be acceptable. OCSEAP should insure the distribution of these data as they become available.

Ship's crew will be responsible for providing CTD and XBT data as required.

Table 4.--Logistics Requirements, RU 551

Institution - NWAFC Principal Investigators - Dunn and Kendall and Wolotira

A. SHIP SUPPORT

1. Cruise tracks (same for each cruise) are depicted in Figure 2. Station positions are listed in Table 4.

2. At each grid station, a ten minute surface neuston tow will be made using a Sameoto sampler. Following that, an oblique tow, from near bottom to the surface, will be made with paired 60-cm bongo nets (mesh size 0.505 mm and 0.333 mm). Calibrated flow meters are installed in each piece of sampling equipment. All procedures follow standard MARMAP recommendations (Kramer et al. 1972; Smith and Richardson, 1977). At selected stations discrete sampling will be conducted, using a one-meter multiple net Tucker Trawl. CTD profiles will be taken at each station. Surface salinity and temperature will be monitored.

Plankton samples will be placed in one liter Nalgene jars, preserved with Sodium Borate neutralized Formaldehyde (10%), labeled and stored in metal boxes. The plankton boxes will be off-loaded in Kodiak at the end of each cruise, barged to Seattle by commercial carrier, and thence shipped air freight to the sorting contractor.

3. The optimum time chronology is to complete the sampling grid in station sequence in as short a period as possible. Ideally, quarterly coverage of the grid would be desirable.

4. The optimum length of each cruise would be 21 days, allowing complete coverage of the sampling grid and sufficient time for diel studies and investigation of small scale anomalies.

Table 4.--Station positions, RU-551

Station	Latitude °N	Longitude °W
G1	57° 47.3'	152° 02.8'
G2	57° 55.3'	151° 43.5'
G3	58° 05.3'	151° 59'
G4	58° 32.2'	151° 37'
G5	58° 40.2'	151° 17.8'
G6	58° 50.4'	151° 33'
G7	58° 58.7'	151° 14.5'
G8	58° 48.3'	150° 59'
G9	58° 38.3'	150° 43.5'
G10	58° 29.8'	151° 02.3'
G11	58° 22.1'	151° 21.7'
G12	58° 03.5'	151° 25'
G13	58° 11.8'	151° 06'
G14	58° 19.8'	150° 46.5'
G15	58° 28.1'	150° 27.7'
G16	58° 18'	150° 12'
G17	58° 09.9'	150° 31.3'
G18	58° 01.8'	150° 50.7'
G19	57° 53.3'	151° 10'
G20	57° 45.2'	151° 28.5'
G21	57° 37.1'	151° 47.7'
G22	57° 28.8'	152° 06.7'
G23	57° 20.7'	152° 25.4'
G24	57° 12.3'	152° 44.5'
G25	57° 04'	153° 03.5'
G26	56° 55.8'	153° 22.5'
G27	56° 47.7'	153° 41'
G28	56° 39.3'	153° 59'
G29	56° 41.3'	154° 33'
G30	56° 51.6'	154° 47.8'
G31	57° 01.7'	155° 03'
G32	56° 53.4'	155° 21.3'
G33	56° 43.5'	155° 07'
G34	56° 33.3'	154° 51.4'
G35	56° 02.8'	154° 06.8'
G36	56° 10.5'	153° 47.8'
G37	56° 19.2'	153° 29.8'
G38	56° 27.3'	153° 11'
G39	56° 35.7'	152° 52.2'
G40	56° 44.2'	152° 33.5'
G41	56° 51.8'	152° 14'
G42	57° 00.4'	151° 55'
G43	57° 08.2'	151° 36'
G44	57° 16.7'	151° 17.3'

Table 4 (Cont'd).--Station position, RU-551

Station	Latitude °N	Longitude 'W
G45	57° 24.8'	150° 58.3'
G46	57° 33'	150° 39.3'
G47	57° 41.7'	150° 20.5'
G48	57° 49.6'	150° 01'
G49	57° 57.8'	149° 40.8'
G50	58° 07.8'	149° 56.2'
G51	57° 59.7'	150° 15.7'
G52	57° 51.7'	150° 35.3'
G53	57° 43.3'	150° 54.7'
G54	57° 34.8'	151° 13.5'
G55	57° 26.7'	151° 32.3'
G56	57° 18.3'	151° 51.3'
G57	57° 10.3'	152° 10.3'
G58	57° 02.2'	152° 29'
G59	56° 54.3'	152° 48.3'
G60	56° 45.8'	153° 12.5'
G61	56° 37.7'	153° 26'
G62	56° 29.1'	153° 44.4'
G63	56° 20.8'	154° 03'
G64	56° 12.9'	154° 21.5'
G65	55° 52.3'	153° 52'
G66	56° 00.2'	153° 33'
G67	56° 09'	153° 14.8'
G68	56° 17'	152° 56'
G69	56° 25.3'	152° 37'
G70	56° 34'	152° 18.3'
G71	56° 42'	151° 58.8'
G72	56° 50'	151° 40.3'
G73	56° 58.2'	151° 21'
G74	57° 06.6'	151° 01.7'
G75	57° 14.6'	150° 43'
G76	57° 23'	150° 23.7'
G77	57° 31.5'	150° 04.8'
G78	57° 39.5'	149° 45.3'
G79	57° 47.8'	149° 25.7'
G80	56° 54.5'	150° 12.5'
G81	57° 04.3'	150° 27.5'
G83	56° 48.3'	151° 06.3'
G84	56° 40.2'	151° 25.4'
G85	56° 32'	151° 44'
G86	56° 23.7'	152° 04'
G87	56° 15.2'	152° 22.3'
G88	56° 04.7'	152° 07.5'
G82	56° 55'	150° 47.3'

Table 4 (Cont'd).--Station positions, RU-551

Sampling stations in the event of foul weather on the shelf:

Station	Latitude °N	Longitude °W
Izhut Bay		
B1 - Z2D	58° 10'	152° 14'
B2 - Z1	58° 13'	152° 17'
Kalsin Bay		
B3 - C5	57° 38'	152° 24'
B4 - C1	57° 37'	152° 25'
Ugak Bay		
B5	57° 24'	152° 34'
B6	57° 27'	152° 41'
Kiliuda Bay		
B7	57° 16'	152° 55'
B8 - L7	57° 18'	152° 59'
B9 - L1	57° 19'	153° 02'
Sitkalidak Str.		
B10	57° 05'	153° 27'
Kaiugnak Bay		
B11 - G2	57° 01'	153° 29'
B12 - G1	57° 04'	153° 36'
Alitak Bay		
B13	56° 52'	154° 08'
B14	56° 54'	154 00.5'
Deadman Bay		
B15	56° 59'	153° 59.5'
B16	57° 06'	153° 52'

Table 4 (Cont'd).--Logistics Requirements, RU 551

5. This RU must be the principal investigation on all cruises. Sampling will be conducted on a 24 hour basis. Sampling time on station will vary as to depth of water and types of gear deployed; an average of 3 hours per station may be used as normal. There is no sample processing time between stations.

6. NOAA ships are expected to provide winch operators and one survey technician per 12 hour watch. Surface salinity and temperature recorders and CTD instrumentation are to be provided by the ship. Echograms are to be taken along all cruise tracks by ship's personnel using appropriate shipboard sonar equipment; original traces are to be provided to Project cruise leader at end of the cruise. All biological sampling equipment will be provided by the project.

7. Weight of equipment is approximately 1,000 pounds, occupying approximately 300 cubic feet of storage space.

8. Telemetering coaxial cable is required for certain sampling equipment.

9. Formaldehyde will be used to preserve plankton samples. The formaldehyde will be on-loaded either in Seattle or Kodiak.

10. We strongly prefer the NOAA ship Miller Freeman as it is the only NOAA vessel assigned to the Northeast Pacific which is suitable for plankton sampling. The quality of data collected off the Freeman is far superior to that collected off the Discoverer due to previous experience of the vessel, ability to maintain vessel speed and wire angle, and in their devotion to a sense of mission. Additionally, the capability of the Freeman to deploy large pieces of sampling gear is far superior to the Discoverer.

Table 4 (Con'd).--Logistics Requirements, RU 551

11. N/A

12. The standard complement of people per cruise, depending on the vessel assigned, will be five to seven, including one co-principal investigator, one or two biologists, and three to four technicians. No foreign nationals will be employed.

XII. Activity/Milestone Chart:

An activity/milestone chart for FY 79 is attached as Table 5.

XIII. Outlook:

The first two years' study of Kodiak Island Food Webs should enable broad descriptions of what organisms are located where, in what relative magnitude, in a quasi-quarterly seasonality. Such efforts, however, have not allowed definition of sequences of events, from spawning, to early life history activity, until settling out or joining the nektonic or demersal regime. Studies through FY 79 probably will not define critical spawning times or areas, except by inference.

Needed in FY 80 are monthly cruises along the Kodiak Island shelf extending from about mid-March through mid-August. Such a sequence of observations should allow definition of critical areas, information on the timing and sequence of life history events along the Kodiak Island shelf. Such data may allow descriptions of communities of organisms susceptible to deleterious impact by oil contamination. Particularly needed are physical-chemical data to define flow in the region.

A significant omission in current OCSEAP studies are food studies of larval fishes. As the early life history stages are most likely to be severely impacted due to oil pollution, their food habits should be defined to allow assessment of causes of mortality.

Estimated costs of such field activities would be $250,000 plus sorting costs of $150,000. Logistics requirements would include the availability of the Miller Freeman for two-week periods each month for six months.

Table 5.--Milestone chart, RU 551, FY 1979

△ - Starting Date
○ - Planned Completion Date
X - Actual Completion Date
(to be used on quarterly updates)

RU # 551 PI: Dunn, Kendall and Wolotira

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 the analysis of fall 1977 zooplankton data	- - -	- - -	○												
Complete the analysis of spring 1978 ichthyoplankton data		△	—	○											
Complete the analysis of spring 1978 zooplankton data			△	—	—	○									
Complete the analysis of summer 1978 ichthyoplankton data				△	—	—	○								
Complete the analysis of summer 1978 zooplankton data					△	—	—	—	○						
OCSEAP Annual Report submitted							○								
Complete the analysis of fall 1978 ichthyoplankton data							△	—	—	○					

Table 5.--Milestone chart, RU 551, FY 1979 (Cont'd)

△ - Starting Data
○ - Planned Completion Date
X - Actual Completion Date
(to be used on quarterly updates)

RU # 551 PI: Dunn, Kendall and Wolotira

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

MAJOR MILESTONES	1978 O	N	D	J	F	M	1979 A	M	J	J	A	S	O	N	D
Complete the analysis of fall 1978 zooplankton data							△	—	—	—	○				
Synthesize data from first four cruises									△	—	—	○			
Complete the analysis of winter 1979 ichthyoplankton data										△	—	○			
Complete the analysis of winter 1979 zooplankton data										△	—	○			
Complete synthesis of data														○	
Write final report												△	—	—	○
Submit final report to OCSEAP															○

XIV. Required 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 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 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 acknowledgement is standard:

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Initial Zooplankton Tabulation

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ID ______________________________

Cruise [1|2|3|4|5|6|7] Station [9|10|11] Haul [12|13|14] Sample [19|20|21]

	Code		#/ Alq	Total #/ Taxa
	33 34 35	37	39 40 41 42	44 45 46 47 48 49 50
Copepoda	5 5			
Chaetognatha [W H L F]	2 1			
Amphipoda	5 8			
Euphausiacea adult	7 6			
Cnidaria	4			
Ctenophora	5			
Echinodermata larva	2 0			
Larvacea [W O T F]	2 5			
Thaliacea	2 6			
Octopoda	3 0			
Teuthoidea	3 1			
Pteropoda	3 5			
Heteropoda	3 6			
Annelida	4 3			
Cladocera	4 8			
Cirripedia larva - Cypris	5 0			
Cirripedia larva - Nauplius	5 1			

30
4

Identifier ______________ No. Jars _____ Date Started ______________________

Aliquot _____/_____/_____ No. Vials _____ Date Completed ______________________

APPENDIX I

Initial Zooplankton Tabulation

page

ID ____________________

Cruise [1 2 3 4 5 6 7] Station [9 10 11] Haul [12 13 14] Sample [19 20 21]

	Code (33 34 35)	37	#/ Alq (39 40 41 42)	Total #/ Taxa (44 45 46 47 48 49 50)
Decapoda larva	6 5			
Decapoda larva - zoea	6 6			
Caridea	6 9			
Penaeidea	7 0			
Euphausiacea larva	7 7			
Isopoda	7 9			
Mysidacea	8 0			
Ostracoda [W B S]	8 4			
Pisces larva	8 6			
Pisces egg	8 7			
Miscellaneous	9 1			
Miscellaneous egg	9 3			
Unidentified	9 7			

80
4

Identifier ________ No. Jars ____ Date Started ________

Aliquot ___/___/___ No. Vials ____ Date Completed ________

To: Appropriate Project Office

Proposal/Revision Date: July , 1978
Contract #: 03-5-022-69
NOAA Project #: N/A
Institution ID #: N/A

FY 1979 RENEWAL PROPOSAL

Research Unit Number 552

TITLE: Seasonal Composition, Abundance and Food Web Relationship of Principal Juvenile and Adult Marine Finfish Species Inhabiting the Nearshore Zone of Kodiak Island's Eastside - Including Icthyoplankton, Meroplankton and Forage Fish.

Cost of Proposal: $155,000. Lease Areas: Kodiak 100%

(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

PRINCIPAL INVESTIGATOR(S):

Name James Blackburn, Fishery Biologist Date July 19, 1978
Peter Jackson , Fishery Biologist

Signature James E. Blackburn
Peter B. Jackson

Address Alaska Dept. of Fish & Game
P.O. Box 686 Kodiak, Alaska 99615

Telephone Number 907 - 486-5751 FTS: N/A

INSTITUTION (Include Department, if appropriate)

Alaska Dept. of Fish & Game

REQUIRED ORGANIZATION APPROVAL:

Name Steven Pennoyer Date ~~July~~ 9-21-, 1978
Signature Steven Pennoyer
Position Chief Research Scientist
Alaska Dept. of Fish & Game
Address Subport Bldg. Juneau, Alaska 99801
Telephone Number 907 - 465-4220

ORGANIZATION FINANCIAL OFFICER:

Name John Stewart Date ~~July~~ , 1978 9-21-78
Signature [signature]
Position Finance Officer
Address Alaska Dept. of Fish & Game
Subport Bld.g Juneau, Alaska 99801
Telephone Number 907 - 465-4157

TECHNICAL PROPOSAL

I. Title: Seasonal Composition, Abundance, and Food Web Relationships of Principal Juvenile and Adult Marine Finfish species inhabiting Kodiak Island's Eastside - Including Icthyoplankton, Meroplankton and Forage Fishes.

Research Unit Number: 552

Contract Number: 03-5-022-69

Proposed Dates of Contract: October 1, 1978 thru September 30, 1979

II. Principal Investigator(s):

James E. Blackburn

Peter B. Jackson

III. Cost of Proposal

A. Science - $155,000.

B. P.I. Provided Logistics - $0.00

C. Total - $155,000.

D. Distribution of Effort by Lease Area: Kodiak - 100%

IV. Background:

A regime of marine organisms highly subject to the potential impact of oil and gas development in the Gulf of Alaska is the pelagic and demersal finfish assemblage inhabiting the nearshore zones. This high potential risk is primarily due to the likelihood of spilled oil coming ashore and the resultant impact to organisms in that zone. The nearshore zone is known to be important to many commercially important species as well as to their food organisms.

The OCSEAP addressed this data need in FY 76 through RU 486 and RU 485 and again in a more comprehensive manner in FY 78 through RU 552, and 553. While this integrated multidisciplinary approach has filled a number of critical data gaps, four primary areas of need remain. Paramount among these are the necessity for complete and integral analyses of the existing data base and to integrate results with cooperative research units in order that full value can be realized as soon as possible from the existing data base.

Of second importance is the need to expand seasonal sampling through the winter months. Existing data on the spatial and temporal distribution as well as relative abundance of nearshore finfish distribution involve only the late spring and summer months; winter observations will be necessary to obtain a complete and comprehensive picture. The third data gap is the lack of information on life history characteristics of nearshore spawning forage fish, i.e. herring, capelin, eulachon, etc. This gap exists because these species cannot be adequately assessed using RU 552 methodology. The last primary need is for more specific data on nearshore marine organisms of commercial or ecological importance. Evaluation of similar environmental studies in other areas has demonstrated the need for increased emphasis on assessing and evaluating those species in nearshore areas in respect to potential hydrocarbon related impacts. This need will overlap with and be addressed by all components of the study proposed here.

V. Objectives:

1. Determine the seasonal composition and relative abundance of principal finfish species (adult and juvenile) on the Kodiak shelf with emphasis on nearshore areas.

2. Describe the temporal dynamics (diel, seasonal, ontogenetic) and habitat use by principal finfish species, including their juvenile stages.

3. a. Determine the temporal and spatial distribution of spawning by nearshore pelagic forage fishes. Determine age, weight and length relationships of these fish species.
   b. Identify spawning substrate commonly use by herring, capelin and other species encountered.
   c. Determine density of capelin spawn on substrate.

4. Conduct sampling so as to permit RU 553 personnel to obtain and analyze stomach contents in order that food webs may be described.

The above objectives for RU 552 are designed to integrate with those of RU 553 to collectively determine the distribution, abundance, and critical life stages of principal nearshore marine fish populations on Kodiak Island's eastside as well as the spatial and temporal distribution of the major food items utilized by those species. A comprehensive approach of this nature is essential to adequately assess the potential risks of petroleum related development to this sensitive and critical nearshore regime.

VI. Strategy and Approach:

As work proposed here consists of three basic elements, or studies, the following discussion of their strategy and approach will consider each separately. In addition to a general discussion of the strategy and approach for each facet, each discussion will include specific sampling and analytical methodologies as well as procedures for insuring periodic calibration and valid intercomparisions of instrumentation.

Study 1

Integrated analysis of existing data base and preparation of comprehensive report on work to date: This first and possibly primary facet is designed to analyze the existing RU 552 data base, synthesize results with appropriate data from associated research units in the Kodiak Lease Area, and produce a comprehensive report on the timing, distribution, relative abundance and major food items utilized by nearshore fish species on Kodiak Island's eastside. Attempts will also be made to depict relationships between key finfish species and their major food items. In addition to utilizing data from RU 552 in FY 78 and 79, data from RU 486 (ADF&G) and RU 485 (FRI) obtained in FY 76 will be heavily drawn upon as well as appropriate data from RU's 512, 553, 332 and 5. This report will be finalized and submitted by September 30, 1979, and will include data obtained during the winter surveys of FY 79.

As this study consists entirely of compiliation, analyses, interpretation and presentation of data, a discussion of sampling methods is not applicable.

Data collected will be proofed, keypunched and edited. From the corrected data one copy will be put into OCSEAP format and submitted, while another copy will be used for analyses. A species list of the fish captured will be presented. The catch information will be summarized as mean and standard error of catch per unit effort by gear, bay, species, and time period. The amount of effort will be summarized by gear, bay, and time period. Relative abundance and rank of abundance by taxon will be presented for each gear, bay, and time period.

In general, tests of significance and confidence limits on statements will not be necessary. Since this study is a survey, the descriptive statistics, mean and standard error of the mean as well as a presentation of the level of effort, are the appropriate methods of displaying results.

In order to describe temporal dynamics of fish species at specific sites, the species will be individually discussed verbally with appropriate tabular and graphic presentations constructed to display the results and interpretation of results.

Study 2

Nearshore finfish sampling surveys: This second study component is designed to build and expand existing data base of RU 485 and 486 (FY 76) and RU 552 and 553 (FY 78) on abundance, composition and trophic relationships of nearshore finfish throughout the winter months. This will provide the year-round data continuum of essential biological parameters necessary for OCSEAP needs. For the sake of comparability, this survey effort will duplicate the methodologies and study areas used by RU 552 in April through August FY 78. The four study areas used in FY 78 collectively represent the major habitat and exposure types of Kodiak Island's eastside: Izhut, Kalsin, Kiliuda and Kaiugnak Bays (Figures 1A - 1D). Two winter surveys will be conducted in each of the four study areas: one in October-November and one in February-March. Each survey will require four to five weeks actual field time, with six to eight days being devoted to each study area. This work will be conducted jointly and be closely integrated with the feeding habits study by RU 553. Further, it is presently envisioned that RU's 552 and 553 will simultaneously utilize the same vessel. The same suite of fishing gear types (described later in this section) used by this RU in FY 78 will be used in FY 79 as far as possible; however, certain gear types (tow net, gill net, trammel net and beach seine) may not be used or used only opportunistically due to inclement weather and/or freezing conditions. Other gear types (try net, trawl, and mid-water trawl) are less subject to weather limiting their use. This suite of fishing gears is designed to provide sampling of all habitat types in each study area. Approximately 120 stations will be occupied in the Marmot-Chiniak Bay areas and 112 stations in the Kiliuda-Sitkalidak Straits area during each survey, at a maximum (Table 1). This RU will have the further responsibility of establishing sampling design, conducting sampling and providing samples to RU 553 for trophodynamic analyses.

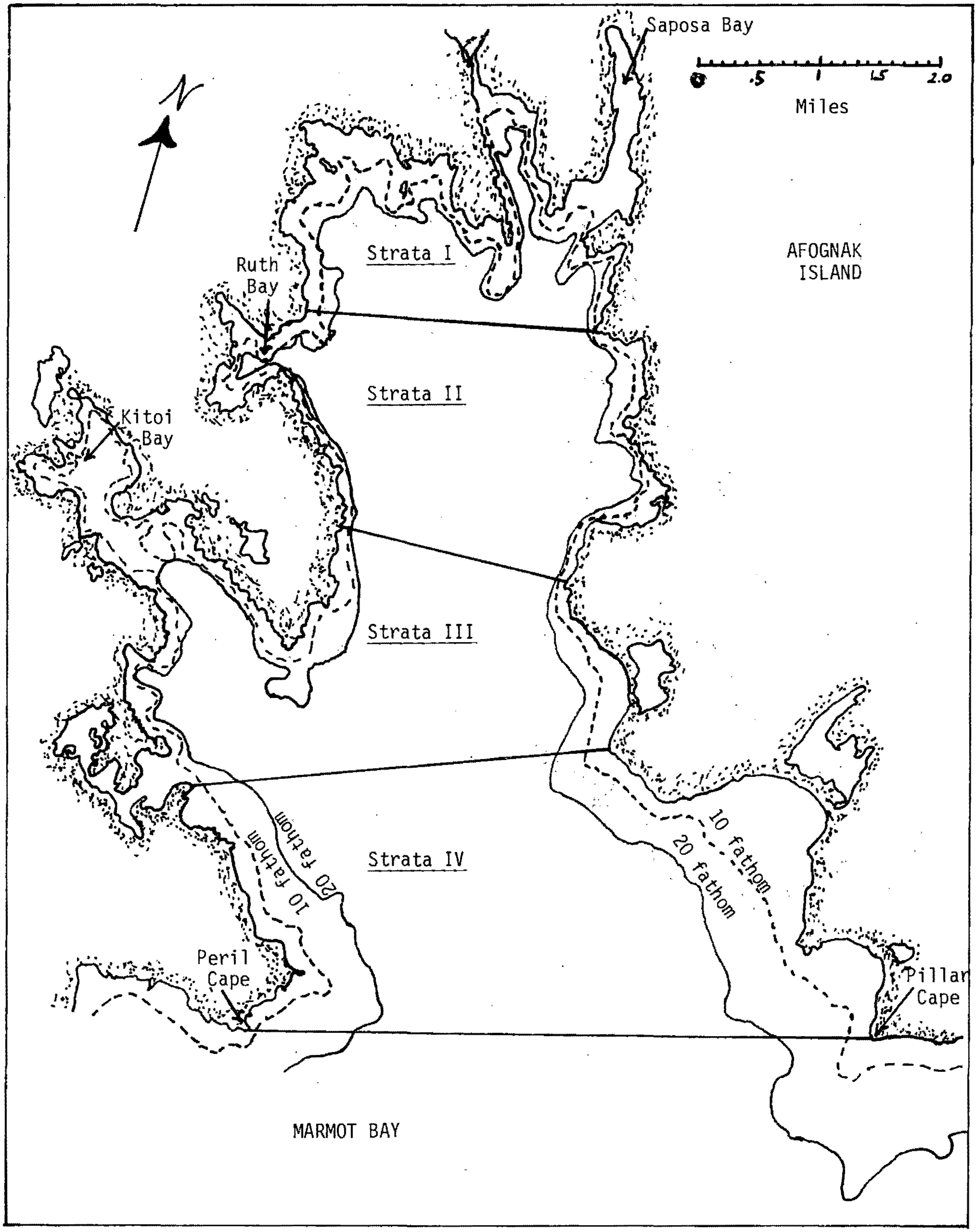


Figure 1A - Izhut Bay sampling region with 10 fathom (18.29 M) and 20 fathom (36.58 M) contours and sampling strata as utilized by R.U. 552 & 553 on Kodiak Nearshore Fish Assessment Study, 1978.

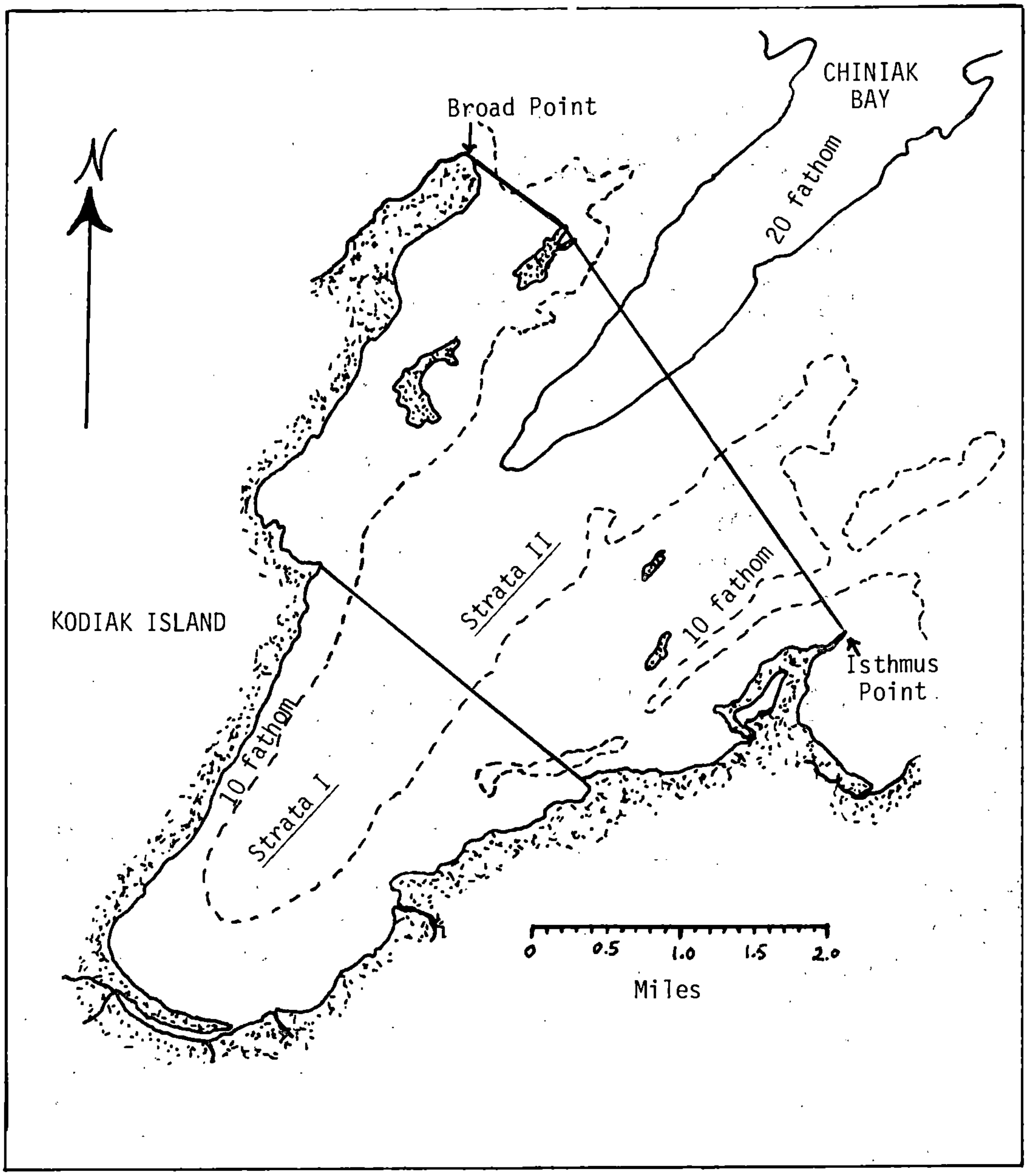


Figure 1B - Kalsin Bay sampling region with 10 fathom (18.29M) and 20 fathom (36.58M) contours and sampling strata as utilized by R.U.552 and 553 on Kodiak Nearshore Fish Assessment Study, 1978.

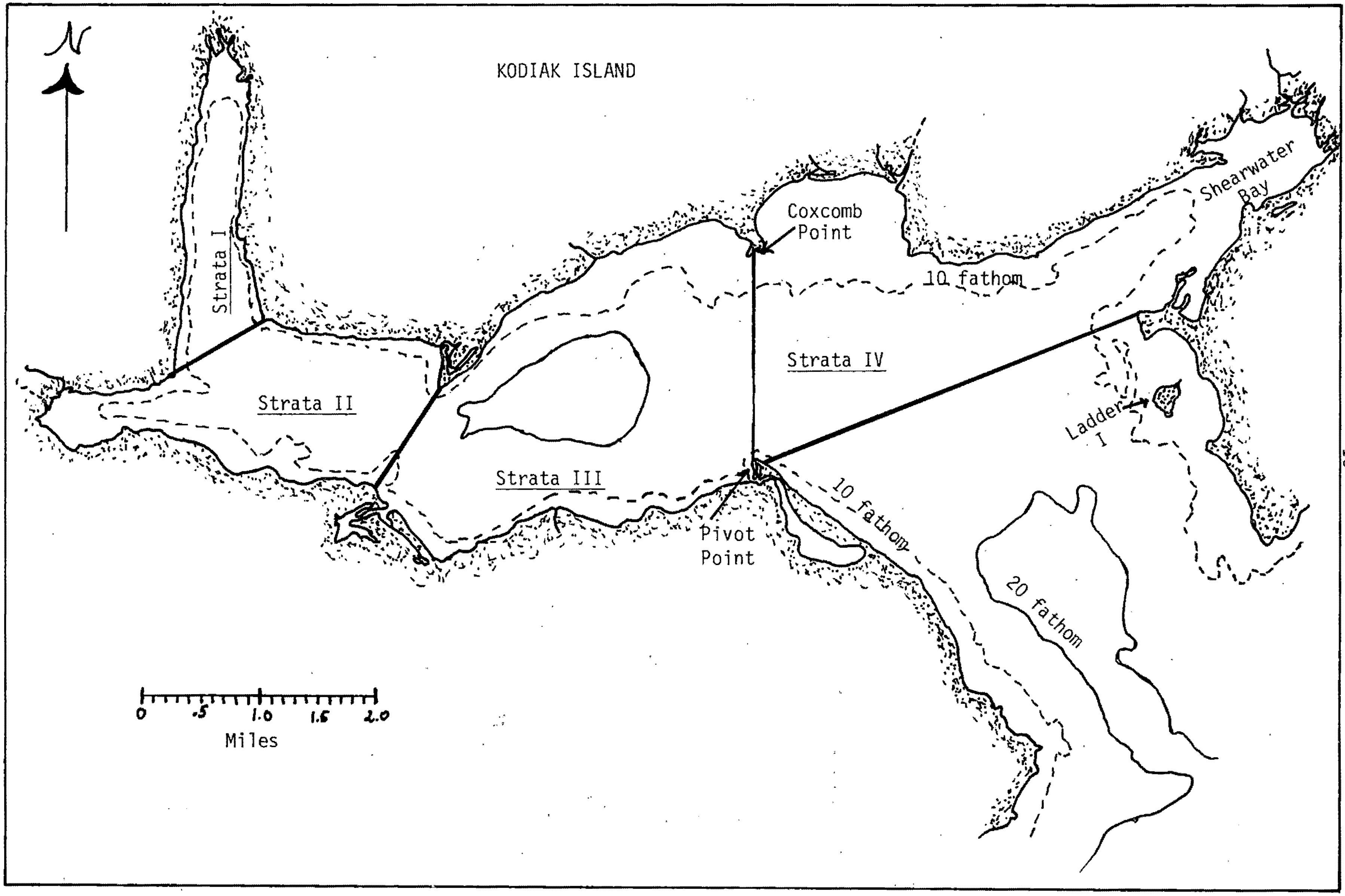


Figure 1C - Kiliuda Bay sampling region with 10 fathom (18.29M) and 20 fathom (36.58M) contours and sampling strata as utilized by R.U.552 and 553 on Kodiak Island Nearshore Fish Assessment Study, 1978.

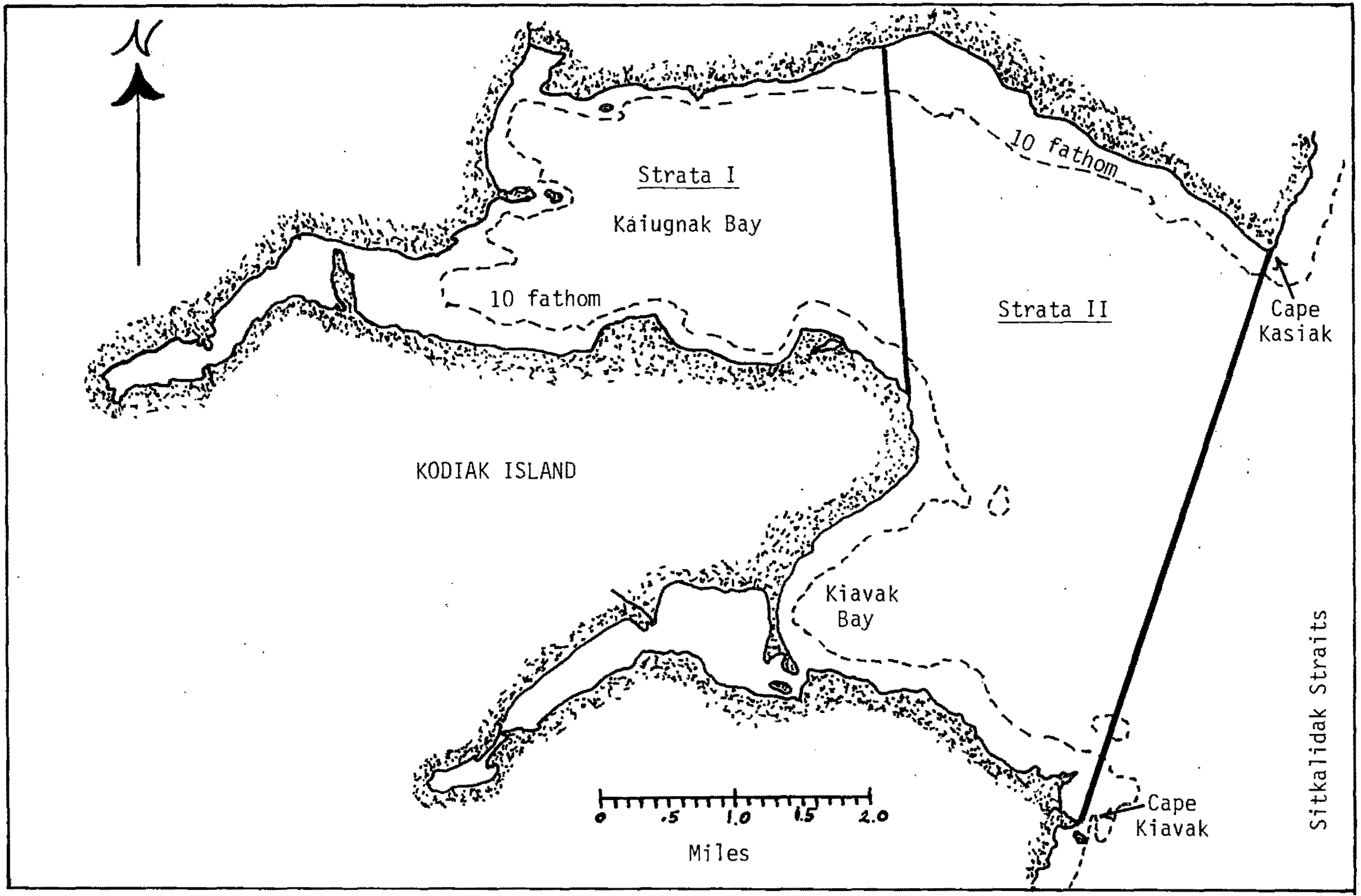


Figure 1D - Kaiugnak Bay sampling region with 10 fathom (18.29M) and 20 fathom (36.58M) contours and sampling strata as utilized by R.U. 552 & 553 on Kodiak Nearshore Fish Assessment Study, 1978.

Specific methodologies and procedures for this work are as follows:

1. Data will be obtained during 2 one month to five week surveys, (October-November and February-March).
2. Each survey shall include four study areas as follows (Figures 1 A - 1 D, 2):
   a. Izhut Bay - inside of a line between Pillar Cape and Peril Cape.
   b. Kalsin Bay - inside of a line between Broad Point and Isthmus Point.
   c. Kiliuda Bay - inside of a line between Pivot Point and Shearwater Point.
   d. Kaiugnak Bay - inside of a line between Cape Kiavak and Cape Kasiak.
3. Surveys will utilize a 60-80 foot seine vessel for primary logistical support as well as for certain fishing operation (i.e. try net and tow net operations and otter trawl operations).
4. Nearshore fishing operations will require the fulltime use of one 14-16 foot skiff equipped with a 25 h.p. outboard engine as well as a 16-18 foot skiff equipped with a 70 h.p. outboard engine to be used in conjunction with the large vessel for tow net operations.
5. Each study area will be sampled in respect to sampling strata designed to insure adequate sampling distribution (See Figures 1 A - 1 D). Actual sampling sites for each gear type will remain identical with those employed in FY 78 studies. The following prioritized suite of gear types will be fished; these gear types were selected on the basis of their composite ability to catch fish species throughout the nearshore zone and priority is based on weather limitations of each gear (Tables 1 & 2):
   a. Beach seine: 155' - tapered from wings to 12' at center, ¼" mesh throughout. Fish in extreme nearshore areas, primarily sandy beaches, at 0-2 fathoms.
   b. Trammel net: 150' X 6' (3 panel).
   c. Variable mesh gill nets: ¼" - 2½" mesh - floating & sinking.
   d. Tow net: 10' X 20' X 43'.
   e. Try net: 20' try net with 1½" X 9' webbing throughout, with 15" X 30" otter boards; 3 to 15 fm smooth bottom.

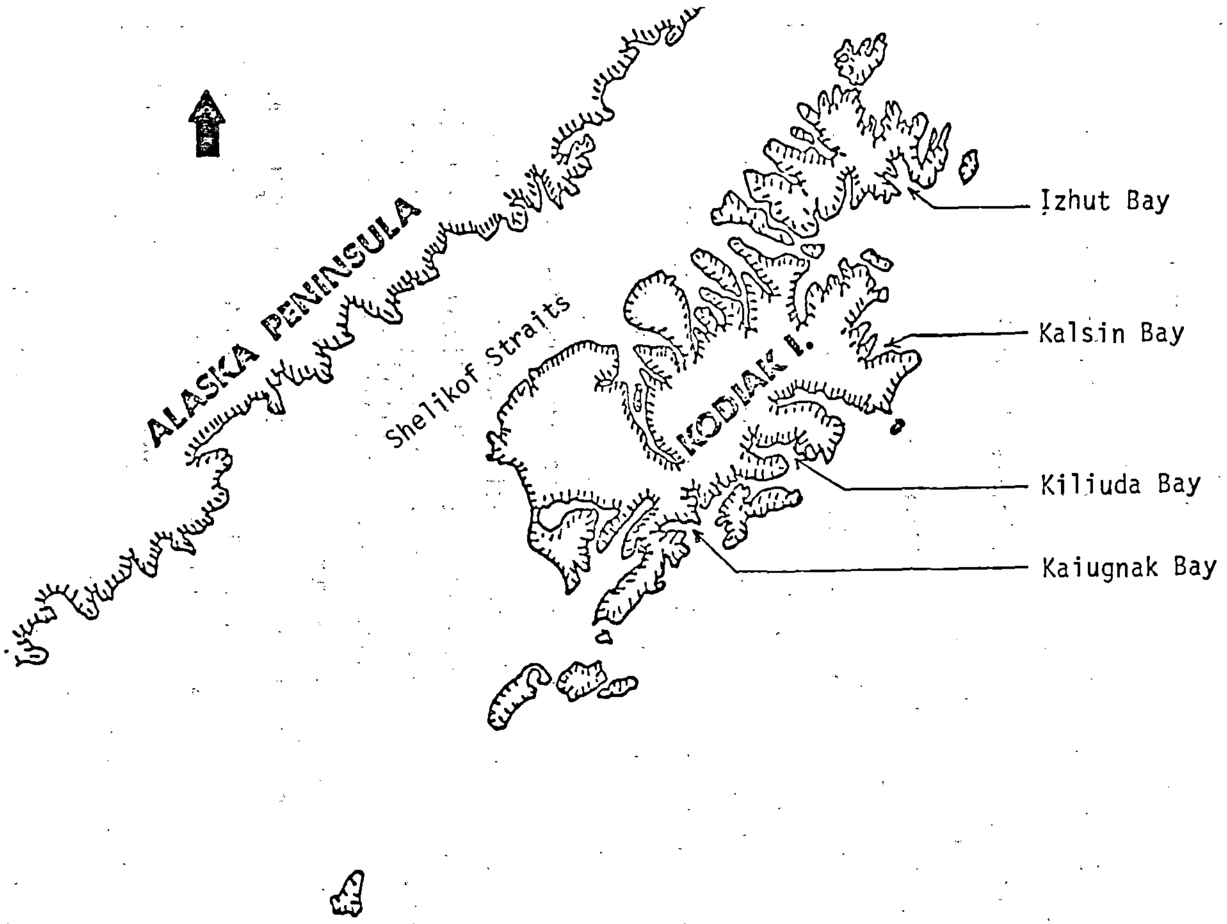


Figure 2 - Primary study areas for R.U. 552 in F.Y.79. Two surveys shall be conducted, one in October - November of 1978 and the second in February - March of F.Y.79. Surveys on each individual study area shall be referred to as a "leg". See Figures 1A - 1D for more detail.

f. Standard 400 mesh Eastern Otter Trawl: fished from a large vessel.

This priority listing will be negotiated between ADF&G and the Project Office to define a minimum sampling effort per bay.

Table 1. Estimated sampling intensity by gear type for each monthly survey.

		# of Hauls by Gear					
Area	# of Regions	B.S.*	GN/ Tml.Net	Mwt.	Tow Net	Try Net	Otter Trawl
Izhut Bay	4	18	15	4	16	13	3
Kalsin	2	12	11	4	11	8	
Kiliuda Bay	4	16	14	5	18	6	3
Kaiugnak Bay	2	12	9	2	8	2	
Totals							
Per Survey	12	58	49	15	53	29	6
Per 2 Surveys		116	98	30	106	58	12

* B.S. = Beach seine
GN = Gill net
Tml = Trammel net
Mwt. = Midwater trawl

6. Exact location fished by each gear type in each sampling region will remain identical with those for each type in the FY 78 surveys and consistent between surveys; additonal sets by various gear types may be added if time permits. While precise sampling stations for each gear type cannot accurately be depicted here, they conform to the depth ranges and habitat type for each shown above. Distribution of sampling effort by gear type in each sampling area is based on allocation by strata and available time. Precise location of sampling stations within strata for each gear type must be based on suitable bottom topography,

Table 2. Sampling specification for Kodiak nearshore finfish assessment study R.U. 552.

Sampling design

1). Locations or bays (number of regions in bay)

- a. Ishut Bay (4)
- b. Kalsin Bay (2)
- c. Kiliuda Bay (4)
- d. Kaiugnak Bay (2)

2). Months, 2 (October-November and February-March)

3). Habitat (gear)

- a. Nearshore, less than 10 fm (beach seine, trammel net, try net, gill net).
- b. Epipelagic 10-20 fm (tow-net, mid-water trawl, try net).
- c. Demersal, greater than 20 fm (otter trawl, mid-water trawl). Try-net also used in this zone to obtain special king crab samples for R.U. 5.

4). Life history stage (juvenile and adult, size class).

5). Species (tentative to be modified from early sampling results according to abundance in catches).

Primary species	Habitat		
a) Pacific sand lance	nearshore	epipelagic	
b) Capelin	"	"	
c) Pacific sand fish	"	"	
d) Masked greenling	"		
e) Rock sole	"	"	demersal
f) Great sculpin			"
g) Yellowfin sole			"
h) Flathead sole			"
i) Pacific cod			"
Secondary species (sampled as catch permits)			
a) Pink salmon	"	"	
b) Chum salmon	"	"	
c) Snake prickleback	"		
d) Rock greenling	"		
e) Irish Lord			"
f) Walleye Pollock			"

Sample size will be 40 fish per region (12), per month (5), per habitat type, (1-2) per life history stage, (2)for each primary species.

bottom type and depth, although all efforts are made to distribute effort within strata for each gear type as evenly as possible. The sampling strata and depth contours within each bay are shown in Figures 1 A - 1 D.

7. The number of sampling regions in each study area and the number of sets made per gear type in each survey is shown in Table 1. This time schedule is based on allotting two days per strata per survey.

8. It must be stressed that while all efforts will be made to maintain the FY 78 sampling intensity for each gear type shown in Table 1, the foul weather and/or sea conditions prevalent during winter months may quite possibly preclude (partially or entirely) use of certain gear types due to obvious safety considerations. The otter trawl, try net and midwater trawl can be used in most cases. Tow nets will be somewhat subject to weather (primarily rough seas) but not as much as trammel nets and gill nets which must be operated from 14-16 foot skiffs, often in rocky areas with heavy kelp growth. The beach seine can usually be fished if the crew is able to come ashore. Use of these latter three gear types can also be precluded by sub-zero temperatures when the webbing freezes immediately upon leaving the water. Hypothermia is a constant threat during small boat fishing operations in winter months and all precautions will be taken to guard against it.

9. Sampling will be conducted by four scientific personnel (2 from FRI and 2 from ADF&G in addition to the vessel crew.

10. The 4 person scientific crew work in two 2-person teams; one to handle beach seines, trammel nets, gill nets and tow nets from the open skiff and the other to remain on-board the large vessel to handle the tow net, try-net and mid-water trawl. In most cases these two crews will be able to operate simultaneously.

11. Catch processing (i.e. species identification, enumeration, subsampling, measuring, weighing, foregut removal) will be done immediately following fishing operations whenever possible. When not possible, large fish will be processed in the field, their data recorded

on appropriate forms and the remaining catch preserved and sent to Kodiak laboratory for final analysis or species identification.

12. Sample handling (beach seine, tow net, gill net, trammel net, and try net).

    While the net is being fished, haul data will be recorded on the File Type 023 Format. Small catches will be sorted immediately by species and life history stage. From large catches, the obvious, large, infrequent species will be sorted out immediately and the remainder of the catch will be subsampled and preserved or subsampled and sorted depending on time available. Preserved samples will be sorted at a later time by species and life history stage. Total counts and weights by species will be taken and recorded.

13. Catch and data handling procedures are outlined sequentially in Figure 3. All data will be recorded on the appropriate OCSEAP/NODC data formats and in accordance with approved data management procedures.

14. Samples for trophic studies will be collected during the nearshore sampling effort as per Table 2, Section 5. Approximately 2000 fish will be sampled for this purpose.

<u>Otter Trawling Procedures</u>

1. Otter trawling will be accomplished in the Izhut and Kiliuda Bay study areas. One day in each of these areas will be utilized for this sampling during each survey.
2. Trawling will be done using a standard 400 mesh Eastern otter trawl. A minimum of three biologists, one from RU 552, one from RU 553, and one from RU 5 will be on board. These sampling operations will be directed by RU 552. The vessel will schedule one day in each study area per survey for this work.
3. All otter trawling will be done at depths from 20 - 50 fm. A total of three hauls will be made daily--two at less than 30 fm and one between 30 and 50 fm. Exact locations will be made identical to those used by RU 552 and 553 and remain as consistant as possible between surveys to insure comparability.
4. All hauls will be one nautical mile in length and, as far as possible, be made in a straight line.

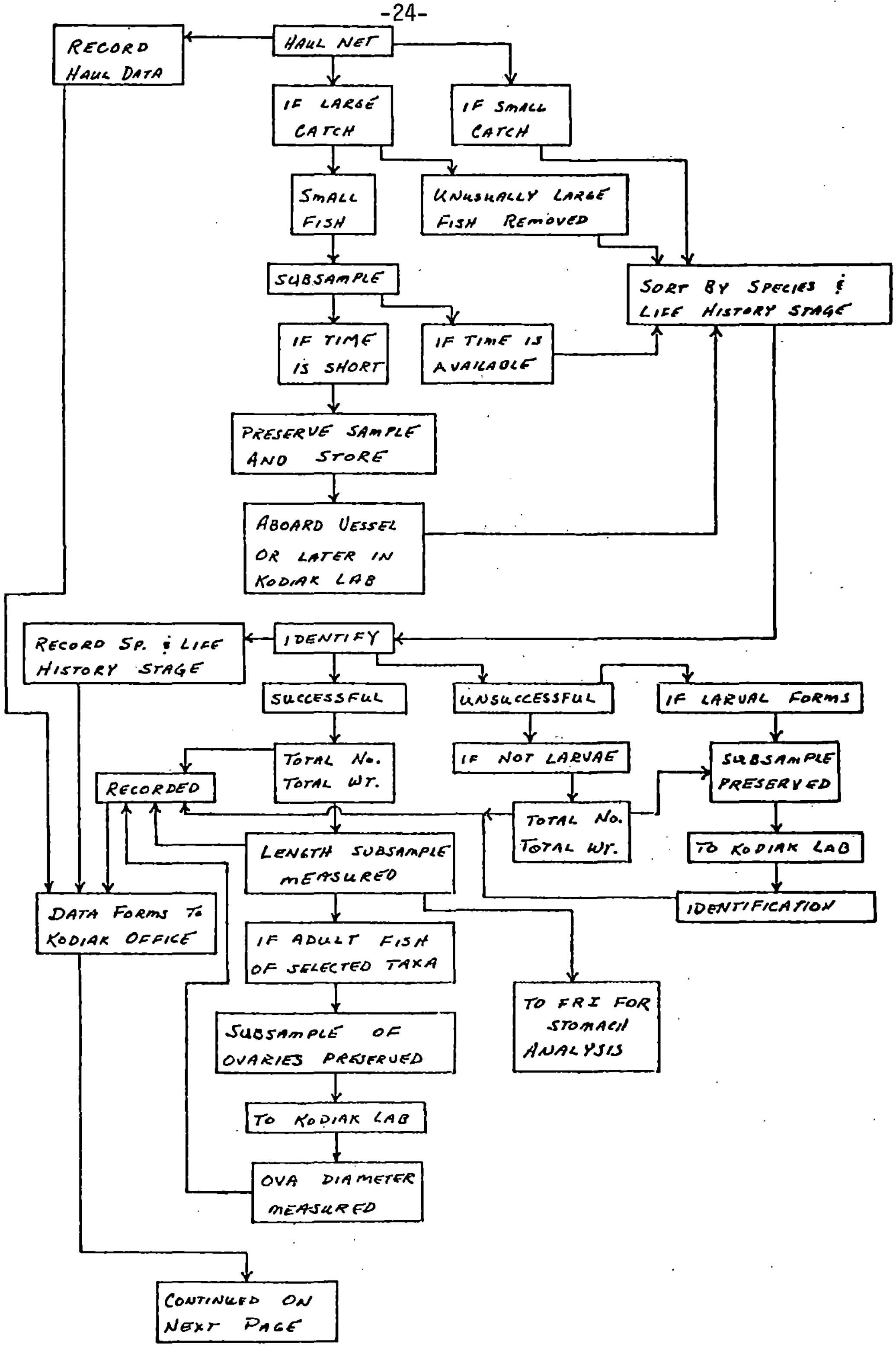


Figure 3 - Data handling and verification procedures planned for File Type 023 data from Study 2 of R.U. 552 in F.Y. 79.

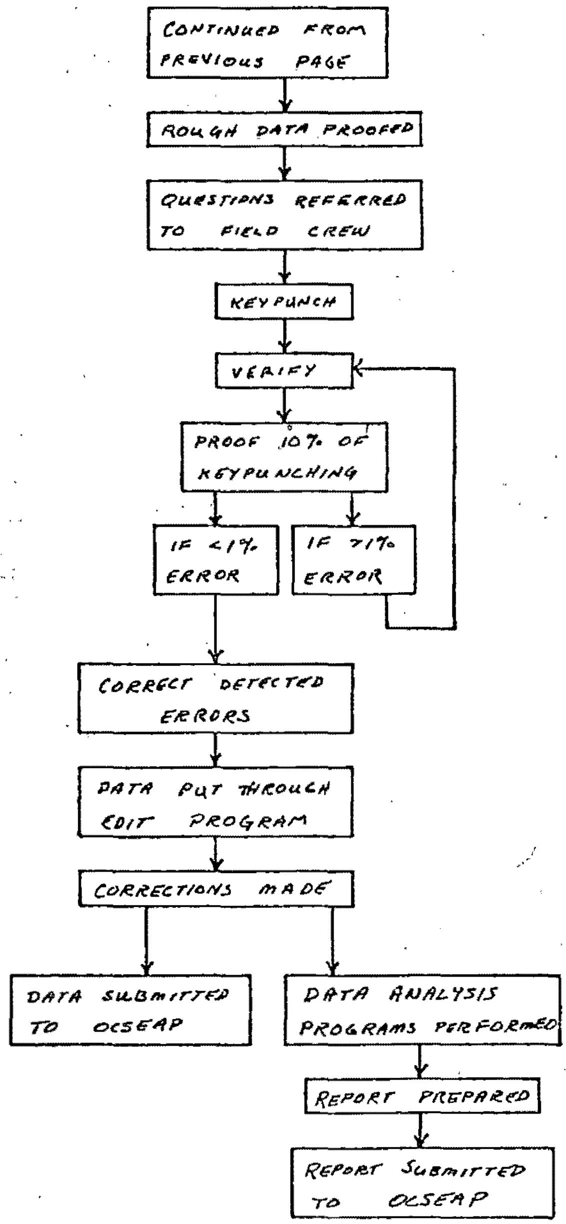


Figure 3 - (Cont.)

5. Catch weights will be obtained to the nearest 5kg as they come aboard the vessel. Prior to subsampling, all "large fish" such as Pacific halibut, skates, large cod, etc shall be removed. A subsample of the remaining catch will then be randomly selected. Subsample selection will be accomplished by dumping the catch onto a 15' X 20' canvas and a rope under the canvas will be lifted to separate out the desired size subsample (not exceeding 200 lbs.). The number and combined weight of all fish of each species in this sample will be determined and recorded.
6. Those species determined as "primary species" (not more than 100 specimens of each) will be measured by standard length to the nearest centimeter.
7. All data obtained will be recorded on the File Types 023 format, keypunched, varified and submitted to the OCSEAP, Juneau Project Office as per Figure 3 and required data submission schedules.

The fishing gear types listed above for use by ADF&G to conduct nearshore fish assessment studies have been selected so as to sample fish species from the entire water column. The gear types and specifications given are of proven effectiveness and have been used by this agency on prior studies in this and other areas. These gear types will be fished in respect to the samling regions enumerated in Table 1, and in those depth zones and bottom types appropriate to each. A two-man crew will be deployed from the large vessel in a 16-18 foot skiff to fish beach seines, floating and sinking gill nets, and trammel nets. These latter three gear types will be utilized from outside the intertidal zone to 4 or 5 fathoms depth, and are especially effective in areas of rock and kelp; a beach seine will be fished from the beach and is the primary gear for sampling the intertidal zone. The large vessel will fish three gear types in waters from 5 to 20 fathoms depth with the tow net, try-net, and a mid-water trawl; these gear types will sample the surface, bottom and mid-water regions of the study areas, respectively. The try-net and mid-water trawl will be fished with the large vessel only, whereas the tow net will require assistance by the 18-22 foot skiff to hold the net in a proper fishing configuration. Sampling for benthic finfish species will be with the standard 400 mesh eastern otter trawl from the M/V COMMANDO immediately offshore from this nearshore sampling. Sampling techniques for each gear type will remain consistant to insure comparability.

Precedures employed by this study component to insure quality control of data products are described in detail in Figure 3. As all data from FY 79 field studies will be included in the comprehensive report scheduled for completion by October 1, 1979, a description of analytical methods and strategies is the same as that shown in Study 1 of this section. The methodology is designed to meet the primary objective of the RU as stated in Section V of this Technical Proposal. The primary instrumentation required to conduct Study 2 will be the navigational instruments aboard the charter vessel which determine position, depth, wind direction and speed. These are calibrated at least annually. Water temperature and salinity will be obtained from a portable Yellow Springs Instrument Co. Model 33 temperature salinity meter.

Study 3

Spawning assessment of coastal and nearshore finfish species: The study area for this work component will include the coastline of Kodiak Island's eastside from Tonki Cape to Cape Sitkinak. The study will consist of two components: aerial surveillance and ground truth surveys, components 1 and 2, respectively.

Component 1 will consist of low level flights along Kodiak's eastside conducted bi-weekly from April 25 through July 15 (Figure 4). A total of six flights each lasting eight hours will be conducted. This time period is chosen to correspond with forage fish (herring and capelin) spawning. The study area will be subdivided into numbered survey areas. Activities of all flights will be documented on File Type 057 format. Forage fish school locations will be recorded and approximate size will be subjectively estimated from photographs. The summarization of this observational data will provide spatial and temporal distribution information of forage fish spawning aggregations. However, species determination generally is not possible with this technique.

The basic methodology and strategy of Component 2 ground truth surveys will be utilization of highly mobile field crews equipped with camping and standarized fishing gear to sample fish located by aerial surveilance. These crews will operate from base camps which will be fished consistently throughout the season, however, the crews will be available for travel to new spawning locations as determined by ongoing aerial surveilance. Sampling will be done with two basic types of fishing gear: a 150' beach seine and a five panel variable mesh gill net. The specifications of these gear types will remain consistent with those used in Study 2 for comparative purposes. These crews will be equipped with rubber rafts for offshore fishing when necessary. A total of two 2-person crews will be deployed, one located on the Trinity (Sitkinak and Tugidak) Islands and the other will work on Kodiak Island's eastside. Prospective base camp locations are near the Sitkinak Loran Station on Sitkinak Island and the other will rotate between Barling Bay in Sitkalidak Straits, and the Alaska Department of Fish & Game hatchery facility at Izhut (Kitoi) Bay (Figure 4). These are areas where intense spawning is expected, however, the crews will be moved to adjacent areas in response to spawning activity detected during aerial surveillance (Component 1). These crews will begin field work with the commencement of spawning and continue until spawning has terminated.

Field activities will consist of fishing with the two gear types, and description of spawn location and density. Species composition of fish sighted from the air will be provided by the fishing operation. In addition, samples of herring and capelin will be taken for age determination to provide age class structure and age at maturity.

Field collections of fish will be handled as in previous work (Study 2), in addition age structures of up to 800 herring and capelin will be collected at each ground sampling site. To ensure adequate sample size for age analysis, very large samples will be selected from initial catches and smaller samples taken once the total sample exceeds 400, as per Table 3.

The following sampling criteria will be adherred to:

1. Within a given test site, nets will be fished in consistent locations whenever possible. Fishing will be conducted day and night.
2. Scales shall be removed from each herring at field camps and put into envelopes for later mounting and reading. Some direct mounting of scales from whole specimens shall be done in the field when deemed possible by the crew leader.
3. All capelin sampled shall have otoliths removed, placed in small vials, and fixed in 50% alcohol. Ages of capelin will be ascertained later at the Kodiak laboratory facility.

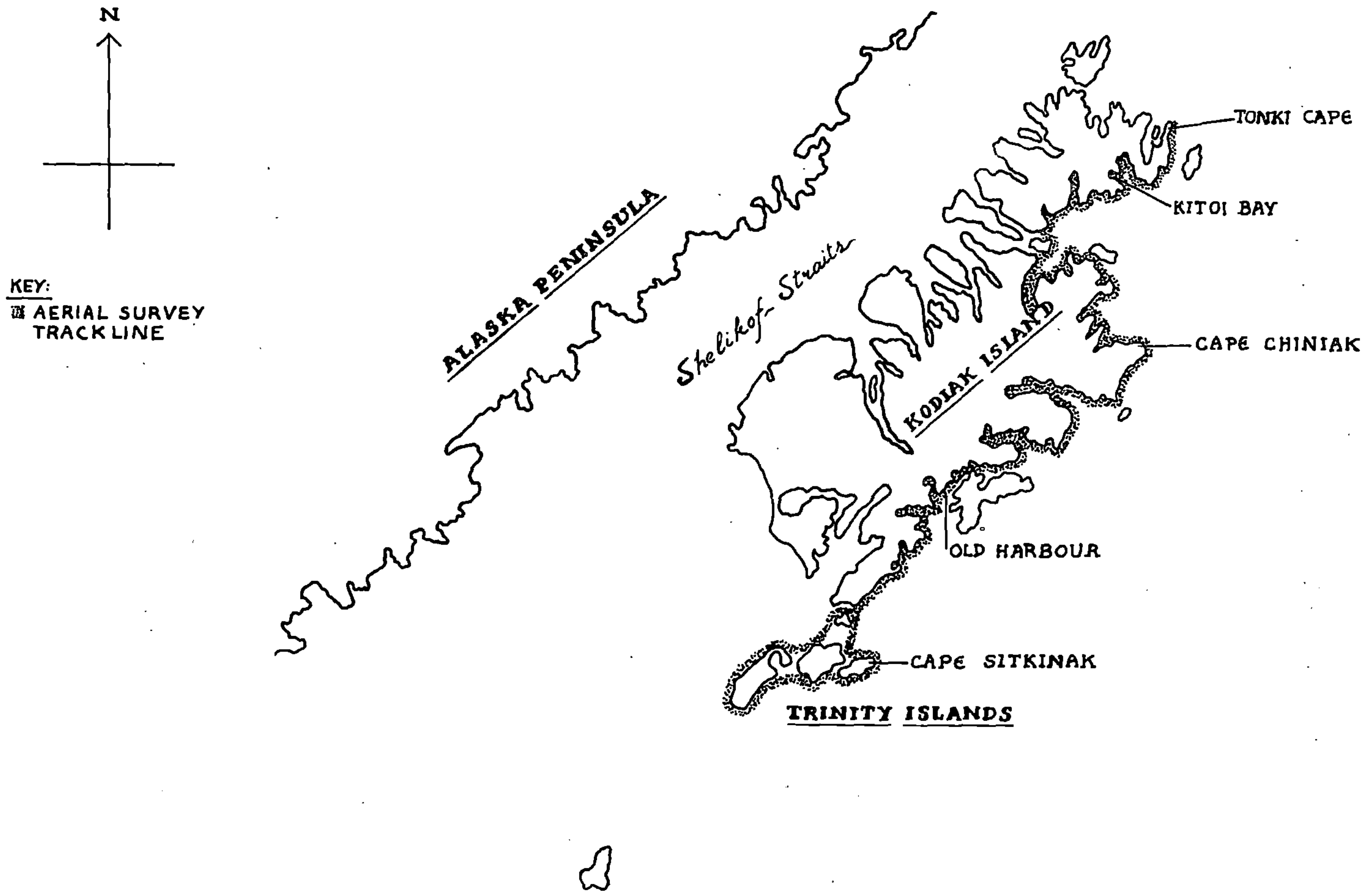


Figure 4 - Aerial survey trackline and location of primary groundtruth sites for study 3 of R.U. 552 in F.Y.79.

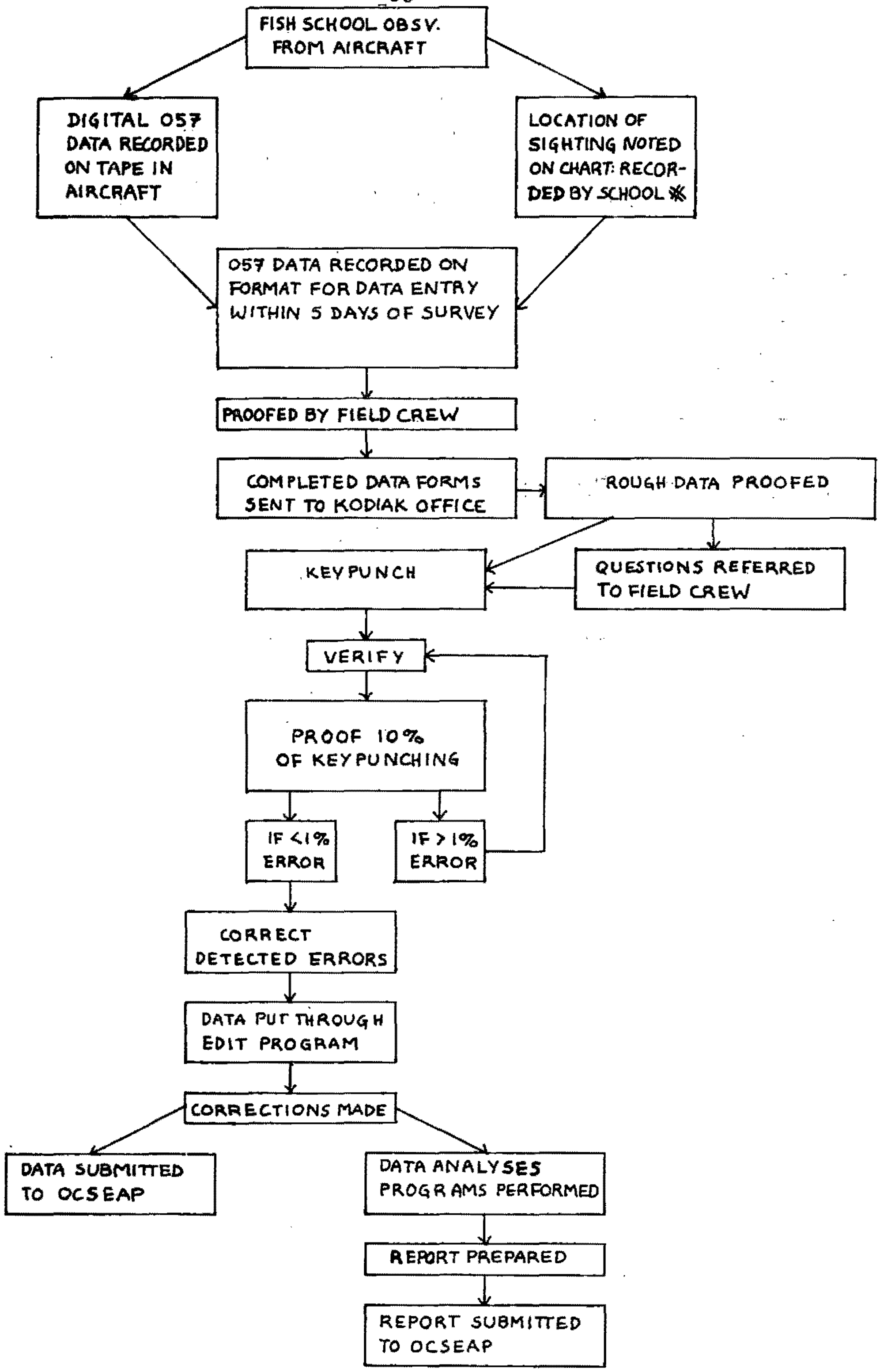


Figure 5 - Data handling and verification procedures planned for file type 057 data from Study 3 of R.U. 552 in FY 79.

Table 3 - Subsampling scheme for herring and capelin groundtruth studies R.U. 552, F.Y.79.

Number Sampled-Total for Test Site	Sub-sample (Herring and Capelin)
1-400	All
400-600	1 in 2
600-800	1 in 3
800-1000	1 in 4
1000-1500	1 in 6
1500-2000	1 in 10
Greater than 2000	1 in 15

Sub-Sampling Scheme (all other species)	
1-200	All
200-1000	1 in 10
Over 1000	1 in 20

4. All fish will be measured to the nearest millimeter — herring in standard length, and capelin in fork length.
5. Whole body weight of all fish sampled will be recorded to the nearest whole gram.
6. Sexual maturity will be determined of all fish sampled. Gonad maturity will be measured with the following subjective scale:

   I = Gonad thread-like. Sex hard to determine. An immature fish.

   II = Gonad ribbon-like. Sex determinable. An immature fish in early maturation stage.

   III = Gonad at least 1/5 size of coelom. Either a fish in early maturation stage or a mature fish approaching a pre-spawning condition.

   IV = Gonad size of body cavity, yet membrance intact and vascularization complete or nearly complete.

   V = Sex products can be producted from vent with GENTLE pressure on abdominable walls of fish. Vascularization beginning to reduce, and ovarian and testian membranes beginning to reassimilate.

   VI = Sex products flow freely. In ready spawning condition.

   VII = Spent. Sex difficult to determine.

   VIII = Recovering adult. Gonads present, yet small.

Sampling adequacy is difficult to define. Based on our three years experience with this type work, the amount of aerial survey effort planned and the 800 fish sample from each test fishing site should be adequate. Past experience has shown, for example, that an excess of 800 fish in a size frequency sample of herring from the surveilance does not significantly change the indicated age class composition, size modes or size at age relationships.

In addition to the forage fish test fishing activities described above, ground truth surveys will also include determination of the extent of egg deposition on the spawning grounds by capelin and Pacific herring. The purpose in this work component is to verify spawning, study the extent and intensity of spawning on various substrait and beach types, and determine the substrait preferred by these two major nearshore pelagic fish species.

As eggs of herring have been shown by Kuhnhold (1969) to sustain a high mortality when contacted by even low concentrations of crude oil, assessment of the abundance of developing fish eggs on major spawning grounds in potentially impacted areas is critical to OCSEAP needs.

Assessment of spawn deposition must necessarily be conducted in two ways as herring spawn on kelp and capelin spawn in sand. In both cases beaches will be mapped with all vegetative and beach types delineated and noted. Areas of intense kelp growth will be divided into transect lines perpendicular to the beachline and spaced ten meters apart; these transects will be walked daily with the extent and density (number of eggs per square centimeter) being noted and mapped. The delineation and intensity of capelin spawning will be determined by obtaining 30cm deep sand cores of a constant volume every 30M along transect lines perpendicular to the beachline spaced 30M apart. Eggs will be separated from these samples by floatation and enumerated. The resulting densities of herring and capelin eggs will be depicted on the beach and vegetative maps and plotted in repsect to tide stages. Dependent on the nature and variance of the data at that point, appropriate statistical tests will be employed to show if correlations exist in respect to species preference for habitat type, tide level, time of day, etc.

Data from ground truth surveys will be used to determine age-weight-length relationships from representative subsamples of the various species. Age group analyses will be performed by age determination from scales or otoliths (depending on species) obtained from catch samples. The primary analyses envisioned in this study would be determination and presentation of seasonal and/or spatial fluctuations in abundance, distriubtion, and age group composition. As this study is descriptive, statistical comparisons are not anticipated. Analysis of aerial surveys will primarily utilize the number of forage fish schools seen per kilometer flown as a measure of abundance per-unit-effort. These values will then be presented by survey and between surveys to describe spatial and temporal abundance of spawning forage fish schools.

VII. Deliverable Products:

A. Digital Data

1-2. Listings of File Types 023 and 057 data parameters, as well as the value ranges for each, are shown in Tables 4 & 5.

3. Sample handling and data varification procedures for data obtained, recorded and submitted under File Type 023 and 057 formats are shown in Figures 3 & 5 respectively.

Table 4 - Definition of File Type 023 digital data parameters utilized in propsoed work for R.U 552 in F.Y.78

Record Type Headers - All Record Types

COLUMNS	INDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
1-3	File Type	I3	XXX	023
4-9	File Identification	I6	XXXXXX	050178-113078
10	Record Type	I1	X	1-8

Record Type 1 - Haul Record

COLUMNS	INDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
11-12	Agency Code	I2	XX	21
13-14	Vessel Code	A2	XX	02-30: A-X
15-16	Cruise Number	A2	AX	N/A
17-19	Haul or Set Number	I3	XXX	0-999
29-35	Latitude	A7	XX.XX.XXA	56°00'00"N-59°00'00"N
36-43	Longitude	A8	XXX.XX.XXA	152°00'00"W-154°00'00W"
44-49	Date (GMT)	I6	XXXXXX	780401-780831
50-53	Time (GMT)	I4	XXXX	0-2400
54-55	Gear Type Code	I2	XX	10-92
56-58	Duration of Fishing	I3	XX.X Hrs.	00.1-36.0
59-61	Distance Fished	I3	XX.X Km.	00.0-03.0
62	Direction of Tow	I1	X	1-9
63	Performance Code	I1	X	0-8
70-73	Mean Bottom Depth	I4	XXXX M	0-275
76	Sounding Record	I1	X (Blank)	1-3
77-78	Bottom Trawl Type	I2	XX	00-40
79-80	Bottom Trawl Accessories	I2	XX	00-32
81-84	Scope or Warp Used	I4	XXXX M	0-1225
89	Present Weather	I1	X	0-9
90	Cloud Amount	I1	X	0-9
91	Sea State	I1	X	0-9
100-104	Sequence Number	5	XXXXX	N/A

Record Type 2 - Trawl Gear Record

COLUMNS	IDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
1-12	Agency Code	I2	XX	
13-14	Vessel Code	A2	XX	
15-16	Cruise Number	A2	XX	
17-19	Haul or Set Number	I3	XXX	
20-21	Gear Type Code	I2	XX	
22-24	Opening Height-Trawl	I3	XX.X M	
25-27	Opening Width of Trawl	I3	XX.X M	
28-30	Overall Trawl Length	I3	XXX M	
31-32	Codend Length	I2	XX M	
33-34	Footrope Length	I2	XX M	
35-36	Headrope Length	I2	XX M	
37	Gear Material Code	I1	X	
38	Opening Mesh	A1	X	
39	Average Body Mesh	I1	X	
40	Codend Mesh	I1	X	
41	Codend Liner	I1	X	
42-43	Number of Floats	I2	XX	
44-45	Float Diameter	I2	XX Cm.	
46	Tickler	I1	X	
47	Roller Gear	I1	X	
48-50	Length of Bridles	I3	XXX M	
51-52	Length of Doors	I2	X.X M	
53-54	Width of Doors	I2	X.X M	
55-58	Warp Length	I4	XXXX M	
59-62	Depth of Gear	I4	XXXX M	
100-104	Sequence Number	I5	XXXXX	

Record Type 3 - Miscellaneous Gear Record

COLUMNS	IDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
11-12	Agency Code	I2	XX	21
13-14	Vessel Code	A2	XX	02-24: A-X
15-16	Cruise Number	A2	XX	N/A
17-19	Haul or Set Number	I3	XXX	000-999
20-21	Gear Type Code	I2	XX	10-92
26-27	Net Depth	I2	XX M	0-19
34	Gear Material Code	I1	X	0-2
39	Seine - Average Body Mesh	I1	X	0-9
40	Seine - Bunt Mesh	I1	X	0-9
41-42	Gillnet, No. of Shackles	I2	XX	1-20
43	Gillnet, Material	I1	X	0-2
44	Mesh	A1	A	0-9: A-D
65-68	Depth of Gear	I4	XXXX M	0-183
100-104	Sequence Number	I5	XXXXX	N/A

Record Type 4 - Species Catch Record

11-12	Agency Code	I2	XX	21
13-14	Vessel Code	A2	XX	02-24: A-X
15-16	Cruise Number	A2	XX	N/A
17-19	Haul or Set Number	I3	XXX	0-999
24-33	Taxonomic Code	I10	XXXXXXXXX	1/
34-41	Total Weight by Species	I8	XXXXXX.XX kg.	2/
42	Weight Determination	I1	X	1-2
43-48	Total Number by Species	I6	XXXXXX	N/A
49	Number Determination	I1	X	1-3
50-59	Total Weight by Species	I10	XXXXXX.XXXX	2/
100-104	Sequence Number	I5	XXXXX	N/A

1/ NODC Taxonomic Codes - March, 1977.

2/ Total Weight of species recorded in Columns 34-41 for large trawl hauls where .01 kg accuracy is acceptable. In catches by smaller gear types where single fish are frequent and more decimal places are necessary, the total weight by species will be recorded in columns 50-59.

Record Type 5 - Length Frequency Record

COLUMNS	IDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
1-32	The same as in the Species Catch Record - (Record Type 4)			
33	Sex	I1	X	0, 1, 2
34-37	Length of Class in mm	I4	XXXX	0-2000
38-41	Length Frequency	I4	XXXX	0-200
42	Length Sample	I1	X	2, 4
43-44	Size of Length Class in mm	I2	XX	1-50
100-104	Sequence Number	I5	XXXXX	N/A

Record Type 6 - Individual Biological Record

1-32	The same as in the Species Catch Records - (Record Type 4)			
33	Sex	I1	X	0, 1, 2
34	Maturity	I1	X	1-5
35-38	Length	I4	XXXX	1-2000
39-44	Weight	I5	XXXXXX	0-100,000
45	Weight Determination	I1	X	1, 2
46-47	Age	I2	XX	0-40
48	Age Structure	I1	X	1, 2, 3
49	Age Determination	I1	X	1, 2
50	Sample Type	I1	X	1, 2, 3
51	Data Type	A1	X	1-9, A-F
52-57	Small Fish Weight	I5.1	XXXX.X	0-5000.0
100-104	Sequence Number	I5	XXXXX	N/A

Record Type 8 - Comments

1-19	The same as in the Species Catch Record - (Record Type 4)			
20-99	Comments	A80	XX etc.	N/A
101-104	Sequence Number	I5	XXXXX	N/A

Table 5 - Definition of File Type 057 digital data parameters with value ranges for each utilized in proposed work for R.U. 552 in F.Y.79.

Record Type Headers - Identical for all Record Types

COLUMNS	IDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
1-3	File Type	I3	XXX	N/A
4-9	File Identification	I6	XXXXXX	N/A
10	Record Type	I4	X	1-4

Record Type 1

11-16	Survey Date	I6	XXXXXX	78501-780930
17-20	Time Begun	I4	XXXX	0001-2400
21-23	Elasped Time	I3	XX.X	00.1-10.0
24-30	Latitude Survey Begun	A7	XXXXXXA	553000N-590000N
39-45	Latitude Survey End	A7	XXXXXXA	553000N-590000N
31-48	Longitude Survey Begun	A8	XXXXXXXA	1513000W-1560000W
46-53	Longitude Survey End	A8	XXXXXXXA	1513000W-1560000W
54-59	Aircraft Number	A6	XXXXXX	N/A
60	Aircraft Type	I1	X	1-9
61-74	Observer - Last Number	A14	XXXXXXXXXXXXXX	N/A

Record Type 2

11-13	Census	I3	XXX	0-48
14-20	Latitude of Census Area	A7	XXXXXXA	553000N-590000N
21-28	Longitude of Census Area	A8	XXXXXXXA	1513000W-1560000W
29-31	Length of Census Area	I3	XXX km	015-250
32-34	Altitude	I3	XXX M	050-6000
35-37	Airspeed	I3	XXX km/hr	100-300
38	Cloud Cover	I1	X	0-9
39	Visibility	I1	X	0-9
40	Sea State	I1	X	0-9
41-42	Weather Code	I2	X	0-9
43-44	Wind Direction	I2	XX	0-9
45	Air Roughness	I1	X	1-3
46	Fishing Type Seen	I1	X	1-4

Record Type 2 (cont.)

COLUMNS	IDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
47	Fishing Gear Seen	I1	X	1-4
48	Tide	I1	X	1-4
49	Survey Rating Index	I1	X	1-5
50	Turbidity	I1	X	1-4
	Date of Observation (in GMT)			
51	Year	I2	XX	00-99
53	Month	I2	XX	01-12
55	Day	I2	XX	01-31
	Time of Observation (in GMT)			
57	Hour	I2	XX	00-23
59	Minutes	I2	XX	00-59

Record Type 3

11-13	Census Area	I3	XXX	0-48
14-17	School Number	I4	XXXX	0000-05000
18-24	Latitude	A7	XXXXXXA	553000N-590000N
25-32	Longitude	A8	XXXXXXXA	1513000W-1560000W
33-36	School Location	I4	XXXXM	0-1500
37-46	School Species	I10	XXXXXXXXXX	N/A[1/]
47	School Activity	I1	X	1-3
48-52	School Size	I5	$XXXXXM^2$	(not used)
53	Beach Type	I1	X	1-5
54	Biota Type	I1	X	1-5
56	School Size Index	A1	A	S,L,M,U
57-58	No Schools Seen	A2	XX	0-50

1/ NODC Taxonomic Code - March, 1977.

Record Type 4

COLUMNS	IDENTIFICATION	ATTRIBUTES	FORMAT	RANGE
11-13	Census Area	I3	XXX	0-48
14-76	Explanatory Text	A63	XXX...XX	N/A
77-80	Sequence Number	I4	XXXX	N/A

B. Narrative Reports

Other than required quarterly and annual reports, preparation of additional narrative reports is not anticipated at this time. In the event special reports are required by OCSEAP, as was the case in FY 76, they will be complied with. In this event, however, it would be appreciated if lead time of at least six weeks is given. The only other narrative reports possibly resulting from this proposed work would be formally published papers of an opportunistic nature depending on findings (species range extensions, newly developed sampling methodology, etc.). In these cases, however, all stipulations in Parts I & J of Section XIV (Standard Statements) will be adherred to.

C. Visual Data

All visual data products produced in conducting studies proposed here will be incorporated in quarterly or annual reports. These products will include maps showing spatial and temporal distribution of principal species by life stage and distribution of sampling sites in the study areas in respect to time period and/or habitat type. Photos of the study areas may be included to show the various habitat types, fish species obtained, various phases of sampling activity and methodologies utilized. Data on life history parameter (i.e. spawning areas, growth rates, spatial and temporal distribution, species and age class composition, mortality rate, etc.) will be depicted by computer or hand produced graphic methods, as well as narrative discussion. Depending on results, comparative data on other biological parameters may be presented through graphic, tabular or pictoral means. All maps submitted in conjunction with narrative data will be supplied on standard maps of the appropriate scale reduced to 8½" X 11" paper. In addition, these map products will be supplied as transparent mylar film overlays in an appropriate scale labeled with the appropriate information to define the origin and interpretation of the map.

D. Other

Submission of other forms of digital or non-digital data products other than those mentioned in A, B, and C of this section is not anticipated.

E. Data Submission Schedule - Table 6.

See attached Data Products Schedule.

Digital data on spatial and temporal distribution and abundance of pelagic and demersal fish species will be submitted to the Juneau Project Office on magnetic disketts in accordance with required schedules. In addition, in-depth analyses of these data will be presented in tabular, graphic and narrative form in quarterly and annual reports. Graphic presentations of species distribution and abundance, potentially shown as isopleths, will be prepared in a manner that these data may be compared over various time periods. Analyses of these isopleths will be discussed in accompanying narrative reports. Detailed appendix tables of all data presented will be included in reports as a supplementary data product.

VIII. Special Sample and Sample Archival Plans

Voucher specimens will be obtained, handled, preserved and cateloged generally in accordance with procedures for this purpose required by the OCSEAP Project Office, Juneau. As freezing facilities aboard vessels and at field camps will be limited, all specimens retained will be preserved. Preservation of fish samples will employ a solution of ten parts water to one part formalin as well as 70% ethyl alcohol (following dehydration) as primary fixatives and preservatives. Household borax (one teaspoon per quart) will be added to these solutions when used as preservatives in order to provide buffering and retard shrinkage. In general, specimens more than a few inches in length will have an incision made on the right side of the abdomen to facilitate penetration of the preservative. The cut will be about half as long as the body cavity and made with a very sharp knife. Fish heavier than three pounds will be prepared for preservarion by making a deep incision into the muscle mass on each side of the vertebral column, operating from inside the body cavity. Specimens retained for archival will be retained in formalin for two to three days, soaked in water for a minimum of two days (water being changed at least once during this period) and dehydrated to 70% alcohol. One change of 70% alcohol will be necessary prior to final preservation in order to prevent color loss. All specimens preserved in the field will be initially retained in wide moutn "Nalgene" bottles of appropriate size, completely

Table 6 -

DATA PRODUCTS SCHEDULE

ta Type .e. Intertidal, nthic Organisms, c.)	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/Yea
Pelagic and Demersal Nearshore Finfish	Diskette	1764 - 105 byte EDP Listings	File Type 023	YES	10-78 To 11-78	1-79
"	"	1764 - 105 byte EDP Listings	"	"	2-79 to 3-79	5-79
Spawning - Intertidal Finfish Species	"	2450 - 105 byte EDP Listings	File Type 057	"	4-79 To 7-79	9-79

immersed in preservative and covered with a leakproof closure. Specimens for archival will be placed in glass bottles or jars for final retention. Specimens will be transferred to the California Acedemy of Sciences for permanent archival at the option and direction of the OCSEAP Project Office.

IX. Logistics Requirements

See attached Logistics Requirements forms and Overview of Logistical Strategies.

X. Anticipated Problems

1. Timely consideration of this proposal is critical as, if accepted, some lead time will be necessary for the State of Alaska to accept new funding prior to project initiation.

2. A timely decision on the charter vessel for the October - November FY 79 survey is necessary in order that plans can be finalized and equipment prepared, much of which must be with a specific vessel in mind.

3. Inclement weather and icing frequently preclude extreme nearshore (less than 10 fathoms in depth) pelagic and demersal fish sampling from open skiffs and in some cases those of the charter vessel. For safety reasons, all extreme nearshore sampling in skiffs must be done with the large support vessel in proximity even though this may reduce the rate at which work is accomplished.

4. Conflicting demands upon the Principal Investigator's time generated by requests from OCSEAP, NODC, NOAA and Boulder for such items as special reports, generation of information for synthesis meetings, and review of synthesis documents, detract from the ability to satisfy the contracted objectives. We recognize that the various demands satisfy a unique and special purpose and enhance the ability of NOAA/OCSEAP to satisfy the needs of BLM. We enjoy the opportunity to contribute to these special needs, however it is difficult to plan for them. Consequently, our schedule for completion of contracted work is always being delayed. We request that OCSEAP offer as much advance notice of activities and description of needs as possible. This will help us plan how much time to devote to non-contract needs.

Overview of Logistical Strategies

Due to the complex and integrative nature of the logistic requirements for RU 552, a detailed description of necessary logistical strategy and optional approaches is essential. While some of this information is necessarily included earlier in this proposal in order to adequately define sampling strategy, it will again be included in this discussion. Logistical strategy for RU 552 as proposed here can, for sake of description, be divided into two basic components: Fall and winter nearshore finfish surveys and spring and summer forage fish assessment.

Winter nearshore forage fish assessment surveys:

Two nearshore fish assessment surveys will be conducted during the winter of FY 79, each lasting five to six weeks. The first will be conducted in October-November, and second in February-March. In order to attain the primary objective of expanding the time frame of the spring-summer FY 78 sampling into the fall and winter of FY 79, it is desirable to maintain sampling continuity and logistical strategy used in FY 78 and shown in Section VI (Study 2) of this proposal. This strategy, which is based on allocating seven days (including travel time) per region per month and fishing the seven gear types in the manner and locations shown, would require full-time or nearly full time use of the vessel for 45 days and result in the sampling intensity shown in Table 1. This schedule contains enough flexibility to allow for 15 weather days (or days vessel use for other purposes) per region per survey.

It is recognized that two major factors exist which may necessitate alteration of this plan - time constraints on vessel usage and inclement weather. In view of these two potential constraints, we offer the following suggestions or options for dealing with them if and when they occur.

A. Option recommended in event of time constraint on vessel usage other than weather - i.e. use by other projects:

1. Elimination of the Kaiugnak and/or Kalsin Bay sampling regions (in that order) from the two winter surveys. That would permit a 25% or 50% reduction in sampling intensity (Shown in Table I) and not affect the sampling continuity in the remaining sampling regions. Preliminary analyses of FY 78 data suggest little difference in fish distribution between sampling regions at a given time.

2. Conduct winter surveys in all four regions, but utilize only the more productive fishing gear types. These are try-net, otter trawl, beach seine, and possibly tow net. This would mean a 24% to 53% reduction in effort depending if the tow net were utilized. Each gear type utilized would be fished at the intensity shown in Figure 1. This strategy would have the advantage of permitting sampling in all four regions, but the disadvantage of sampling from each region not being comparable with those in FY 78.

B. Options recommended when inclement weather prevents sampling at the intenisty originally planned.

1. Reduce the total suite of gear types utilized in winter surveys to only those which could be fished in most weather and use no other gears for the entire survey. These gear types would be otter trawl, try net, midwater trawl, and beach seine. This strategy would have the advantage of comparability between sampling regions within the survey, but the disadvantage of winter surveys not being comparable to those in FY 78.

2. Attempt to utilize all gear types as originally planned, but have planned procedure for which gear types would be eliminated in the event that inclement weather reduces available fishing time. In this event, it is recommended that only the following gear types be used as they are the most productive: try net, otter

trawl, beach seine, and tow net. If further time restriction is necessary, it is recommended to eliminate the tow net.

C. It must be recognized that modifications of any of these options may be necessary due to particular field conditions at that time, and that the final decision for these modifications must rest with the Field Party Chief.

In respect to the above options, we strongly recommend adhering as closely to the FY 78 strategy and sampling intensity as possible, primarily in order to insure data comparability. If it is necessary to exercise optional approaches, we recommend Option A-1 in the event of reduced vessel time and Option B-2 in the event inclement weather reduces available fishing time. It will obviously be necessary to make a joint decision on these matters and we will be willing to negotiate for the best mutual decisions.

Forage Fish Assessment:

The strategy and logistical approach for this work component is described in Section VI (Study 3) of this proposal. Basically, this approach consists of two aspects - aerial and ground surveys. A total of six aerial surveys, each lasting approximately eight hours is proposed. Each survey will extend from Tonki Cape south to Cape Sitkinak and be conducted at low level (1000 ft. - 305m) from light, single engine aircraft (Figure 4). Surveys will be conducted semi-weekly from April 25 through July 15. Exact survey dates cannot be given at this time as they may change due to weather. All attempts will be made to conduct surveys at exact two week intervals.

Ground surveys will be conducted from these primary sampling sites located at Sitkinak Island, Barling Bay (Old Harbor), and Kitoi Bay by 2 two-person field crews. These crews, which will be equipped with outboard engine powered skiffs and complete camping equipment, will establish base camps and move to new portion of their immediate area where forage fish are spawning in response to reports from aerial surveilance. One crew will remain at Sitkinak Island, establishing a camp at or near the loran station, while the other will rotate between the two stations on Kodiak Island proper - Barling and Kitoi Bay. It should be emphasized that these base camps are areas of expected intense spawning, and crews will be moved to adjacent areas as indicated by aerial surveilance. Movement of ground crews between sites will be primarily by inter-island scheduled flights (see CPF-2), with some assistance by surveilance aircraft.

The sampling intensity for forage fish assessment is considered a minimal coverage due to funding limitation, as any less intensity would detract from achieving stated objectives. If alteration of logistical requirements for this work component are necessary, however, we remain agreeable to negotiate on these matters.

D. Prioritized List of gear types to be used, days necessary to complete work and weather limitations.

Priority Gear	Days	Limiting Conditions
1. Beach Seine[a]	2	1½' - 2' seas, daylight, 28-32°C, modest wind.
2. Trammel Net[a]	1	2' - 2½' seas, daylight, 28-32°C
3. Gill Net[a]	1	2' - 2½' seas, daylight, 28-32°C
4. Tow Net[b]	1	1½' chop, 4'-5' swell
5. Try Net	2	4'-5' seas
6. Otter Trawl	1	4'-5' seas
7. Midwater Trawl[b]	1	4'-5' seas

a. Beach seine, trammel net and gill net may be worked on the same day or beach seine used on a separate day.

b. Tow netting and midwater trawling may be conducted on the same day.

IX 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 Dept. of Fish & Game PRINCIPAL INVESTIGATOR James E. Blackburn Peter B. Jackson

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. All stations within 20 fm. (36.58m) contour of four study area shown in Figures 1A-1D and 2.

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. Successive sets for various nearshore finfish species with a variety of sampling gear types. Specifics on sampling operations in Section VI, Study 2.

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 4 - 5 week surveys; one in October-November of 1978 and one in February-March of 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.) 28 actual fishing days for each of the 2 surveys.

5. Do you consider your investigation to be the principal one for the operation thus requiring other activities to piggyback or could you piggyback? R.U. 552 is a principal operation which will provide samples for R.U.553 in addition to satisfying its own specific objectives. 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. Need 8-12 daylight hours per day. Sampling time per station will vary between 20 min. and 3 hours depending on gear type.

6. What equipment and personnel would you expect the ship to provide? Trawl doors and bottom trawl winch (hydrualic) with cable. Expect vessel to provide captain and at least one deck hand.

7. What is the approximate weight and volume of equipment you will bring? 2500 lbs. 700 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? ______ If yes, they should be on board the ship prior to departure from Seattle or time allowed for shipment by barge. Formalin (30% solution) to be put aboard in Kodiak.

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. M/V COMMANDO vessel ideally suited for nearshore work, crew fimiliar with project and procedures, crew highly experienced in this type work, reasonable daily charter rate.

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? . Daily charter rate of approximately $1200. Vessel tentatively available according to skipper. Verification of availibility presently being pursued by OCSEAP Sub-Artic Project Office, Juneau.

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 biologists from R.U. 552 - Leslie J. Watson and James E. Blackburn.

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 Figure 4.

2. Describe types of observations to be made. Repetitive low level (800-1000 ft.) flights over beachline of Kodiak Island's eastside with single engine aircrafts to enumerate the number nad relative size of spawning forage fish schools.

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.) Six - 8 hour surveys conducted bi-monthly from April 20, 1979 - July 15, 1979 over trackline show in Figure 4. Surveys conducted approx. 4/26, 5/7, 5/22, 6/7, 6/22, 7/7. Duties may vary slightly.

4. How many days of flight operations are required and how many flight hours per day? Described in 3, above.
Total 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 use requiring fulltime use of aircraft while while under charter. Additional passengers not advisable due to low level, somewhat hazardous flying conditions.

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.

None.

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

5 lbs. - 1/2 cu. ft.

8. What type of aircraft is best suited for the purpose?
Cessna 180, 185, or 210 equipped with floats.

9. Do you recommend a source for the aircraft?
If "yes", please name the source and the reason for your recommendation. Flyrite Inc: or Kodiak Western Alaska Airlines due to local availability, pilot experience & local knowledge

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

$125/hr.

11. How many people are required on board for each flight (exclusive of flight crew)?
One person in addition to pilot.

12. Where do you recommend that flights be staged from?
Kodiak, Alaska

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).

   Study 3 work will require subsistence support for 3 - two person ground crews for 62 days (May & June of 1979). These crews shall be at Kitoi Bay, Old Harbor and Sitkinak Island in camp facilities.

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

   Field camp facilities using funds proposed here.

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

   $7.00 per person per 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? Figure based on estimated daily food costs per person.

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?

   No further logistical problems are anticipated other than those already discussed or planned for in air logistics costs.

XI. Information Required from other Investigators

Completion of the work proposed here will require information from RU's 485, 486 and 512 from FY 76 as well as from RU 553 in FY 78. Necessary information from these RU's will be used to synthesize with apparent results and conclusions from RU 552 field work to determine if broader correlations or relationships exists. A great deal of interaction between investigators for the Kodiak studies will be required to achieve the integrated results necessary to fulfill overall program needs. For example, possible correlations between the distribution of various fish and plankton species must be investigated and any tentative conclusions related to trophic studies. In order to achieve this degree of integration, investigators must design a scheme or plan to insure that all pertinent data and information are exchanged.

XII. Activity Milestone Chart

See Table 7.

XIII. Outlook

The extensive data analysis and synthesis planned for the Kodiak nearshore fish assessment and trophic relationship study is designed to provide an assessment and evaluation of work completed thus far and, hopefully, to indicate the optimum direction for future studies in this area. This analysis and synthesis of data obtained to date coupled with the addition of the FY 79, late fall and winter FY 79 surveys and spring and summer forage fish assessment studies, therefore, should be very instrumental in providing a platform from which to make decisions on the optimum direction for future work. The overall goals or objectives for this RU are integral in satisfying overall OCSEAP Program needs in the Kodiak area - to assess and define temporal changes in species composition and feeding habits of principal life stages of marine organisms. Success in attaining this overall objective, therefore, is directly dependent upon the ability of this and the other integrated RU's to fully attain their objectives and meaningfully integrate results. The complex and temporal nature of the objectives undertaken by this RU obviously preclude their attainment with a single year's data — a minimum of three years will be required to adequately delineate seasonal fluctuation, varify conclusions and take full advantage of and integrate information obtained by

MILESTONE CHART

0 - Planned Completion Date

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

RU # 552 PI: J. F. Blackburn and P. B. Jackson

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
Finalize sampling plan for FY 79	0														
Purchase equipment and supplies	0				0		0								
Hire and train survey personnel	0				0		0								
Conduct nearshore fish survey	1----	0			1---	0									
Conduct forage fish spawning survey							0----	----	----	0					
Data compilation and verification for nearshore fish survey FY 79	1----	----	0		1----	----	0								
Digital data submission (File Type 023	1--0 (FY 78 data)/--0 (FY 79) 1---0 (FY 79)														
Data compilation and verification for forage fish spawning surveys									1----	----	0				
Digital data submission (File Type 057)											1--	0			
Data analysis for comprehensive report							1----	----	----	----	0				
Data product development		1----	----	----	0				1----	----	0				
Submisison of quarterly reports			X								X		X		
Submission of Annual report (using spring and summer FY 78 data)							x								
Develop preliminary draft of comprehensive report (FY 78 and 79 data											1----	0			
Submit final comprehensive report															0

637

56

other RU's. While effort levels in FY 80 should remain at the levels shown for FY 78-79 with possibly some change in emphasis as a result of FY 79 comprehensive data analyses, they could be reduced in FY 81 with some effort shifted to new study areas on Kodiak's eastside.

This partial shift in effort levels in FY 80 would allow a greater spatial distribution of information, permit the representativeness of existing conclusions to be tested, and should be able to be done quite efficiently as procedures and methodologies will be well established by that time.

The personnel, logistical requirements and equipment needed by this RU in FY 80 are anticipated to remain essentially the same as those stated here for FY 78-79 with the exception of inflationary increases. As stated earlier, a partial shift in emphasis should occur in FY 80 so as to determine the representativeness of results from the initial four study areas. These shifts could be moving effort in Kalsin and Kaiugnak Bays to inner Ugak Bay and Alitak, respectively, while maintaining existing effort levels in the Izhut and Kiliuda Bay sampling areas.

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-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

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

JAY S. HAMMOND, GOVERNOR

DEPARTMENT OF FISH AND GAME
Commercial Fisheries - OCS

P.O. Box 686
Kodiak, AK 99615

September 1, 1978

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

Dear Dr. Bruce:

Attached is a set of replacement pages for the RU 552 proposal for FY 79. Changes have been made in it as you requested in your letter of August 24, 1978. Please insert the changed pages and renumber pages as follows:

Present Page #	Change To
32	31
36-42	34-40
44	43
46-50	50-54
52	56

It may not be clear that we intend to use two small boats. A 14 to 16 ft. aluminum skiff and a 16 to 18 ft. aluminum seine skiff. The former for beach seining and setting trammel and gill nets and the latter for tow netting.

The response to your item number 2 of the referenced letter is attached —Explanatory Notes on Cost Proposal Form - RU 552.

In response to item number 3, there was no camping gear purchased on RU 486 funds or on RU 552 funds. We purchased three each 2-man tents on RU 512 funds in FY 76 and sufficient small items for short term camping i.e. mess-kits, small stoves. These tents would serve well for short term camping, however, something larger will be required for a two month stay at field camps.

In response to item number 4, no, the request for per diem is not the same as the request for food for field crews. Per diem is necessary to pay ex-expenses incurred on trips to Juneau, Seattle and Anchorage.

In response to item number 7, yes, we are willing to negotiate sampling priorities with the Project Office. We are willing to negotiate virtually any other aspect of the proposal also. Our proposal is our best estimate of how to do what you have requested and we remain responsive to requests and open to negotiation of any item.

In response to item number 8; Table 2, page 21 of the proposal was in error and the line that reads: 2). Months, 5 (April - August), should be changed to: 2). Months, 2 (October - November and February - March). The species listing on page 21 is the only information we have on what fish RU 553 intends to take for food habits. This was the intent of this table. If you want a list of which species we expect to catch, please see Quast and Hall, 1972. List of Fishes of Alaska and Adjacent Waters with a Guide to Some of Their Literature. NOAA Technical Report NMFS, SSRF - 658. 47 pgs.

In response to item number 9, stomach collections were inadvertently included and are now excluded.

The comprehensive list of information gaps that you requested in item 10 has been added to the proposal. This task will be very worthwhile. It should be pursued in some detail to be credible. A list of information gaps and suggestions for the direction of future research should begin with a summary of research completed and status of knowledge. This section should be followed by a summary of potentially degrading results of oil and gas exploration activity and by an assessment of impact of the various factors upon the environment. This should highlight geographical areas where more knowledge is needed, show where existing information is sufficient and provide some indication of which species require more study. A good example of a similar study is Trasky, L.L., L.B. Flagg, D.C. Burbank 1977. Impact of Oil on the Kachemak Bay Environment. Vol. 1 of Environmental Studies of Kachemak Bay and Lower Cook Inlet. A.D.F.& G., Marine/Coastal Habitat Management. Anchorage, Alaska. This example is directed toward assessment but the same sort of coverage is necessary to have a list of data gaps that will withstand criticism.

There is no time to prepare such a report between now and July 1979 even if funding were immediately available. But between now and then a sufficient amount of work could be done to produce a tentative list of data gaps and the work could continue after July 1979 in order to complete the documentation of data gaps. Additional funding would be necessary. The time of our personnel is entirely accounted for and devoted to other aspects of this study. A first guess at the time necessary to compile the necessary information and canvass the agency groups that should have input to this assessment is about 12 man months. At F.B. I salary, including benefits, travel and per diem expenses, about $20,000 will be necessary.

In item number 11 you requested that we collect and submit data on air temperature, wind direction (in Beaufort scale) and wind speed (in compass direction code, 1 to 8) in record type 1. This can be easily accomodated, however, it is of no value to us and will require a minor change in our format. If this information is requested for the use of another project, as indicated by Jawed Hameedi, then you probably would like routine observations of wind speed and direction determined by accurate instrumentation. If we take it on our data forms it will be selectively collected during calm periods, at selected calm locations within very small portions of bays and be estimated in Beaufort scale by untrained observers working in small boats. Perhaps you would like it on a separate format that allows more accurate, systematic measurement. We will accommodate your wishes on this matter.

You have requested that we record and submit tide data and tide stage code. The latter we are doing and will continue to collect, but the tide data requested is tidal height in meters to the nearest 0.1 m. As we have no access to a surveyed tidal height guage, we can only accomplish this by interpolation between heights of high and low tide from published tide tables. This is of no value to us and I question that this is what you want. We will accommodate your wishes on this matter also but before we invest a lot of hours calculating tidal height for 200 times in a month cruise, lets be sure this is of value.

Specific response to comments handwritten onto a copy of the proposal returned to us:

Pg. 24 - The comment "work up" is inappropriately placed in the square "aboard vessel or later in Kodiak Lab." The work up samples consists of sorting, the next step in the chain of events.

Pg. 25 and pg. 30 - The block "verify" refers to verify keypunching.

Pg. 26 - A note in the margin noticed a "size change of skiff". We are planning to use 2 small skiffs that will be locally procured.

Pg. 39 - Under Columns,	1-33	-	Same as in Record Type 4
	34	-	Sex
	35-38	-	Length of class
	40-43	-	Length Frequency
	44	-	Length Sample
	Delete	-	Size of length class in mm.

Under Record Type 6, delete small fish weight.

I trust that the changes made and comments included here are sufficient. If there is any question please contact me.

Cordially,

James E Blackburn

James Blackburn
Fishery Biologist III

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

TO:	NOAA OCSEAP Bering Sea - Gulf of Alaska Project Office P. O. Box 1808 Juneau, Alaska 99802
TITLE OF PROJECT:	Seasonal Composition and Food Web Relationships of Marine Organisms in the Nearshore Zone of Kodiak Island - Including Ichthyoplankton, Meroplankton, Forage Fishes, Marine Birds and Marine Mammals
CURRENT CONTRACT NUMBER:	03-5-022-67
RESEARCH UNIT NUMBER 553	
PERIOD OF PERFORMANCE:	1 October 1978 to 30 September 1979
PRINCIPAL INVESTIGATOR:	Donald E. Rogers Research Associate Professor Fisheries Research Institute College of Fisheries University of Washington Seattle, Washington 98195 Phone: (206) 543-7628 or 543-4650
AMOUNT REQUESTED:	$ 237,000
LEASE AREA:	Kodiak Island, 100%
DATE: October 17, 1978	Donald E. Rogers, Principal Investigator
	Robert L. Burgner, Director Fisheries Research Institute Phone: (206) 543-4650
	Donald E. Bevan, Associate Dean College of Fisheries Phone: (206) 543-4270
UNIVERSITY OFFICE TO BE CONTACTED REGARDING GRANT OR CONTRACT NEGOTIATION:	Grant and Contract Services Room 1, Administration Bldg, AD-24 University of Washington Seattle, Washington 98195 Phone: (206) 543-4043
OFFICIAL AUTHORIZED TO GIVE UNIVERSITY APPROVAL:	Acting for Donald R. Baldwin Donald R. Baldwin, Director Grant and Contract Services

Work Statement I - Food Habits

Technical Proposal

I. Title: Seasonal Composition and Food Web Relationships of Marine Organisms in the Nearshore Zone of Kodiak Island - Including Ichthyoplankton, Meroplankton, Forage Fishes, Marine Birds and Marine Mammals

Research Unit Number: 553

Contract Number: 03-5-022-67

Proposed Dates: October 1, 1978 to September 30, 1979

II. Principal Investigator: Donald E. Rogers
Research Associate Professor
Fisheries Research Institute
University of Washington WH-10
Seattle, WA 98195
(206) 543-7628

III. Cost:

A. Science: $ 76,700
B. PI provided logistics: 0 (provided by OCSEAP)
C. Total: $ 76,700
D. Distribution by Lease Area: 100% Kodiak

IV. Background

This proposed research is essentially an extension of current research that is being conducted by RU # 553 on feeding habits of nearshore fish of Kodiak Island. Sampling has been conducted during the spring and summer of 1978 and the proposed research would be undertaken at the same four bays in the fall of 1978 and the winter of 1979.

Colin Harris, of the Fisheries Research Institute, completed some work on the feeding habits of fish around Kodiak Island during the summer of 1976. To this date, however, no one has investigated the feeding habits of these fish during the fall and winter. This proposed study will therefore provide new information on seasonal feeding habits of ecologically or economically important fish around Kodiak Island.

Participants of the Kodiak Synthesis Workshop in March 1977 emphasized the need for more baseline assessment of fish and invertebrate fauna around Kodiak Island. In particular, there were major information gaps regarding the food habits and trophic relationships of inshore fish. This continued trophic study is needed to permit conclusions about the food habits of ecologically or economically important fish and to identify important trophic relationships between components of the inshore ecosystem that may be affected by development of petroleum resources.

V. Overall Objectives

Determine the food habits of several nearshore pelagic and demersal species and the changes in food habits with respect to:

1. Location
2. Season
3. Habitat
4. Life history stage

This information is needed to assess the potential effects of oil on the inshore fish fauna, whether they are direct effects of oil through ingestion of contaminated prey or indirect effects through depletion of critical prey types.

Specific Objectives

Determine the food habits and trophic relationships of several economically or ecologically important fish during the autumn and winter.

VI. General Strategy and Approach

FRI personnel will work closely with ADF&G personnel in planning and carrying out the sampling program. ADF&G will be primarily responsible for field work (collection of fish), use and maintenance of sampling gear, and logistic support (under RU # 552). FRI will be primarily responsible for ensuring adequate sampling for the food habits phase of the study, for assisting in fishing, for subsampling fish for their stomachs, and for laboratory examination of the stomach contents.

The experimental design takes into account four major variables in the ecosystem which probably affect the feeding habits of the fish and/or the distribution of both fish and prey items. These variables are:

1) Location-Sampling will be conducted in four bays around Kodiak Island. Each bay has been divided into 2-4 areas.

2) Season-Sampling has been conducted (FY 78) during the spring and summer. We are proposing to sample during the autumn and winter since the life history stages of the fish, fish species, prey types and prey life history stages are probably all affected by the change in the seasons.

3) Habitat-Habitat is divided into nearshore (less than 10 m), epipelagic, and demersal (greater than 10 m).

4) Life history stage - The diet of a fish changes with its size and age. Therefore, the length and life history stage (juvenile or adult) is recorded for each fish.

Since we do not know what species of fish are prevalent during the fall and winter, we will select during sampling approximately 15 economically or ecologically important species for special attention.

A. Sampling Methods

Field and laboratory techniques will be essentially the same as in RU # 485 FY 76. The Alaska Department of Fish and Game (RU # 552) will determine the sampling strategy for fish and therefore our sampling will necessarily follow their design. An outline of the stomach sampling design is given in Table 1. The actual numbers of stomachs taken will, of course, depend on the number caught by RU # 552 and to the amount of time available to our field crew (2 people) to process stomach samples.

As the fish are landed, they will first be sorted by species. Then our field crew will pick out specimens according to species and size (life history stage). Lengths will be taken on the larger fish and recorded. The haul number, gear type, identification number and species will also be recorded. The stomachs will then be removed and each one will be placed in a separate Whirlpak bag along with 10% formalin and an identification label. Smaller fish will be preserved whole. Lengths will be taken and stomachs removed later in Seattle. Samples will be shipped from the field to Seattle as often as is practical.

B. Analytical Methods

In the laboratory, the contents of each large fish will be blotted dry and then the total stomach contents will be weighed to the nearest .01 gram. The contents will then be sorted into the lowest possible taxonomic categories. Each group will be counted and weighed to the nearest .001 gram.

If the fish are small, lengths will be taken in the laboratory on a group of fish and an average length will be recorded. Stomach contents will be pooled and the contents from the pooled stomachs will be treated as above. Average numbers and weights of prey organisms per stomach will be calculated.

Additionally, a digestion factor (on a scale from 1-6) and a stomach fullness factor (on a scale from 1-7) will be assigned to each stomach. The sizes of prey from some selected stomachs will also be measured. Data will be keypunched from MESA/EDS format no. 100 forms and later transformed to NOAA/EDS format no. 023 by the computer.

Identifications of prey organisms by each technician will be spot-checked by others working in the laboratory. In addition, a reference collection in the College of Fisheries will be used to verify some identifications. Specimens will be sent out to experts whenever necessary. Voucher specimens will be retained by the project.

All data will be processed by FORTRAN computer programs specifically written for the NOAA/EDS format record types. Processing will include statistical analysis of the stomach content data, calculation of Shannon-Weiner diversity indices by number and biomass, and generation and plotting of IRI values. The methods are described in "ADF&G-OCS Fish Food Habits Analysis" by C. A. Simenstad, October, 1977 (FRI-UW-7735).

We will adopt several safeguards against errors and inadvertant omissions of data. Data forms are designed for ease of use in the field and for readability by keypunchers. Data will not be transcribed by hand from form to form except in special circumstances and data will be recorded immediately to prevent unnecessary loss of information. Balances used to weigh stomach contents will be checked frequently to assure accurate weights. All data keypunching will be verified (see Figure 1).

VII. Deliverable Products

A. Digital Data

For each item (prey taxon) in a stomach we will provide the number per fish, and the weight per predator. In addition, we will list the fullness of each stomach, the level of digestion of the contents, the weight of the total stomach contents and the length of the fish. For each sample of a given predator, we will provide the frequency of occurrence (%), total weight (%), total number (%), and the index of relative importance (IRI) which equals the frequency of occurrence times the sum of numerical and gravimetric composition. All digital data will be submitted in file type FT 023 to OCEAP. See Table 2 for a list of parameters and possible ranges of those parameters.

B. Narrative Reports

The required quarterly and annual reports will be submitted and these will contain all information collected by this project.

C. Visual Data

Graphs, tables, and figures will be used in the required reports to present the data collected on seasonal changes in food habits for a given species, differences among species, and the interrelationships in feeding (food web). This will include:

1. Tables and figures showing types of prey items for all stomachs and size frequency distribution of food items in selected fish stomachs.

2. Tables showing feeding selectivity (or electivity index) of principal fish species to the extent that data on abundance of prey items is available to this project.

4. Diagrams or mathematical formulations of trophic web structure of selected locations with estimates of biomass in different food web components and mass transfer coefficients derived from literature. Mylar overlaps will be used whenever appropriate and these maps will be submitted to the BLM - Alaska OCS office. Paper reductions of these maps will be included in the annual report.

D. Other Non-Digital Data

None.

E. Data Submission Schedule

See chart.

VIII. Special Sample and Voucher Specimen Archival Plans

Voucher specimens will be retained by the project. Duplicate specimens will be provided to OCEAP if this is requested.

IX. Logistics Requirements:

See RU # 552

X. Anticipated Problems

We do not anticipate any problems because this project involves rather routine methods of collection and processing of samples and the analytical methods are well established.

XI. Information Required from Other Investigators

Sampling statistics, e.g., date, location and number of fish in catch, will be obtained from RU # 552. We will maintain close liaison with the ADF&G Kodiak Studies.

XII. Activity/Milestone Chart

Attached

XIII. Outlook

Sampling in 1980 would provide information on yearly variation in the feeding habits of the fish near Kodiak Island. Funding through 1980 would, in addition, provide time to model the data collected from 1978 through 1980. Quarterly reports and one final report would be submitted during this time. Cost would be approximately $80,000 assuming that the Alaska Department of Fish and Game was again providing the logistical support.

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 submited 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 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."

Table 1. Schedule of samples of Kodiak Nearshore Food Habits Study

Sampling design

1. Locations or bays (number of regions in bay)
   a. Izhut Bay (4)
   b. Kalsin Bay (2)
   c. Kiliuda Bay (4)
   d. Kaiugnak Bay (2)

2. Months, 2 (October/November and February/March)

3. Habitat (gear)

   a. Nearshore, less than 10 fm (beach seine, trammel net, try net, gill net)
   b. Epipelagic (tow net, midwater trawl)
   c. Demersal, greater than 10 fm (otter trawl)

4. Life history stage (juvenile and adult, length)

5. Species

   Approximately 15 species of ecologically or economically important fish will be chosen from the three habitats for special attention. Since we do not know what species are prevalent during the fall and winter, we will select the species while sampling.

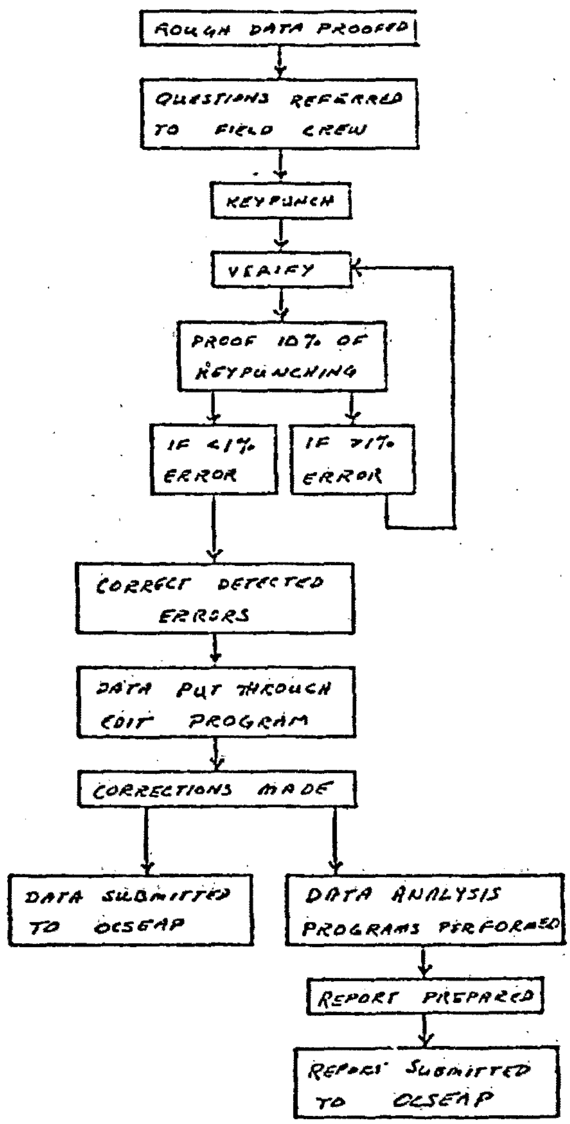
6. Sample size

   The sample size will be a maximum of 20 fish per bay (4), per month (2), and per life history stage for each important species, for a total of about 5,000 stomachs. This intensity of sampling approximately equals that during the spring and summer of FY 78.

Table 2. File Type 023 (Shellfish) Fish Resource Assessment

Common to all records	Range or meaning
File Type	Always 023
File Identifier	
Record Type	7
Agency Code	
Vessel Code	
Cruise Number	
Haul or Set Number	
Sequence Number	
Record Type 1 - Record Type 6	Will be submitted by RU # 552.
Record Type 7	
Sample Number/Taxonomic code	2 digit alpha-numeric/ 2-10 digit numeric code
Number of Prey/Volume of prey	0-9999/NA
Organ Code	NA
Stomach Fullness Code	1-7
Life History Code	7 or 8
Stomach digestion Code	1-6
Weight of Stomach Contents	0-9999.99 g
Life History Code	1-8 or A-H, J, L, M, P
Wet Weight of Prey	0-9, 999.999 g
Weight Method Code	1-8
Gut Position	NA
Number of Stomachs Pooled	0-99
Length of Fish	1-9999 mm
Record Type 8 - Text	
Text	

Figure 1. Diagram of data processing procedure.



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/Yea
Stomach samples	Tapes	2 tapes	NOAA/EDS Format No. 023	yes	October 1978 to March 1979	Tune 1979

MILESTONE CHART

0 - Planned Completion Date

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

RU # 553 (food habits) PI: Donald E. Rogers

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
Purchase supplies	0														
Conduct field work	1	--0			1	--0									
Process stomach samples		1-	- - -	- - -	- - -	- - -	- - -	0							
Analyze data					1	- - -	- - -	- - -	- - -	- - -	0				
Submit data									0						
Submit quarterly report	0			0						0					
Submit annual report							0								
Submit final report												0			

Other Information

a. See qualifications section

b. The Fisheries Research Institute does not have nor does it propose any other contracts dealing with the feeding habits of fish around Kodiak Island.

c. Dr. Rogers will actively lead and supervise the proposed work and will take full responsibility for timely completion of all objectives. He will spend more than 25 percent of his time on this project. He is also principal investigator of the Wood River (NOAA) and Continental origin (WPFMC) projects.

d. Key personnel assigned to this project are: Dr. D. E. Rogers, Ms. B. J. Rogers, and Mr. M. Wangerin. Resumes are attached. We are requesting funding for approximately 3 person-years of effort. We estimate (based on work conducted in FY 78) that it takes 3 people 1 month to process 1000 stomachs. Therefore, to process 4000 stomachs will take 3 people 4 months. The duties are divided as follows:

	No. of months estimated
Dr. Rogers (Principal Investigator)	
Supervising	2
Editing	1/2
Attending meetings	1/2
	3
B.J. Rogers (Project Leader)	
Writing reports	4
Taxonomic assistance	2
	0
Data analysis	2
Attending meetings	1
	9
M. Wangerin (Laboratory Director)	
Processing fish stomachs	3
Data analysis	2
Field work	1
Writing reports	1 1/2
Attending meetings	1/2
Purchasing supplies	1/2
Hiring lab personnel	1/2
	9

Research Assistant	No. of months estimated
Processing fish stomachs	3
Data Analysis	1
Writing reports	1/2
	4 1/2 (100% of time)

Student Helpers	
Processing fish stomachs	8 (100% of time)

e. -

f. Donald E. Baldwin
Grant and Contract Services
University of Washington
Phone: (206)543-4043

Work Statement II - Zooplankton

I. Title: Seasonal Composition and Food Web Relationships of Marine Organisms in the Nearshore Zone of Kodiak Island - Including Ichthyoplankton, Meroplankton, Forage Fishes, Marine Birds and Marine Mammals.

Research Unit Number: 553

Contract Number: 03-5-022-67

Proposed Dates: October 1, 1978 to September 30, 1979

II. Principal Investigators: Donald E. Rogers, FRI, Seattle, WA
Murray Hayes, NWAFC, NOAA/NMFS, Seattle, WA

Project Leaders: Douglas J. Rabin, FRI, Seattle, WA
Robert Wolotira, Jr., NWAFC, NOAA/NMFS, Kodiak, AK

III. Cost of Proposal

A. Science: FRI - $160,300*

B. OCSEAP provided logistics: $131,555 (estimate) for charter and boat work

C. Total: $160,300 (excluding logistics)

D. Distribution of effort by Lease Area: Kodiak - 100%

IV. Background

Zooplankton were sampled in the nearshore regime of Kodiak Island, Alaska, by the University of Washington, Fisheries Research Institute, from March through August 1978. This research was requested by the Outer Continental Shelf Environmental Assessment Program in order to assess the potential impact of oil in Kodiak waters.

The FY 78 field program was specifically designed to recognize possible nursery areas for larval forms of fish, shrimp, and crab species of both commercial and ecological importance. Consequently, station locations, gear usage, and sampling frequency were integrated into a research program that remained consistent throughout the study period. Concurrent laboratory activities included the identification and enumeration of captured fish, shrimp and crab larvae.

One of OCSEAP's present needs is the necessity for seasonal continuity to the spring-summer field research. This proposal requests that autumn and winter research be conducted in FY 79 in order to complete one year of sampling. These proposed efforts should enable OCSEAP to recognize those species that spawn during the autumn and winter periods.

*includes estimated plankton sorting expenses for RU # 551 and RU # 553.

In addition, autumn and winter sampling will help to determine critical time periods, in addition to critical areas, during which oil pollution may occur.

As in FY 78, four bay areas will be sampled with discrete surface-subsurface and day-night plankton tows. The proposed research will be coordinated with concurrent studies of both juvenile and adult fishes (RU 552) and their feeding habits (RU 553). This will enable optimum use of charter time and should assist in subsequent analysis and modeling of fish and invertebrate populations and food web relationships.

V. Study objectives:

1. Describe seasonal composition, distribution, and relative abundance of major life stages of selected holo- and meroplankton forms in selected bay areas of the Kodiak archipelago. Emphasis will be placed on planktonic stages of fishes, crabs, shrimp, euphausiids and copepods.

2. Determine seasonal development and succession of selected commercially and ecologically important fish and invertebrate species (Table 1).

3. Correlate observed biological distributions with local hydrographic regimes and bathymetry.

VI. General Strategy and Approach

FRI personnel will work closely with NMFS, ADF&G, USFW personnel and the Juneau project office in planning and carrying out the sampling program. FRI will be primarily responsible for field work (collection of the plankton), use and maintenance of sampling gear, and logistic support. FRI will use gear types and sampling methodology similar to that used by NMFS (RU 551). In addition, both FRI and NMFS will employ the same plankton sorting center and sorting options. FRI will be responsible for examination and analysis of the ichthyoplankton. NMFS will be responsible for examination and analysis of shrimp and crab larvae. Sampling of zooplankton will be coordinated with marine bird trophic studies (RU 341), and juvenile and adult fish studies (RU 552).

In addition to the field work, our major effort will be devoted to analysis of all samples collected during FY 78 and FY 79, and to develop an integrated report. Data will be exchanged between the related research units, i.e., RU's 138, 551 and 552, active in the Kodiak area in FY 78 and FY 79. This will help insure analysis and synthesis of data in the manner, format and timing most useful to fulfill BLM needs for implementation of lease area decisions.

Table 1. Possible ecologically and commercially important species for which seasonal planktonic development and succession will be determined in the Kodiak nearshore area.*

	Scientific Name	Common Name
Fishes		
	Clupea harengus pallasi	Pacific herring
	Mallotus villosus	capelin
	Pleurogrammus monopterygius	Atka mackerel
	Anoplopoma fimbria	sablefish
	Hemilepidotus jordani	yellow Irish lord
	Myoxocephalus polyacanthocephalus	great sculpin
	Trichodon trichodon	Pacific sandfish
	Gadus macrocephalus	Pacific cod
	Theragra chalcogramma	walleye pollock
	Ammodytes hexapterus	Pacific sandlance
	Atheresthes stomias	arrowtooth flounder
	Hippoglossoides elassodon	flathead sole
	Lepidopsetta bilineata	rock sole
	Limanda aspera	yellowfin sole
Crab		
	Cancer magister	Dungeness crab
	Chionoecetes bairdi	tanner (snow) crab
	Paralithodes camtschatica	king crab
Shrimp		
	Pandalus borealis	pink shrimp
	Pandalopsis dispar	sidestripe shrimp
	Pandalus hypsinotus	coonstripe shrimp
	Pandalus goniurus	humpy shrimp
	Pandalus platyceros	spot shrimp

*Final selection of species will be determined by suitable frequencies of occurrence and relative abundances.

A. Sampling Plan

Zooplankton will be sampled during two cruises, one during October-November 1978 and the other during February-March 1979. The areas to be sampled are along the southern and eastern shores of Kodiak and Afognak Islands and include Marmot (Izhut), Chiniak (Kalshin), Kiliuda, and Kaiugnak bays. Stations will be located in the inner, central, and outer portions of each bay (Table 2; Figs. 1A and 1B). Distance between each station will be 8-14 kilometers. Izhut and Kiliuda bays will include one station each for diel sampling. The most seaward stations will correspond with specific nearshore sampling locations of the extensive (NMFS) offshore plankton surveys.

Stations will be sampled with a 50 cm x 30 cm surface neuston sampler with .505 mm mesh net, bongo-arrayed plankton nets with 60 cm openings and mesh sizes of .505 mm and .333 mm, a 1 m^2 opening-closing Tucker trawl with a .505 mm mesh net, and an epibenthic plankton sled with a .505 mm mesh net. The neuston net will sample at the surface, the bongo nets and Tucker trawl will sample from near bottom to the surface, and sled will sample demersal plankton. The plankton sled will be used only in those areas where the echogram from a recording fathometer indicates a suitable bottom type. Diel sampling will utilize closing nets with .505 mm mesh (Table 3).

Table 2. Station locations for Kodiak Island nearshore zooplankton research, 1978-79.

Bay	Station	Latitude		Longitude		Gear use *
Izhut	Z1	58	13	152	17	N,B
	Z2 (diel)	58	10	152	14	N,B,T,S
	Z3	58	06	152	10	N,B
	Z4	58	08	152	03	N,B
	Z5	58	05	152	18	N,B
	Z6**	58	15	152	16	N,B
	Z7**	58	13	152	18	N,B
	Z8**	58	11	152	20	N,B
Kalsin-Chiniak	C1	57	37	152	25	N,B,S
	C2	57	41	152	19	N,B
	C3	57	44	152	14	N,B
	C4	57	42	152	04	N,B
	C5	57	38	151	55	N,B
Kiliuda	L1	57	19	153	02	N,B
	L2 (diel)	57	16	152	55	N,B,T,S
	L3	57	12	152	45	N,B
	L4	57	16	152	37	N,B
	L5	57	36	152	54	N,B
	L6**	57	20	153	09	N,B
	L7**	57	18	153	06	N,B
	L8**	57	20	152	55	N,B
Kaiugnak	G1	57	04	153	36	N,B
	G2	57	01	153	29	N,B,S
	G3	56	56	153	27	N,B
	G4	56	58	153	14	N,B
	G5	56	52	153	35	N,B

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*N = neuston, B = bongo, T = Tucker, S = sled.

**Stations added 5/78.

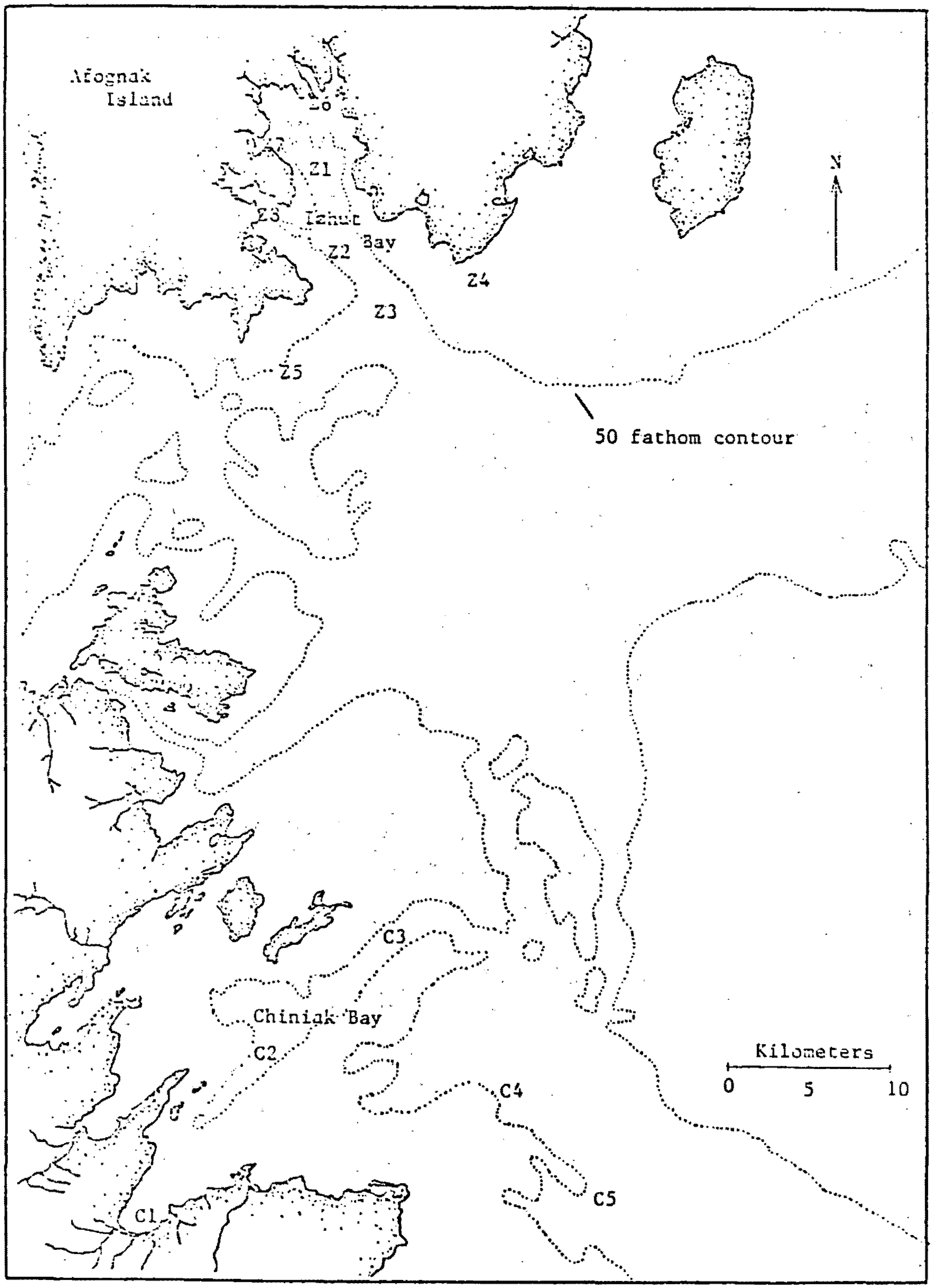

Fig. 1A. Station locations for Kodiak Island nearshore zooplankton research, 1978-79.

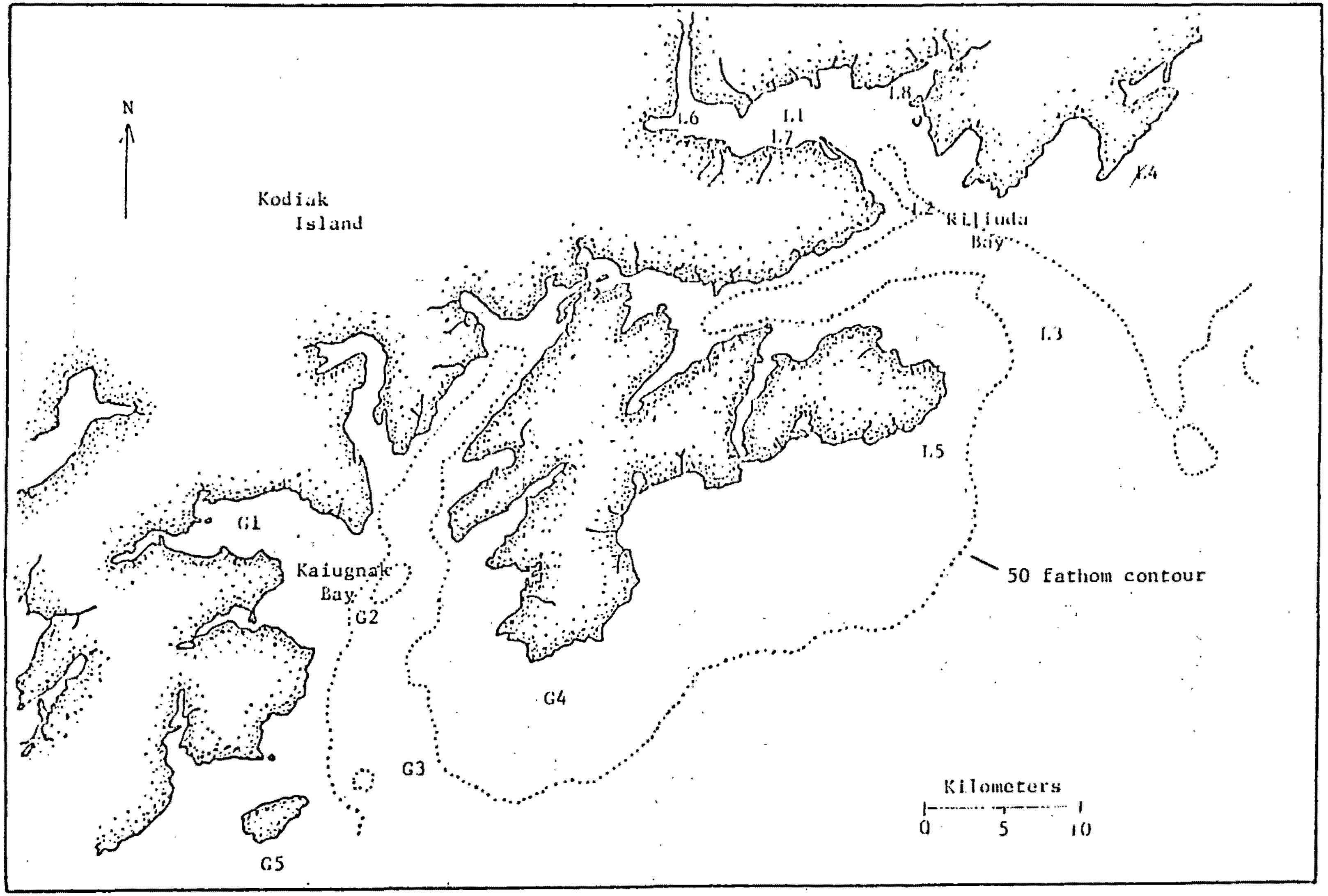

Fig. 1B. Station locations for Kodiak Island nearshore zooplankton research, 1978-79.

Table 3. Sampling methodology for Kodiak nearshore-zooplankton field program, 1978-79.

Gear type	Mesh Size (μ)	Tow characteristics	Duration (minutes)	Speed (knots)
Neuston	505	horizontal-surface	10	∿ 2
*Bongo	333 and 505	double oblique near bottom to surface	5-20	∿ 2
Tucker (opening closing for diel variations)	505	horizontal at -10, -30, -50, -70, -90 m	5 per depth	∿ 2
Epibenthic sled (opening-closing)	505	horizontal-bottom	10	∿ 2

*rate of descent: 50 m of wire/min with 30 second hold at maximum depth
rate of ascent: 20 m of wire/min

The zooplankton-sampling gear will be deployed from the research vessel with a heavy-duty winch and cable. The vessel will maintain a speed of 2-3 knots to permit efficient sampling. Constant rates of descent and ascent will be maintained and wire angle and length of wire out will be monitored to assure adequate and consistent sampling. A flowmeter will be attached to each frame in order to measure volume of water filtered. (These methods will be modified from the methods of RU 551 to accommodate bay-sampling limitations.)

Field processing of the samples will include rinsing of the plankton samples into 1 ℓ Nalgene bottles, addition of identification tags to each jar, preservation with formaldehyde to make a 5% formalin solution buffered with 20 ml of a saturated sodium tetraborate solution, and subsequent storage in aluminum shipping containers.

At the end of each cruise plankton samples will be shipped to the sorting center for separation into specified planktonic components. Details of the sorting procedure are included in Section VI-B - Analytical methods. Generally, the samples will be sorted by major taxa and returned to the PI's for detailed processing.

Environmental data will be collected at each station and will include prevailing sky conditions, water temperature and salinity profiles. A salinometer will be used to measure surface and subsurface temperature and salinity. In addition, 2 bathythermograph (XBT) casts will be made per bay per sampling cycle. The XBT information will provide temperature profiles that can be utilized to augment the extensive surveys' environmental observations and can be used to cross-check the concurrent salinometer data.

B. Analytical Methods

FRI will pre-sort ca 10% of the plankton samples for fish eggs and larvae, return them to the original plankton, and ship them to the sorting contractor along with the remaining plankton samples. The sorting contractor will not know which samples are pre-sorted. Upon completion of sorting, a listing of the number of fish eggs and larvae in the sorted samples will be sent to FRI. If the numbers of fish eggs and larvae found in the pre-sorted samples do not agree closely with the counts obtained by NWAFC, then all plankton samples must be re-sorted at contractor's expense. This procedure will be repeated until the contractor and FRI counts agree.

The sorting contractor will first take a settled volume of each sample (Kramer, et al., 1972). All fish eggs and larvae (i.e., samples are not split) will be sorted out of the neuston, 0.505 mm Bongo, one-meter Tucker trawl, and epibenthic sled samples. The fish eggs and larvae (or juveniles) will be bottled separately by the sorting contractor according to station, gear, etc., and returned to FRI for identification.

Zooplankton from the 0.333 mm Bongo nets, after volumes are determined, will be sorted to major categories (e.g., Class, Phyla, or Order) from an aliquot of the total (ca 500 organisms) and enumerated. An additional subsample will be taken by the Kodiak laboratory, NWAFC, to obtain adequate numbers of shrimp and crab (ca 200 each). Eight major taxa (Euphausiacea, Chaetognatha, Copepoda, Amphipoda, Decapoda (Natantia), Decapoda (Reptantia), and Pisces eggs and larvae will be placed in separate labeled vials and returned to FRI.

Selected samples* will be examined for approximately 200 adult euphausiids which will be identified to species, enumerated, lengths measured and wet weights (Weibe, et al., 1975) determined. The euphausiid species will be placed in separate vials and returned to FRI.

Samples from the Tucker trawl and epibenthic sled (.505 mm mesh) will be subsampled for about 500 organisms. From the subsamples shrimp (Natantia) and decapod crab (Reptantia) larvae will be removed. If this aliquot yields insufficient number of decapod larvae, then additional subsampling will be conducted by the Kodiak laboratory, NWAFC.

At FRI, fish eggs and larvae will be identified to lowest taxa possible, counted (some taxa will be measured), and life history stage noted. These data will be entered on ADP forms for keypunching into ADP cards and for subsequent analysis (Charts 1 & 2).

Zooplankton data (numbers per aliquot) and samples will be returned by the contractor to FRI for analysis. The aliquot of copepods will be sent to the Auke Bay (NMFS) laboratory for identification to species; the shrimp and crab samples will be sent to the Kodiak laboratory, NMFS, for identification to species and life history stage. Data consisting of numbers per species per aliquot will be returned to the Seattle laboratory for subsequent analysis.

Samples of fish eggs and larvae will be archived at FRI. Copepod samples will be stored at the Auke Bay Laboratory and crab and shrimp larvae at the Kodiak Laboratory. Other invertebrates will be stored at FRI for one year or forwarded to any archiving center designated by OCSEAP.

Fish eggs and larvae will be identified to the lowest possible taxa as will the larvae of crab, shrimp, euphausiids and copepods. Other zooplankton will be identified only to class, order, or family.

* See page 31 for selected samples.

Chart 1. Flow diagram for field and laboratory activities

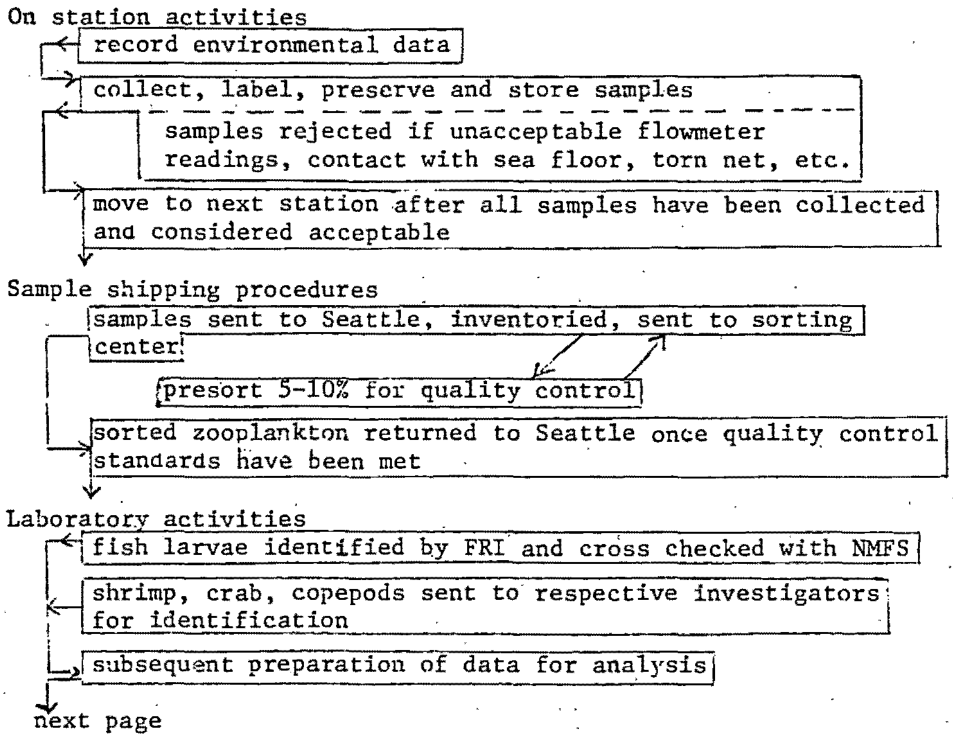

Chart 2. Diagram of data processing procedure.

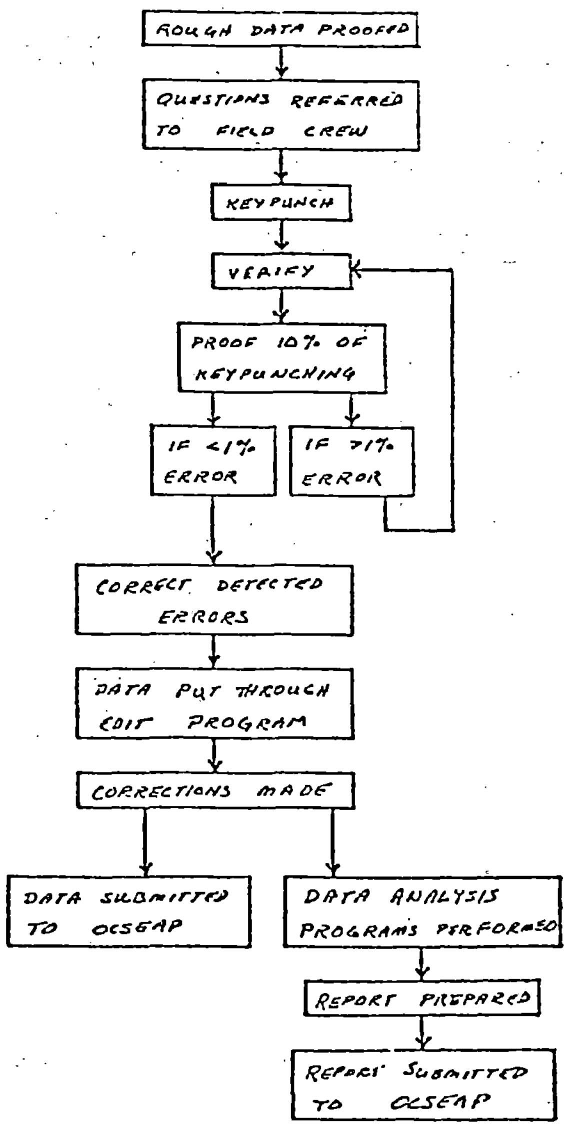

Table 1. Estimated numbers of plankton samples to be collected by RU 553 in FY 79, according to cruise period and gear type, and associated sorting costs (based on FY78 costs)

Cruise Period	Neuston	$	Bongo(0.505)	$	Bongo(0.333)	$	Tucker (and sled)	$	Total	$
October-November 1978	28	1260	26	1248	26	2132	32	1848	112	6,488
February-March 1979	28	1260	26	1248	26	2132	32	1848	112	6,488
Separation and identification of euphausiids from Bongo(0.505) and Tucker trawl(0.505) samples collected from 3/78 - 3/79.*									144	5,024
							TOTAL		368	18,000

*Note: Euphausiids will be removed from Bongo (0.505 mm) samples taken at stations #1 and #3 in each bay and for each cruise and from both day and night Tucker trawl (0.505 mm) samples taken at -10 m and -30 m in Kiliuda Bay for all cruises.

Bongo samples are selected for their proximity to the heads and headlands of each bay. Tucker samples are selected for their proximity to the surface and the depths at which birds may feed.

All data will be recorded on forms designed to facilitate subsequent processing by ADP methods. Computer programs will be used to convert observed data to numbers or biomass per standard unit, either per 1000 cubic meters of water filtered or under 10 square meters of sea surface, as appropriate (Kramer, et al., 1972).

Standard methods of analysis will be used. Examples of such analyses for ichthyoplankton may be found in Richardson and Pearcy (1977) and in Houde (1977, a, b, c,); for macrozooplankton, in Pearcy, et al. (1977).**

Field sampling will be conducted in accordance with standard MARMAP procedures. Flowmeters will be calibrated before and after each cruise. Common stations have been selected to overlap offshore stations of the offshore extensive survey for direct comparison of survey results. Research Units 551 and 553 will use the same sampling gear mix.

Adequate quality control checks have been established to monitor the performance of the sorting contractor. Routine checks on the accuracy of identification of fish larvae will be made. Close coordination will be made with the NMFS extensive survey for agreement in identification of larvae and to coordinate typing of unknown specimens. Standard ADP quality control checks will be made.

VII. Deliverable Products

A. Digital Data

The information will be submitted in the proper file type (FT 024) to OCSEAP for archival in EDS. Again these data submissions will be carefully coordinated with RU 551 (Appendix I).

B. Narrative Reports

The required quarterly and annual reports will be submitted and will describe methods, spatial and temporal intensity of sampling, current status of knowledge, statistical treatments, results, discussion and conclusions.

Interim data products will be included in quarterly and annual reports as they become available.

C. Visual Data

Graphs, tables, and figures will be used (when appropriate) to present (as examples):

a. Diagrams showing the total relative abundance of plankton and meroplankton by seasons in selected bays.

b. Species listings by season in rank order of abundance.

** See appendix 2 for examples of literature cited

C. Visual Data cont'd

c. Contour maps of the distribution for principal taxa by means of overlays.

d. Contour maps of the distribution of selected species by means of overlays.

e. Figures and tables showing patterns of abundance with depth and time i.e., diel and seasonal.

D. Other Digital Data

None

E. Data Submission Schedule

See milestone chart

VIII. Special Sample and Voucher Specimen Archival Plans

Voucher specimens and series will be retained by the principal investigators and duplicates exchanged where appropriate or requested. Any general requirements of OCSEAP will be accommodated. Samples will be retained by the PI's for the duration of RU 553.

IX. Logistics Requirements

To be provided by OCSEAP. See attached forms.

X. Anticipated Problems:

Field work scheduled for FY 79 will take place during the severe weather conditions that characterize Kodiak's autumn and winter periods. It is necessary then to consider a significant reduction in the number of days suitable for field work, given the length of each cruise period, the time needed to collect the normal number of samples taken during a single cruise, and the number of research units participating in a single boat charter. We anticipate that field work will be conducted in Izhut, Chiniak-Kalsin, and Kiliuda bays.

However, little or no time may remain to sample Kaiugnak Bay during the autumn and/or winter periods.

We do not anticipate any other major problems. Cooperation with NMFS personnel (RU's 380, 490, 551) will provide technical assistance if the need arises.

XI. Information required from Other Investigators

Arrangements have been with NMFS personnel to exchange specimens and/or data when necessary for identification or analytical purposes.

Funds allocated for sorting expenses are being managed by FRI and used by both FRI and NMFS. Communication will therefore be maintained regarding t(status of current and anticipa( ) expenditures. Since total samples may exceed the sorting budget periodic review of sorting schedule and options will be made.

XII. Management Plan

See attached Activity/Milestone/Data Management Chart. This is a cooperative proposal among FRI, NMFS, ADF&G, USFWS. The principal vehicle of coordination will be frequent one-to-one contacts among PI's and the field parties.

A project office will be maintained at the Kodiak facilities of NMFS for use of all PI's and their field parties.

The final report and publications will be authored by the respective PI's and will maintain their discipline/organization identification.

This work will be accomplished under the administrative control of Dr. Don Rogers and Dr. Murray Hayes. All field work, identification of ichthyoplankton, and data analyses will be supervised by D. Rabin and staff. Copepods will be identified by the Auke Bay laboratory, NWAFC, and crab and shrimp larvae will be identified by the Kodiak Laboratory, NMWAFC.

XIII. <u>Outlook</u>

The overall objectives for this RU are integral in attaining overall OCSEAP Program objectives in the Kodiak area - to assess temporal changes in species composition of principal life stages of marine organisms. Success in attaining this overall objective, therefore, is directly dependent upon the ability of this and the other integrated RU of this program in fully attaining their objectives and meaningfully integral results. The complex and temporal nature of the objectives undertaken by this RU preclude their attainment in a single season - a minimum of three years will be required to adequately delineate seasonal fluctuation, verify conclusions and take full advantage of and integrate information obtained by other RU's of this program. While effort levels in the four study areas should remain at the levels shown for FY 78 and FY 79, they could be reduced in the initial study areas in FY 80 and some effort shifted to new study areas on Kodiak's northeast and southwest sides. This partial shift in effort levels to new areas in FY 80 will allow a greater spatial distribution of information, permit the representativeness of existing conclusions to be tested, and should be able to be done quite efficiently as procedures and methodologies will be well established by that time.

The personnel, logistical requirements and equipment needed by this RU in FY 79 and FY 80 are anticipated to remain essentially the same as those stated for FY 78 with the exception of inflationary increases. As stated earlier, a partial shift in emphasis should occur in FY 80 so as to determine the representativeness of results from the initial four study areas. These shifts could be moving effort in Kalsin and Kaiugnak bays to west Marmot Bay, inner Ugak Bay and/or Alitak Bay, while maintaining existing effort levels in the Izhut and/or Kiliuda Bay sampling areas.

Projected funding needs for FY 80 are estimated at $175,000 (excluding logistics).

XIV. 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 they 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 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 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."

LITERATURE CITED

Houde, E. D. 1977a. Abundance and potential yield of the round herring, Etrumeus teres, and aspects of its early life history in the eastern Gulf of Mexico. Fish. Bull. 75(1):61-90.

Houde, E. D. 1977b. Abundance and potential yield of the Atlantic thread herring, Opisthonema oglinum, and aspects of its early life history in the eastern Gulf of Mexico. Fish. Bull. 75(3):493-512.

Houde, E. D. 1977c. Abundance and potential yield of the scaled sardine, Harengula jaguna, and aspects of its early life history in the eastern Gulf of Mexico. Fish. Bull. 75(3):613-628.

Kramer, D., M. J. Kalin, E. G. Stevens, J. R. Thraikill, and J. R. Zweifel. 1972. Collecting and processing data on fish eggs and larvae in the California current region. NOAA Tech. Rep. NMFS Circ.-370, 38 p.

** Pearcy, W. G., E. E. Krygier, R. Mescar, and F. Ramsey. 1977. Vertical distribution and migration of oceanic micronekton off Oregon. Deep Sea Res. 24:233-245.

** Richardson, S. L., and W. G. Pearcy. 1977. Coastal and oceanic fish larvae in an area of upwelling off Yaquina Bay, Oregon. Fish. Bull. 75(1):125-147.

Weibe, P. H., S. Boyd, and J. L. Cox. 1975. Relationships between zooplankton displacement volume, wet weight, dry weight, and carbon. Fish. Bull. 73(4):777-786.

** included in appendix 2

MILESTONE CHART

/ - planned initiation

0 - Planned Completion Date

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

RU # 553 (Zooplankton) PI: Dr. Donald E. Rogers Project Leader: Doug Rabin

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
Finalize sampling plan with OCSEAP, et al.	0														
Purchase equipment and supplies	0														
Establish plankton sorting agreement	0														
Hire field and laboratory personnel	0														
Conduct field work		/---	0		/---	0									
Ship plankton samples for sorting			0			0									
Identify designated planktonic components				/---	---	---	---	---	0						
Analyze plankton data									/---	---	0				
Submit quarterly progress reports	X			X						X					
Submit annual report with data and preliminary analysis (from spring - summer 1978 field work only)							X								
Submit final report for FY 78 and FY 79 zooplankton research												X			

July 1978

DATA PRODUCTS SCHEDULE For RU 553 (Zooplankton)

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. Zooplankton	tapes	2-3 tapes	024	by FRI	March/78 to March/79	April and September/79

July 1978

LOGISTICS REQUIREMENTS for RU 553 (Zooplankton)

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 Fish. Res. Inst. / Univ. WA PRINCIPAL INVESTIGATOR Dr. Donald E. Rogers

Project Leader: Doug Rabin

A. SHIP SUPPORT (for FY 79)

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 Figures 1A and 1B and Table 2. Stations associated with Izhut, Chiniak, Kiliuda, & Kaiugnak bay areas.

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. 60 cm bongo net arrays, neuston net, mid-water Tucker trawl, epibenthic sled, temp/salinity instrumentation, echo sounder records.

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, one during Oct-Nov 1978 & second during Feb-Mar 1979. Schedule one week/bay/cruise (2 day plankton, 2 days fish, 3 days weather)

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 above.

5. Do you consider your investigation to be the principal one for the operation th requiring other activities to piggyback or could you piggyback?
Principal user.
Approximately how many vessel hours per day will be required for your observati and must these hours be during daylight? Include an estimate of sampling-time station and sample processing time between stations.

8-12 daylight hours.

6. What equipment and personnel would you expect the ship to provide?
Adequate H/O winch, operator, booms to lift and deploy gear, dry storage, work space, navigation, fish finder, radar, radio, 20 cu ft. freezer.

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

2-4000 lbs 100 ft^3

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

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. Formalin for preservation

Do you have a ship preference, either NOAA or non-NOAA? If "yes", please name the vessel and give the reason for so specifying. COMMANDO - multipurpose fishing type with crew of 3 including master, deck hand fisherman-cook, engineer.

If you recommend the use of a non-NOAA vessel, what is the per sea day charter cost and have you verified its availability? The COMMANDO is available at $1,200/day

How many people must you have on board for each leg? Include a list of participants, specifically identifying any who are foreign nationals. Normally 4. 1 project leader and 3 scientists/technicians

July 1978

Appendix I. File Type 024 -- Zooplankton

Common to all records	Range, use and/or meaning
File Type	Always '024'
File Identifier	
Record Type	
Station Number	Z1-Z9, C1-C9, L1-L9, G1-G9*
Record Type 1 - File Header	
Vessel	R/V Commando
Cruise/Cruise Dates	01-12/March 01,1978 - April 30, 1979
Area/ Project	Kodiak/ Kodiak Food Web (RU 553)
Investigator/Institution	Rogers and Rabin/FRI-UW
Record Type 2 - Location	
Latitude/Longitude	55°00'00"-60°00'00"/148°00'00"-157°00'00"
Date in GMT/Time in GMT	March 01, 1978 - April 30, 1979/00:00-23:59
Depth to bottom	5-500 meters
Sample Interval	0-300 meters
Ship Speed	1.0-9.0 knots
Surface Water Temperature	-1.0-15.0 degrees Celsius
Record Type 3 - Total Haul Data	
Gear Code/Mesh Size	(use File 024 Gear Code)
Duration/Haul Length	0.1-1.0 hours/10-3000 meters
Total Settled Volume	0-9999 ml
Total Water Displaced	N/A
Total Dry Weight of Haul	N/A
Volume of Water Filtered	50-1500 m^3
Duration of Tow	0 hr 4 min 0 sec - 1 hr 0 min 0 sec
Haul Type Code	D = double oblique; H = horizontal
Record Type 4 - Subsample Data	
Sample Number/Taxonomic Code	*use letter/number combination/Zooplankton-Fishes
Life History Code	0,1,2,3,4,5,6,7,8
Size of Subsample	0.1-100.0 %
Number in Subsample	0-10,000
Concentration	0-1,000 per m^3
Dry/Wet Weight	N/A
Number of Adults	0-1000
Number of Juveniles	0-5,000
Number of Eggs/Larvae	0-50,000/0-10,000
Record Type 5 - Text	
Sequence Number	
Text	
Record Type 6 - Subsample Data	
Concentration	0-999.999 per m^3
all other Field Names	same as for Record Type 4

Life History Code

blank - No information
0 - Indeterminable
1 - Egg
2 - Nauplius
3 - Zoea
4 - Megalop
5 - Veliger
6 - Larva
7 - Juvenile
8 - Adult
9 - Combination of 6, 7, and 8
A - Combination of 7 and 8
B - Combination of 6 and 7
C - Juvenile/adult - sexual maturity unknown
D - Polyp
E - Cypris
F - Copepodid
G - Pupa
H - Nymph
L - Egg carrying female
M - Egg case
P - Parts
Q - Immature
R - Subadult
S - Trochophore larvae
T - Subadults and juveniles
U - Mating pairs

File 024 Gear Code

01 - 3/4 meter ring net

02 - 1 meter ring net

03 - 1 meter NIO (National Institute of Oceanography) net

04 - 60 centimeter Bongo net

05 - 60 centimeter Vertical closing ringnet

06 - 1 foot ring net

07 - Niskin bottle

08 - 2 meter Tucker net

09 - Samiyoto Neuston sampler

10 - .5 x 1.0 meter Marmap Neuston Net

11 - 61 Centimeter Bongo Net

12 - 20 Centimeter Bongo Net

13 - 1.0 x 2.0 Meter Marmap Neuston Net

14 - 6 foot Issacs-Kidd Midwater Trawl

15 - Epi-benthic sled with two 1 meter Tucker Trawls

16 - One meter Tucker Trawl with two nets

17 - One meter Tucker Trawl with four nets

The following were submitted as Appendix 2 for this proposal:

Richardson, Sally L. and William G. Pearcy (1977). "Coastal and Oceanic Fish Larvae in an Area of Upwelling off Yaquina Bay, Oregon", FISHERY BULLETON: VOL. 75 NO. 1, pp. 125 - 145.

Pearcy, W. G., E. E. Krygier, R. Mesecar and F. Ramsey (1977). "Vertical distribution and migration of oceanic micronekton off Oregon", DEEP-SEA RESEARCH, Vol. 24, pp. 223 - 245.

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

College of Fisheries
Fisheries Research Institute

27 November 1978

Dr. Herbert E. Bruce, Project Manager
OCSEAP Project Office
P. O. Box 1808
Juneau, Alaska 99802

Dear Dr. Bruce,

This letter is written in response to your letter, RF x 41-553-2166, dated November 15, 1978. Several comments have been made by your office on our (RU 553) revised proposal for FY '79. Our additions, clarifications, and explanations to your questions/observations, as appropriate, are listed below.

Item 1. Please accept a change in the proposal title to "Seasonal Composition .... Kodiak Island - Including Ichthyoplankton, Meroplankton (Shellfish), Zooplankton and Fish."

Item 2. Section VII. B. (p. 4). A final report based on FY's '78 and '79 field sampling data analysis and literature review will be submitted on September 30, 1979.

Item 3. Statement acknowledged and noted for incorporation into revised proposal.

Item 4. Statement acknowledged and noted for incorporation into revised proposal.

Item 5. Section IV. First paragraph (p. 19). Second sentence should read "This research was requested .... impact of OCS oil and gas development in the Kodiak lease area."

Item 6. Statement acknowledged and noted for incorporation into revised proposal.

Item 7. Section VI. B. (p. 28). Please note - copepods will not be identified by personnel at the Auke Bay (NMFS) laboratory, in FY '78 or '79, due to an OCSEAP decision not to fund this work (see letter to Doug Rabin, FRI, from Murray Hayes, NMFS/NWAFC, dated November 8, 1978). Consequentl a listing and analysis of copepod species will not be reported on. Section VII. C. (p. 32) should indicate that taxonomic analysis will be presented by FRI for ichthyoplankton, euphausiids and zooplankton in accordance with the appropriate visual data products.

Item 8. Section VII. X. (p. 32). A final report based on FY's '78 and'79 work statements will be submited on September 30, 1979.

cont'd ... ./.

<u>Item 9</u>. Statement acknowledged and noted for incorporation into revised proposal.

<u>Item 10</u>. Statement acknowledged and noted for incorporation into revised proposal.

<u>Item 11</u>. Statement acknowledged and noted for incorporation into revised proposal.

<u>Item 12</u>. P. 34 and p. 41. Dr. Murray Hayes' administrative responsibilities in RU 553 for FY '79 will be directed towards the proper management of those (Reptantia and Natantia) samples that have been and will be collected by RU 553.

We anticipate these additions, clarifications, and explanations will both satisfy the proposal's needs and permit the immediate initiation of funding for ongoing FY '79 field/laboratory research.

Sincerely,

Donald E. Rogers
Principal Investigator

DER:DR:ikp

TITLE: QUALITY ASSURANCE PROGRAM FOR TRACE PETROLEUM COMPONENT ANALYSIS. OCSEAP Research Unit 557.

PRINCIPAL INVESTIGATOR: William D. MacLeod, Jr., Ph.D.

TOTAL COST OF PROPOSAL: $50 K

PERIOD OF PROPOSAL: October 1, 1978 through September 30, 1979

INSTITUTION: NOAA National Analytical Facility
Environmental Conservation Division
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
Northwest and Alaska Fisheries Center
2725 Montlake Boulevard East
Seattle, Washington 98112

PRINCIPAL INVESTIGATOR:

Name William D. MacLeod, Jr. Date Aug. 31, 1978
Signature William D. MacLeod, Jr.
Address: NOAA, NMFS, Northwest & Alaska Fisheries Center,
2725 Montlake Blvd. E., Seattle, WA 98112
Telephone: (206) 442-4240 FTS 399-4240

ORGANIZATIONAL APPROVAL:

Name Donald C. Malins Date 8/31/78
Signature Donald C. Malins
Position: Director, Environmental Conservation Division
Address: NOAA, NMFS, Northwest & Alaska Fisheries Center,
2725 Montlake Blvd. E., Seattle, WA 98112
Telephone: (206) 442-7737 FTS 399-7737

ORGANIZATIONAL FINANCE OFFICER:

Name ______ Date ______
Signature ______
Address:

Telephone:

August 31, 1978

TECHNICAL PROPOSAL

I. TITLE: Quality Assurance Program for Trace Petroleum Component Analysis

RESEARCH UNIT NUMBER: 557

CONTRACT NUMBER:

PROPOSED DATES OF CONTRACT: October 1, 1978 - September 30, 1979

II. PRINCIPAL INVESTIGATOR: William D. MacLeod, Jr., Ph.D.
Manager, NOAA National Analytical Facility

III. COST OF PROPOSAL:

A. Science $50.0 K

B. PI - provided logistics 0.0

C. Total $50.0 K

D. Distribution of effort by Lease Area: Non-Area Specific

Laboratory Studies

IV. BACKGROUND:

A quality assurance program for chemical analyses of petroleum components among BLM/OCS environmental studies is an objective of the BLM/OCS and OCSEAP programs. In connection with this, OCSEAP has prepared an interim reference material from a harbor sediment known to be contaminated with aliphatic and aromatic hydrocarbons. The NOAA National Analytical Facility (NAF) has performed over 30 replicate analyses on 100-g portions of this reference material by four procedures typical of the state-of-the-art required for OCS environmental studies. When the reference material (sediment) met satisfactory homogeneity criteria by these analyses, NAF distributed six 100-g portions to each of 14 BLM/OCS PI's for interlaboratory comparisons. Continuation of this program in FY 79 is necessary to collate the analytical data, when reported, and place them in a statistical context for the NOAA/BLM OCS program.

In addition to hydrocarbons, petroleum contains many organic compounds more polar than hydrocarbons. Analytical methodology to extract and analyze such polar organics at trace levels remains largely unexplored with respect to samples from the marine environment. Hence, establishment of efficient, statistically-proven, ultra-sensitive analytical procedures is important to the OCS program.

OBJECTIVES:

The objectives are to coordinate and conduct an analytical quality assurance program that permits comparison of results among investigators within the OCSEAP program as well as between OCSEAP and other BLM-funded investigators, and to recommend procedural modifications for improved analytical techniques. Specifically, these objectives include:

1. Continue to distribute interim intercalibration reference materials for heavy hydrocarbon analysis.
2. Receive and tabulate results of analysis of reference material by other laboratories. Submit these data to OCSEAP/BLM.
3. Evaluate existing methods and develop new methods for the analysis of hydrocarbons and petroleum-related polar compounds in environmental samples. Recommend procedural modifications to OCSEAP/BLM.
4. Summarize and submit to OCSEAP/BLM all NAF data on the characterization and chemical composition of two typical Alaskan crude oils. Integrate this data with oil-industry data on Alaskan crudes. Industry data to be supplied by OCSEAP/BLM.

VI. STRATEGY AND APPROACH:

1. When the results from hydrocarbon analyses of the interim intercalibration material are returned to NAF from the 14 OCS PI's, NAF will collate the results; NWAFC statisticians will evaluate the data. The results of the statistical analysis of the intercalibration data will be reported to OCSEAP. OCSEAP has suggested to the 14 participating laboratories that the 24 aliphatic and 21 aromatic hydrocarbons routinely reported by NAF also be reported by them. If most of these laboratories report back analytical data on most of these hydrocarbons, along with typical blank analyses, it should be possible to make useful statistical statements about the quality assurance of OCS hydrocarbon analyses.

2. During FY 1978 NAF performed over 30 replicate analyses on the reference material in question, using four typical current extraction procedures. When the statistical evaluation of the intercalibration analyses is complete, analytical methodology for hydrocarbons in sediments may be explored further, if problems still exist with the methodology. In addition, studies will be directed toward efficient and reproducible trace analyses of polar petroleum-related organic compounds from marine environmental samples.

As an initial step, NAF will isolate various polar petroleum organics and test their recovery in analytical procedures at ppb levels using sensitive glass capillary gas chromatography (GC) and mass spectrometry (MS) techniques, and others as becomes necessary. If conditions can be found that permit 50% or better recovery at the 10^{-8} g level, the 10^{-9} g level should be tested.

3. Analysis of the composition of the two main Alaskan crude oils (Upper Cook and Prudhoe) will employ standard NAF adsorption chromatography, GC and GC/MS techniques described in NOAA Tech. Memo. ERL MESA-8. Principal constituents amenable to these techniques will be identified by their mass

spectra and GC retentions, where suitable reference spectra or compounds are available. Special attention will be given to the polar fraction that follows the aromatic hydrocarbons on adsorption chromatography. Other analytical techniques will be employed as necessary. Gravimetric quantitations of the aliphatic, aromatic and polar fractions will be compared with quantitations of the total GC response of these fractions.

VII. OUTPUT:

A. DIGITAL DATA:

Digital data from chemical analyses will be tabulated in standard NAF format for compounds routinely reported by NAF.

B. NARRATIVE:

In quarterly and annual reports, NAF will describe the findings of the project which will include parameters measured, numbers of samples analyzed, methodology employed, improvements or recommendations on methodology, results from the intercalibration study with statistical evaluation of the data and analysis of Alaskan crude oils.

C. VISUAL DATA:

NAF will support parts A and B with charts and graphs (e.g., gas chromatograms, mass spectra) to illustrate the analyses of petroleum constituents in environmental samples, and the intercalibration results.

D. OTHER:

NAF will retain laboratory logbooks, notebooks, working GC analysis charts and MS data tapes for one year after contract completion.

E. DATA SUBMISSION:

Chemical analytical data will be submitted with quarterly and annual reports.

VIII. SAMPLE ARCHIVAL PLANS:

NAF will store the interim intercalibration reference material at -15°C until the supply is exhausted.

IX. LOGISTICS REQUIREMENTS: None

X. ANTICIPATED PROBLEMS: None

XI. INFORMATION REQUIRED FROM OTHER INVESTIGATORS:

NAF requires the analytical results from the interim intercalibration reference material from the 14 OCSEAP and BLM/OCS PI's. OCSEAP has issued instructions to these PI's and assumes responsibility for their compliance.

XII. ACTIVITY/MILESTONE CHART: See attached Milestone Chart.

XIII. OUTLOOK:

Quality assurance studies will be needed as long as OCSEAP is collecting chemical analytical data. As analytical methodology for polar organics in petroleum proves effective and comes on-stream for chemical analyses, NAF believes that OCSEAP should include analyses of selected nitrogen, oxygen, and sulfur (N, O, S) containing compounds in their quality assurance program.

MILESTONE CHART

RU #: 557 PI: William D. MacLeod, Jr.

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 Reports				0						0			0		
Annual Report							0								
AK oil composition data				0			0			0			0		
Intercalibration results				0			0								

1. COVER PAGE

8 January 1978

Proposal Title

OIL POOLING UNDER SEA ICE
(In association with RFP NOAA 11-78)
The Transport and Behavior of Oil Spilled
in and Under Sea Ice
Research Unit 562

Principal Investigator

A. Kovacs

Total Cost

$56,464

Institution

U.S. Army Cold Regions Research and Engineering Laboratory
Hanover, N.H. 03755

Period of Work

1 April 1978 to 30 September 1979

Signature

A. Kovacs (ext 411)
(Principal Investigator)

D.R. FREITAG (ext 201)
(Technical Director)

F. Ferraro (ext 315)
(Comptroller)

CRREL Telephone (603) 643-3200
AUTOVON: 684-3400
FTS: 834-7585,6,7

IV. Background

The main thrust of this proposal is to obtain information on the significant bottom relief which exists under both first and multi-year sea ice. This work will be a large scale extension of previous field studies performed under OCSEAP Research Unit #88, DYNAMICS OF NEAR-SHORE SEA ICE. It is also directly associated with and will provide topographic information needed to evaluate the migration behavior and pooling of oil released under sea ice as required in NOAA RFP: 11-78 "The Transport and Behavior of Oil Spilled in and Under Sea Ice."

V. Objectives

The objective of this proposal is to acquire detailed cross-sectional information on the thickness and bottom relief of both first year and multi-year sea ice found in the waters over the continental shelf of Beaufort and Chukchi Sea. Cross-sectional profiles of first-year sea ice of different thickness will be obtained to determine the meso scale bottom relief vs ice thickness. The special variation in under ice relief will also be determined. The profiling will provide under ice topographic information which will be used to determine the direction that oil discharged under fast ice will flow and the quantity of oil which can be expected to pool in the under ice relief.

VI. General Strategy and Approach

The proposed field observations will be made in the area of our past field camp on Narwhale Island located to the northeast of Prudhoe Bay and the area of Harrison Bay. The field work will be focused on the Prudhoe Bay - Harrison Bay area as it is an area of current offshore exploration interest. The proposed field study makes use of previous survey results which have been published in the 1977 proceedings of the 9th Annual Offshore Technology Conference as OTC Paper 2949 "Sea ice thickness profiling and under ice oil entrapment" by A. Kovacs (see attached report). These results indicate that the bottom of first year sea ice has significant relief which could greatly limit the lateral spread of oil. The intent of this study is to verify this finding, to determine if the bottom relief of first year sea ice varies with thickness and to determine if the relief consists of individual pockets or is a series of ripples. The spatial configuration and distribution of the under ice relief will of course govern the lateral movement of oil under sea ice.

If it is found that the bottom relief under first year sea ice is a series of ripples, then the distance between and the preferred orientation of the ripple will be determined. Current information will be studied to ascertain if the ripples are the result of water movement under the fast ice cover.

VII. Sampling Methods

Cross-section profiling will be made using a VHF impulse radar system. This system and its operation is described in the report "Sea Ice Thickness Profiling and Under Ice Oil Entrapment" by A. Kovacs. The report is included herein as Appendix A. The radar system will be operated from the ice surface. The radar antenna will be pulled along the ice surface at approximately 2 km/hr. At this speed the sampling rate of the radar will provide a depth measurement every 5 cm. This rate is more than adequate to provide the horizontal resolution needed to give a representative cross-section of the ice cover.

An elevation survey will be made along each section of ice to be profiled. The station markers from this survey will serve as distance control markers for the radar profile. Direct drill hole thickness measurements will be made at several stations along each profile. These depth measurements will provide ice thickness information to be used as a check on the radar measurements.

To determine if the relief under the fast ice consists of random pockets or has a preferred "ripple" orientation, ten or more parallel profiles will be made. The separation between the profiles will be determined in the field and will be governed by the apparent frequency of the under ice relief. However, based on previous survey results the separation between the lines will probably be between 2 and 5 m, i.e. significantly less than one half of the apparent periodicity of the under ice undulations. The resulting profile information will be used to construct a topographic map from which an assessment will be made of the under ice relief and the quantity of oil which could pool within it.

VIII. Analytical Methods

Not applicable.

IX. Anticipated Problems

Foreseen funding delays will probably preclude initiation of field work during April-May 1978 when the first major and timely field effort should be made. This anticipated delay can be avoided by rapid transfer of funds upon project approval.

X. Deliverable Products

The results of the program will be a CRREL report(s) describing the field study and the analysis results. The report will contain appropriate maps, graphs, photographs, data tabulations, original graphic records, etc as required to best develop the specific aspect of the research. Graphic and analog magnetic tape records of the field data will be submitted for accession into the OCS data bank.

XI. <u>Information Required from Other Investigators</u>

None.

XII. <u>Quality Assurance Plans</u>

Not applicable.

XIII. <u>Archival Plans</u>

Not applicable.

XIV. <u>Logistics Requirements</u>

A. Ship Support
Not applicable.

B. Aircraft Support - Fixed Wing
Not applicable.

C. Aircraft Support - Helicopter

1. Locations of flights

Prudhoe Bay - Harrison Bay area. To transport personnel and equipment to survey sites on the fast ice.

2. Types of observations

To perform impulse radar profiling.

3. Time

Winter profiling is to be undertaken in late April (April 15-30). Fall profiling shall be undertaken in late October when the fast ice is relatively thin. Departure from the late winter field program into May may prevent the obtaining of profile information if an early warming occurs as occurred in 1977. When the sea ice warms up the brine channels open up. This increases the conductivity of the ice, preventing the radar transmitted electromagnetic energy from penetrating to the ice bottom and back.

4. Days - hours of operation

During each flyable day helicopter transport to and from the field site will be required. Flight time will depend upon distance from Prudhoe Bay to the work site.

5. Passengers

Max passenger load will be three per trip.

6. Equipment

Internal load will be approx. 500 lbs. to be moved with personnel. External load may be 800 lbs and would consist of a Cushman Trackster.

7. Helicopter type
   205 or equivalent.

8. Helicopter source
   NOAA because they are generally responsive to project needs.

9. Helicopter cost
   Not Available

10. Staging area
   Deadhorse and Oliktuk Dew Line Station.

11. Navigation
   Inertial navigation desired for easy relocation of work sites.

D. Quarters and Subsistence Support

1. Prudhoe Bay Study
   a. Location - Deadhorse
   b. Time - 12 April - 1 May
   c. Personnel - max 3 persons - approx 21 man days.

   Harrison Bay Study
   a. Location - Oliktuk Dew Line Station
   b. Time - 20 April - 25 April
   c. Personnel - max 3 project persons with possible 2 NOAA aircraft persons - approx. 15 man days.

2. Support source
   Mukluk at Deadhorse and the Dew Line Station at Oliktuk Pt.

3. Cost
   As arranged by the Alaska OCS Project Office.

E. Special Logistic Problems

None

IV. Management Plan

The principal investigator is highly experienced in managing Arctic and Antarctic research programs and is presently a principal investigator along with W.F. Weeks in OCSEAP Research Unit #88 Dynamics of Near-Shore Sea Ice.

The proposed program will develop as follows:

		Date
1.	Perform winter profile studies in Prudhoe-Harrison Bay area.	15 April 78
2.	Supply early interpretation results to investigators working on NOAA RK-8-0031 contract studies.	30 July 78
3.	Perform fall profile studies in the Prudhoe-Harrison Bay area.	15 Oct 78
4.	Complete first paper on cumulated field results.	1 Jun 79

XVI. Outlook

The proposed study will provide information on subice topography needed to understand the movement and pooling of oil under fast ice and multi-year ice as needed by those investigators performing work under the pending NOAA 11-78 solicitation "The transport and behavior of oil spilled in and under sea ice." The work proposed here will be an extension of a pilot study made in conjunction with past work performed under OCSEAP work unit R.U. #88. Additional work on under ice topography may be proposed as a result of the data to be obtained and to verify that similar relief exists at fast ice locations along the Chukchi and Bering Sea coasts. The cost of this expanded field work is of the order of $75K.

XVII. The standard statements numbered 1, 2, 4, 5, 6, 7, 8, 9 and 10 as given in the instructions for preparing proposals to OCSEAP/NOAA are applicable to this proposal and will be binding under the contract.

Archival of Voucher Specimens of Biological Materials
Collected under the Outer Continental Shelf
Environmental Assessment Program
(OCSEAP) Support

Solicitation No. NOAA 11-78

Research Unit 563

Principal Investigator: William N. Eschmeyer

Total Cost of Project: $119,609

Institution: California Academy of Sciences

Departments: Ichthyology, Invertebrate Zoology, Botany, others as needed

Principal Investigator:

Dr. William N. Eschmeyer
Director of Research
California Academy of Sciences
Golden Gate Park
San Francisco, CA 94118
(415) 221-5100 (ext. 220)

Other signatures:

George E. Lindsay
Director
California Academy of Sciences
(415) 221-5100 (ext. 224)

Nancy B. Dykes
Business Manager
California Academy of Sciences
(415) 221-5100 (ext. 280)

TECHNICAL PROPOSAL

Archival of Voucher Specimens of Biological Materials Collected under the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Support

Solicitation Number: NOAA 11-78

Research Unit Number: California Academy of Sciences

Contract Number:

Proposed Date of Contract: April 1, 1978 to March 31, 1981, with possible renewal for a like period

II. Principal Investigator: Dr. William N. Eschmeyer, Director of Research and Chairman, Department of Ichthyology, California Academy of Sciences.

Collaborators (same institution):

a. Dr. Welton Lee, Chairman and Curator, Department of Invertebrate Zoology

b. Dr. Tomio Iwamoto, Associate Curator, Department of Ichthyology

c. Dr. Dennis Breedlove, Chairman and Associate Curator, Department of Botany

d. Dr. Sylvia Earle, Curator, Department of Botany (Algae)

e. Dr. Peter Rodda, Chairman and Curator, Department of Geology (including Diatoms and Mollusks)

Invertebrate Coordinator: Dustin Chivers, Senior Scientific Assistant, Department of Invertebrate Zoology

IV. BACKGROUND

The California Academy of Sciences, founded in 1853, is a non-profit research and educational natural history museum consisting of scientific departments, support departments, an aquarium, planetarium, and display halls. The primary purposes of the Academy are to acquire and maintain scientific collections of specimens, to carry on research on these specimens, to make the collections available to the scientific community, and to interpret the natural world through educational activities, displays, and publications.

A primary concern is permanence of the institution receiving the contract. Natural history museums are stable centers for collections of scientific specimens, more so than most university collections which are subject to changing emphases of biology departments and the strengths of individual scientists (note the recent transfer of all of the Stanford University natural history collections, the collections of Hopkins Marine Station, and the transfer of the University of California invertebrate collections to the California Academy of Sciences). The Academy has demonstrated long-term support for its collections.

All of the Academy departmental research collections are in the top 10 in the United States, with most in the top 2 to 6 nationally. Two departments that will receive the bulk of the OCSEAP material are discussed briefly below. Besides these, the Academy's Department of Botany, which includes the recently transferred Dudley Herbarium from Stanford University, would house terrestrial plants and marine algae resulting from the project. Included in the Department of Geology is one of the world's finest diatom collections and library, with much Alaskan material resulting from the activities of G Dallas Hanna; should diatom collections result from the OCSEAP program they could be processed into this collection. The Academy's dry mollusk collection also is part of the Department of Geology and, with the recent inclusion of the Stanford collection, is one of the world's finest; dry mollusks would be placed in this collection and those in preserving fluids in the Department of Invertebrate Zoology. The Academy's Department of Ornithology and Mammalogy also would accept specimens from this contract if any should become available, and this department is especially strong in western North American species, including emphasis on marine mammals.

The latest Annual Report for the Academy is submitted as additional information but not included as part of the proposal.

Department of Ichthyology

The collection of fishes at the California Academy of Sciences has been ranked as the second most important fish specimen resource in the United States by the Advisory Committee for the Development of a National Plan for Ichthyology (Copeia, 1976, no. 3, pp. 625-642). It contains over 1 million specimens, in 175,000 lots, representing about 14,000 nominal species, and primary and secondary type specimens representing about 3,000 species. It is worldwide in scope, with especially important collections from North America, Japan, Asia, the central and western Pacific and South America. The collection is housed in facilities which were expanded in 1967 and 1968 with the assistance of the National Science Foundation. Additional space will be made available in early 1978. The collection is widely and intensively used, both nationally and internationally by scientists and students. It is of considerable historical importance because of its age, the large number of publications based on it, the large number of type specimens, and its continued use by scientists and students. It provides a data base to governmental agencies concerned with environmental quality and endangered species, and it serves as a principal source of research materials for scientists and students. The collection has received considerable financial support from the National Science Foundation, for remodeling in 1967, for incorporation of the Vanderbilt and Stanford University collections, and is currently supported by an NSF curatorial support grant.

The present staff includes the following:

Dr. William N. Eschmeyer, Chairman and Curator
Dr. Tomio Iwamoto, Associate Curator
Dr. Warren Freihofer, Associate Curator
Mrs. Lillian J. Dempster, Associate Curator (parttime)
Mr. W. I. Follett, Curator Emeritus
Ms. Pearl M. Sonoda, Senior Scientific Assistant
Mr. James Gordon, Curatorial Assistant
Mr. William C. Ruark, Curatorial Assistant
Mrs. Betty A. Powell, Secretary

The fish fauna off California is very similar to that off Alaska, with the exception of areas west of the Aleutians. The Academy holds extensive collections from off western U.S. as well as Japanese specimens. Specimens from Alaska are not well represented in fish collections. The Academy's Alaskan holdings include specimens collected by the ALBATROSS 1906 North Pacific Cruise (Japan, Aleutian Islands, and Kamchatka), specimens collected from 1949-52 by a number of Stanford scientists and students working out of Point Barrow, and other smaller collections.

The Department of Ichthyology has had experience processing large collections, such as the incorporation of the 40,000-bottle Vanderbilt Foundation collection and the 75,000-bottle Stanford collection into the departmental collection. It serves as a repository for specimens from scientists, and from Federal and State agencies and some private ones, such as the Department of Fish and Game of California, several universities, NMFS Seattle Laboratory rockfish project, ERDA Farallon Islands dump site project, and some private consulting firms in the Bay Area.

Additional information is provided on this department by submission of portions of a funded NSF grant entitled, "Support for the care and use of the Collection of fishes at the California Academy of Sciences." One copy is provided, and it is not considered a formal part of this proposal.

Department of Invertebrate Zoology

The Department of Invertebrate Zoology has developed into one of the major repositories of preserved invertebrates in North America. It has extensive collections from Baja California, Central America, the Galapagos Islands, Alaska, British Columbia, and Southeast Asia. Alaskan holdings of importance include the U.S. fur seal investigations of 1919-21, the Department of Naval Research Pt. Barrow project in the 1950's, the U.S. Department of Interior Alaska Earthquake Study of 1965, the G.E. MacGinitie Naval Research project 162-911 that resulted in the publication, "Distribution and ecology of the marine invertebrates of Pt. Barrow, Alaska" (Smithson. Publ. vol 128), specimens collected by the Stanford University expedition in 1951, and many collections resulting from G. D. Hanna's work on Alaskan mollusks and his long-standing involvement in Alaskan biology.

This department also has had extensive experience serving as a voucher specimen repository for a variety of agencies. Recent additions include deposition of specimens by the California Department of Fish and Game (Fort Ross to Pt. Lobos, Point Arena Reactor Site Study), Monterey Bay Benthos Study by Hopkins Marine Station, Moss Landing Monterey Bay Study for the City of Watsonville, Santa Cruz Intertidal Study, Stanford Research Institute collections, EPA Farallon Radioactive Dump Site Study, Brown and Caldwell, Inc. Gulf of the Farallons study and Five-county Study of Sewage Disposal Sites, U.S. Geological Survey of South San Francisco Bay, U.S. Bureau of Reclamation Delta-Mendota Canal Study, U.S. Army Corp of Engineers Mouth of the Columbia River Baseline Study, the San Francisco International Airport Outfall Study, etc.

The Department of Invertebrate Zoology staff consists of the following:

Dr. Welton Lee, Chairman and Curator
Mr. Dustin D. Chivers, Senior Scientific Assistant
Dalene R. Drake, Curatorial Assistant

The Department is augmented by 4 Associates, 2 Field Associates, and other personnel working on specific grants, such as the San Francisco Bay Project which was funded by Sea-grant and several private foundations. This project involves the preparation of voucher specimen collections from this region, preparation of literature files, and the preparation of identification manuals.

The Department's facilities and collections are growing rapidly, and its collections form one of the largest and best curated invertebrate collections in the western United States. Numerous private and governmental agencies have recognized it as a desirable archival depository, and they have turned over extensive and biologically significant collections and associated data bases to the Academy for long term curation.

V. OBJECTIVES

1. Establish and maintain a fully cataloged museum collection of biological voucher specimens collected under the auspices of the Alaskan OCS Environmental Studies Program.

2. Specify appropriate collection and preservation techniques for various marine taxa.

3. Coordinate the shipment of preserved materials from other principal investigators to the archive.

4. Provide quarterly ADP formatted data summaries on the status and content of the collections.

VI. GENERAL STRATEGY AND APPROACH

1. Voucher Policy

In conjunction with the designated OCSEAP representatives, the voucher policy will be finalized. The draft voucher policy is well done and needs only minor modification in our opinion (for example, propylene phenoxetol and propylene glycol are probably not essential for field preservation of most general plankton collections). The curators of each pertinent Academy department will participate in preparing the voucher policy.

If the voucher specimen labels have not been printed, we suggest the addition of "number of specimens" in the lot. If it was thought desirable by the Project Coordinator, we would add catalog numbers directly to the voucher specimen labels, in which case provision for this could be made on the labels.

Instructions and tips on packing and shipping specimens to the archive will be prepared, along with a listing of any additional information desired by the archive from principal investigators (such as preserving solution from which specimens were removed, how to prepare invoices of specimens if needed, etc.)

2. Processing of Specimens

Location of work--In the spring of 1978, a 1152-sq. ft. room will be modified for use by the Department of Ichthyology. Funds are on hand for this rennovation, which includes construction of a workroom with sink and installation of 1727 sq. ft. of metal shelving. The Department of Ichthyology will not need most of this room for several years, and it is proposed that this area be used for the initial processing of specimens from this project.

Initial curation of specimens (in project workroom)--

a. Acknowledge receipt of each shipment
b. Unpack shipment, check against invoice
c. Transfer to final preserving solution and container
d. Examine quality of identifications and labeling (by appropriate Academy curator).

e. Catalog specimens in appropriate departmental collection. This provides each lot or sample with a unique number.
f. Enter data in computer (see 4 below).
g. Place on shelves in systematic order in the project workroom.

Provide sender of shipment and NOAA coordinator with a printout of contents of shipment after processing and cataloging.

Confirm identifications--Academy scientists and visiting scientists will be encouraged to examine the project material in their area of specialty to confirm identifications and correct identifications, adding an appropriate identification label documenting their identification. Note that we have included some funding in the proposal for reimbursement of expenses of specialists for confirming identifications in their area of specialty. We have had these funds available for visitors upgrading identifications in the general collections. The contribution to any one investigator is small, and some graduate students have been paid hourly to spend additional time during a visit to upgrade identifications in their area of specialty.

Subsequent integration with appropriate departmental collection--It is desirable that during the project, or initial portion of the project, that the specimens resulting from this project be kept isolated to facilitate their study. At a later date they will be transferred to the departmental scientific collections. (Proper care of the voucher specimens is insured if they are in the general collections where, for example, alcohol levels are checked routinely or botanical collections are fumigated regularly, and the voucher specimens are available for subsequent study by visiting scientists.)

It is tentatively proposed to distinctively mark the containers resulting from this project. For example, each of the 40,000 bottles of the Vanderbilt fish collection were marked before their incorporation into the Academy fish collection in 1968. Also, a note will be placed on the label or in the bottle indicating that these voucher specimens may not be loaned.

3. Personnel Strategy (See Appendix for additional information on key project personnel)

The principal investigator has strong interests in the fish fauna from the area involved and will, besides supervising the project, participate actively in aspects of the project dealing with fishes. He will devote 25% of his time to the project. (Should this proposal be funded, he will relinquish the chairmanship of the Department of Ichthyology to provide time for the project.)

The Senior Assistant and Invertebrate Coordinator has had extensive experience in identification and curation of invertebrates, especially from the N. Pacific, and he will supervise the processing of invertebrate groups as well as oversee purchase of all supplies and equipment.

Curatorial assistants will be hired as soon as shipments in sufficient volume are received. We want to employ two halftime assistants, one specializing in fishes and one in invertebrates. It is expected that existing Academy curatorial assistants will be interested in switching to this project, and halftime of their current position will be filled by new personnel.

For certain specialty groups and anticipated low-volume ones, such as algae or terrestrial plants, we propose using appropriate Academy technicians and reimbursing their departments for time spent on this project through the inclusion of hourly funds in the budget

3. ADP Strategy

"Computerizing" large specimen collections is in its infancy, and most such attempts have been heavily funded as experimental studies. Use of large computers and generalized cumbersome programs have not been as satisfactory as the use of mini computers with immediate access and with data entry by departmental curatorial assistants rather than computer technicians. At the present time the Academy's Department of Herpetology has a mini computer that perhaps could be used for the present project with the addition of more memory units, but the Academy is currently examining larger mini computers with remote terminals, and it is anticipated that purchase of such equipment will be made in the near future. Should the purchase of a central Academy computer system not be accomplished in time for the present project, it is proposed that a self-contained mini (such as an HP 1000 or IBM 5110) be leased for this project.

Formatting will be done as prescribed in the RFP, with the Principal Investigator and Dr. Alan Leviton of the Academy's Department of Herpetology representing the Academy.

All project personnel will be trained in data entry. If a separate catalog label is prepared it will be done concomitantly with data entry.

The data base probably will be kept on disks and will be converted to tapes for quarterly submission.

VII. SAMPLING METHODS

Not applicable.

VIII. ANALYTIC METHODS

Not applicable.

IX. ANTICIPATED PROBLEMS

Despite the well thought out and specified voucher policy provided by NOAA to principal investigators involved in activities resulting in voucher specimens, we anticipate that a few investigators will not follow this policy and will ship to the archive extraneous materials collected during their study. Working through the NOAA Coordinator, we would want to assist in selecting proper voucher specimens in these cases.

We do not anticipate additional problems unless the amount of material to be deposited far exceeds the volume we anticipate at this writing.

X. DELIVERABLE PRODUCTS

A. Digital Data

To be worked out with NOAA's Environmental Data Service. Digital tapes to be submitted quarterly as required.

Parameters

These will be established with the NOAA Project Coordinator. The format minimally should provide for data retrieval by taxon, NODC Code number, catalog number, geographic location, and project, but also should provide more detailed information as needed by principal investigators, such as lists of vouchers by vessel station numbers, etc.

For each voucher specimen lot we would enter all the information on p. 16 of the RFP, along with the number of specimens in the lot, the catalog number, and provisions for future reidentifications. We also would add our own internal filing code to assist in subsequent retrieval of voucher specimens from the collections. This consists of entry of the department and its filing category (family number in fishes, numerical systematic file number in invertebrates).

List of digital products

See attached Data Products Schedule.

B. Narrative Reports

1. Finalized voucher policy, including preserving techniques.

2. Voucher specimens by project or by each shipment, indicating catalog numbers and reidentifications; to be provided to Project Coordinator and individual principal investigators so that they may include archive voucher catalog numbers in their reports and publications.

3. Other reports as specified in the RFP.

C. Visual Data

None seem to be needed.

D. Other Non-digital Data

None requested.

E. Submission Schedule

As specified in the RFP. See attached schedule (Appendix).

XI. INFORMATION FROM OTHER INVESTIGATORS

We anticipate the need to communicate with principal investigators shipping voucher specimens to the archive. Some labels may lack sufficient data, discrepancies will no doubt occur occasionally, etc. We would like to correspond directly to clarify these problems as they arise. From certain contractors (or from the NOAA Data Base) we might desire lists of stations and associated data, especially from extensive vessel cruises resulting in numerous voucher specimens, so that we may check data on labels, clarify labels that are not completely legible, etc.

Normally when museums or scientists send specimens they prepare a "specimen invoice" and the recipient verifies receipt of the specimens. For the present project, perhaps the principal investigator sending the voucher specimens to the archive will not need to prepare an invoice as long as the specimens are properly labeled and the archive returns a printout of the material received as soon as it is processed.

XII. QUALITY ASSURANCE PLANS

1. Permanence. As discussed under BACKGROUND INFORMATION, the Academy is a stable natural history museum capable of providing long-term care to the voucher specimens deposited in the Academy scientific specimen collections.

2. ADP Committment. As outlined earlier, computer data management of natural history collections is best accomplished on mini computers or direct access terminals, with data entry made by departmental curatorial assistants. We believe the ADP strategy described under item VI(3) will insure prompt submission of accurate data tapes to the NOAA Data Center.

3. Scientific Competence. This is assurred by the training and experience of the organization and its staff, the on-site scientific associates, and the scientific visitors that will confirm identifications while utilizing the extensive Academy collections for systematic research purposes.

XIII. SPECIAL SAMPLE AND VOUCHER SPECIMEN ARCHIVAL PLANS

Not applicable.

XIV. MANAGEMENT PLAN

The principal investigator (Eschmeyer) will supervise all aspects of the project, including the preparation of reports, and will report directly to the NOAA Project Coordinator. He will supervise the processing of all fish voucher specimens and conduct all correspondence and related items. He will devote at least 25% of his time to the project.

The Senior Assistant and Invertebrate Coordinator (Chivers) will supervise the processing of non-fish groups and will be responsible for ordering all curatorial supplies and equipment needed for the project.

Curatorial assistants will be drawn from present Academy staff, with replacements for their vacated duties. They will be employed on this project as soon as the level of shipments of voucher specimens warrants. Provision for hourly workers for specialty groups is made.

All project personnel will be trained for data entry into the computer.

See also item VI. GENERAL STRATEGY AND APPROACH.

XV. OUTLOOK

Once voucher specimens are deposited, we will retain and curate them indefinitely. We anticipate that we would be able to provide at little or no cost an updated data base to accommodate reidentifications and changing systematic nomenclature that occur long after the project is terminated.

At the termination of the proposed initial 3-year contract, the cost of an extension would depend on the amount of voucher material still to be deposited by principal investigators. If the voucher material outstanding is extensive, we anticipate that the cost of continuation would be about $30,000 per year until the bulk of the material is deposited. We anticipate little or no subsequent expense, and processing of miscellaneous collections could be done at Academy expense, as is done with small collections from Federal and State agencies and from scientists and other contributors of scientific collections.

We also would like to offer for consideration that the archival center eventually receive for permanent storage certain information generated by principal investigators and subcontractors that might not be deposided or stored elsewhere, such as original field logs from vessel collections.

XVI. 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. 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 will be borne by the Project Office.

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

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

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

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 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.

8. 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."

XVII. OTHER INFORMATION

The principal investigator, William N. Eschmeyer, shall actively lead and supervise the proposed work, and shall take full responsibility for timely completion of all objectives, independent of the percentage of his salary requested in the budget.

Data Products Schedule

Type Intertidal, hic Organisms,)	Media (Cards, coding sheets, tapes, disks)	Estimated Volume (Volume of processed data)	OCSEAP Format (If known)	Processing and Formating done by PI (Yes or No)	Collection Period (Month/Year to Month/Year)	Submiss (Month/
ucher specimen ta	Disks, converted to tapes for submission	Unknown	To be established	Yes, in conjunction with NOAA	May 1977 to end of project and as long thereafter as desired	Beginning Sept. 197ε quarterly thereafter

RU #: ______________ PI: William N. Eschmeyer

△ Actual Completio

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

MAJOR MILESTONES	1977 O	N	D	1978 J	F	M	A	M	J	J	A	S	O	N	D
Finalize voucher policy															
Prepare shipping instructions for principal investigators sending specimens to the archive															
Order equipment and supplies															
Establish data format															
Process voucher specimens												TO	END	OF	PROJECT
ADP first operational															
Confirm identifications, upgrade where possible												TO	END	OF	PROJECT
Submission of first data tape to NOAA, quarterly thereafter															

ARCTEC, Incorporated Proposal No. 460P

THE TRANSPORT AND BEHAVIOR OF OIL

SPILLED IN AND UNDER SEA ICE

- - -

TASK 1: PHYSICAL PROCESSES

- - -

SOLICITATION NO. NOAA-10-78

Research Unit 567

January, 1978

Principal Investigators:

Lawrence A. Schultz
Paul C. Deslauriers

Supporting Investigators:

Seelye Martin, University of Washington
Timothy Kao, Catholic University of America

Starting and Completion Dates: April 1, 1978 to September 30, 1979
Total Cost of Proposal: $ 99,947; $ 38,750 in FY 78, $ 61,197 in FY 79.

Offer Authorized by:

Lawrence A. Schultz
Vice President

Submitted to

National Oceanic and Atmospheric Administration
Contracting Office
325 Broadway
Boulder, Colorado 80302

Submitted by

ARCTEC, Incorporated
9104 Red Branch Road
Columbia, Maryland 21045

1. BACKGROUND

The continuing energy crisis, particularly the shortages of oil and natural gas, indicate that the petroleum reserves already found and expected to be found in the Alaskan offshore region will be developed in a timely manner. This increased petroleum industry activity related to the exploration, development, production, and transportation of Alaskan offshore oil and gas will increase the potential for accidental spills of oil in the region.

The Outer Continental Shelf Environmental Assessment Program (OCSEAP) is a comprehensive environmental study program associated with the proposed development of oil and gas on the outer continental shelf. The program is managed by the National Oceanic and Atmospheric Administration (NOAA) for the Bureau of Land Management (BLM). The OCSEAP studies are designed to provide an environmental information base to support management decisions associated with the identification and selection of lease-sale areas. The OCSEAP program is organized into the topical areas of contaminant baselines, sources, hazards, transport, reconnaissance, and effects.

The primary objective of the Alaskan OCS Environmental Studies Program is to provide the technical information required to support management decisions associated with the protection of the OCS marine environment from damage due to oil and gas exploration, development, and production activities. The program is geared towards the development of providing meaningful data in a readily usable form, and in a timely manner so that any required corrective action can be taken before serious or irreversible environmental damage can occur. Through this program, NOAA has established itself among the world leaders in the area of Arctic oil pollution research and development. The other major programs concerned with the effects of oil pollution on the aquatic Arctic environment have been conducted by the U.S. Coast Guard, Environment Canada, The Canadian Bureau of Indian and Northern Affairs, the joint Canadian government-petroleum industry sponsored Beaufort Sea Project, and programs supported by two petroleum industry groups--the Alaska Oil and Gas Association (AOGA) concerned with Alaskan petroleum development, and the Arctic Petroleum Operators Association (APOA) concerned with Canadian Arctic petroleum development.

In general terms, the work completed to date associated with the extension of oil spill mitigation techniques to the aquatic Arctic environment has indicated that many of the oil spill response techniques and much of the hardware which has been developed for use in the warmer climates can be applied with relative ease to combating oil spills in the open water regions of the Arctic. However, modifications must be made in consideration of the low temperatures, and means must be made available for transporting, deploying, and operating the equipment and techniques at the spill site. Also through the extension of existing technology, it is generally agreed that some oil spill response capability exists in the case of oil spilled on the surface of solid ice cover through the adoption and extension of techniques used in combating terrestrial oil spills in warmer climates. In the Arctic regions, however, spill situations must include a consideration of the following: oil spilled beneath solid ice cover and on top of solid ice cover, oil sandwiched within solid ice, oil intermixed with broken ice pieces in either an unconsolidated or consolidated form, and oil contained within cracks and leads in areas of major ice floes. In Arctic regions, the oil spill response problem is further complicated by the presence of snow which may intermix with the oil or ultimately completely cover the oil, thereby eliminating the possibility of visual detection. The unique characteristics of the aquatic Arctic environment have a major impact on all functions of the oil spill response effort including spill behavior prediction, detection, surveillance, containment, recovery, temporary storage, transfer and logistics. The first of these oil spill response functions, that of oil spill behavior prediction, stands out as the single most important long-lead time item, since projections of oil spill behavior are of major importance to the planning function many years in advance of the other oil spill response functions. While techniques for predicting the behavior of spilled oil find application in guiding an oil spill response effort after a spill has occurred, this application is judged to be secondary in importance to the use of these techniques in long-term advance planning of environmental protection systems, the evaluation of potential environmental impact, and the advanced planning of oil spill response efforts. In terms of OCSEAP interest, the concern is indeed the primary one of oil spill transport directed towards determining the ways in which contaminant discharges move through the environment, and using projected trajectories of spilled oil to estimate the ultimate environmental impact of the spill. A major portion of the Alaska OCS Environmental Studies Program is allocated to determining a description and characterization of the fate of oil spilled in and under sea ice within the Alaskan OCS lease area. The program proposed herein is directed towards the establishment of this capability.

A great number of mathematical models have been developed for predicting the behavior of oil spilled in open water. These models vary greatly in the level of sophistication, the accountability and handling of the many forces which act on an oil spill, and in the general approach towards modeling as distinguished between deterministic and stochastic models. In most of the open water spill behavior models, the behavior of the oil is generally characterized as a combination of spreading and bulk movement. The oil spreading mechanism is concerned with the natural spreading of the oil on a calm sea with no contribution due to the action of winds, waves, currents, or other external factors. The movement or drift mechanism is concerned with the effects of the external factors on the slick motion. Drift modeling has been further subdivided into transport and trajectory models, where a transport model is defined as a model concerned with the drift of the oil slick as a whole, and a trajectory model is concerned with the drift of a point source in the oil slick such as the center of mass. In general terms, transport models combined with an oil spreading model are useful in predicting potential shoreline impact areas in nearshore and restricted waters. The trajectory models are more useful in determining probable impact areas on a monthly or seasonal basis and, with a current flow input, can be useful in predicting the movement of an actual spill.

Because of the great dependence of model results on the adequacy of input data in the case of deterministic models, stochastic approaches to oil spill behavior models have more recently been developed. In the stochastic approach, a large number of solutions are obtained based on random characteristics of winds and currents to form a probabilistic statement of the oil spill behavior. The statistical treatment of winds and currents can provide for changes in speed, magnitude, and direction at regular time increments based upon historical data. The stochastic approach is useful in planning activities associated with determining probable impact areas for site-specific and time-specific spill situations.

While this substantial effort has been devoted towards the development of oil spill behavior models for open water conditions, none of the models developed to date have included ice conditions or ice dynamics. The impact of the presence of ice cover on oil spill behavior prediction is so predominant that relatively few, if any, of the techniques which have been developed for open water spill behavior prediction are useful. The reason is simply that the major forces of interest in the open water spill behavior model no longer act directly and independently on the oil, rather they act on the oil through the ice, or through oil/ice interaction. In the case of oil spilled in ice infested waters, the dominant physical phenomenon is the interaction of the oil with the ice and the effect on oil movement caused by ice movement, which in turn is caused by external forces. The problem is particularly difficult for locations where there are wide variations in ice conditions on a seasonal basis, extending from open water in the summer, through annual ice formation in the nearshore zone, to involvement with multi-year ice farther offshore.

Even the preceding brief review of current capabilities in oil spill behavior prediction rapidly leads one to the conclusion that the approach to be used in developing an oil spill behavior model for use in ice infested waters is not to attempt an extension of the methods and techniques which have been developed for open water oil spill behavior prediction. Since the major physical factors are expected to be the movement of the ice and the interaction of the spilled oil with the ice, a more effective approach would be to take existing models of ice dynamics which have been developed for the Arctic, and to superimpose the relative behavior of the oil to the ice upon the ice dynamics model. For example, the model of ice dynamics developed by the Arctic Ice Dynamics Joint Experiment (AIDJEX) modeling group, provides information on the velocity of the ice field, its deformation, the stress transmitted through the ice, and the ice thickness distribution. The AIDJEX model has been primarily concerned with the central Beaufort Sea, but it has more recently been investigated for applicability to nearshore applications [1]. If this ice dynamics model, which presently has a minimum grid size of 10 km, could be further refined to a finer grid size, and the relationships describing the relative interaction of oil with ice could be superimposed on the model, the result would be an oil spill trajectory model for ice infested waters. This approach of adapting an existing ice dynamics model to an oil spill behavior prediction model for use in ice infested waters appears to be the most efficient approach toward meeting the requirements of the NOAA program which this proposal addresses.

The program outlined in NOAA's Request for Proposal (RFP) consists of three specific work tasks. The first program task is directed towards the determination of oil/ice interaction through vertical migration, interaction with pressure ridges, and horizontal transport. The second task is concerned with the development of the numerical model which results in the determination of oil spill trajectories based upon ice velocity fields and deformation, and oil/ice interaction. The third task is concerned with the application of oil spill trajectory models to specific oil spill scenarios. In this proposal, ARCTEC, Incorporated is responding solely to the Task 1 effort concerned with quantitatively characterizing oil/ice interaction. Since the results of this work must input directly into the numerical model, ARCTEC is prepared to work closely with the program coordinator and the contractor selected for the preparation of the numerical model to ensure that our development of quantitative definitions of the physical processes associated with the oil/ice interaction is completed in a form suitable for incorporation into the numerical oil spill trajectory model. ARCTEC personnel have long-standing personal relationships with all major investigators in the field of ice dynamics and cold regions oil pollution, and can guarantee close cooperation with the selected investigator to ensure that the results of ARCTEC's work are fully coordinated with program needs and result in a totally integrated work effort.

The following sections of this proposal outline the objectives of the proposed program, the general strategy and approach proposed by ARCTEC to meet the program objectives, the management plan proposed to guide the study effort, the costs associated with the proposed effort, and the background, experience, qualifications, and facilities of ARCTEC, Incorporated associated with the proposed effort. Further background discussion related to each of the three subtasks comprising Task 1 of the overall program will be found in the section describing our proposed approach to that subtask.

2. OBJECTIVES

The general objective of the proposed program is to develop a means for projecting the fate of oil spilled in and under sea ice within the Arctic OCS lease area. As identified in the RFP, the more specific objectives to be addressed in this program are:

1. To study the containment potential and transport of oil by ice moving over the continental shelf, and,

2. To determine the likely long-range trajectories of ice and spilled oil contained in the ice.

The achievement of these objectives requires a program which includes laboratory testing, field testing, and mathematical modeling. These studies of the transport and behavior of oil spilled in and under sea ice in the Arctic will result in the development of a model for projecting the fate and final destination points of spilled oil. This model will then be used for evaluating the threat posed by spilled oil to marine organisms.

In order to meet the program goal, the RFP states objectives for each of the three major work tasks. The objective of Task 1 is to determine by field and laboratory experiments the physical processes by which spilled oil gets incorporated in, and transported in and under, sea ice. The objective of Task 2 is to determine by numerical modeling the ice velocity field and the deformation of sea ice on the continental shelves of both the Beaufort and Chukchi Seas, so that oil spill trajectories and percent oil incorporation in pressure ridges can be deduced for different ice conditions under mean climatological conditions and extreme events including a major sea ice outbreak from the Chukchi Sea to the northern Bering Sea. The objective of Task 3 of the program is to determine, by combining the relevant information, the sequence under Tasks 1 and 2 as well as any other relevant information, the sequence of events, likely trajectories, and destination points for oil for selected hypothetical oil spill scenarios. The work proposed herein addresses only Task 1 of the overall program, but with the recognition of, and appreciation for, the importance of integrating the results of the Task 1 effort into the numerical modeling effort of Task 2, and the application of the numerical model in Task 3.

In the RFP, the objective of Task 1 was further defined through the establishment of three subtasks, and a statement of objectives for each subtask. In brief, Subtask 1.1 is concerned with the vertical migration of oil through ice, while Subtask 1.2 is concerned with the interaction of oil with pressure ridges, and Subtask 1.3 is concerned with the horizontal transport of oil beneath ice cover. The objective for the study of each of these physical phenomena was stated in the RFP as follows:

Subtask 1.1: To determine how and at what rates oil moves upward through multi-year ice to the surface.

Subtask 1.2: To determine how and at what rates oil gets incorporated into pressure ridges formed from ice of various thicknesses.

Subtask 1.3: To determine how oil of different velocities spreads and is moved by ocean currents under sea ice with different underside roughness characteristics.

The program proposed herein addressing Task 1 will result in the development of answers to numerous questions associated with oil/ice interaction including the following:

1. How does oil move through first-year and multi-year ice? Under what conditions will it reach the surface and how long will it take to reach the surface?

2. How does oil get incorporated into pressure ridges and how and when does it get released?

3. How much oil can be expected to be trapped within pressure ridges, in rafted ice, hummocks, leads, and surface relief in the bottom ice surface?

4. How does oil move horizontally under ice of different surface roughnesses through the action of ocean currents? How thick are the oil films likely to be under ice cover having a range of surface conditions?

5. What is the bulk transport of spilled oil by sea ice of different concentrations?

6. How does oil of different viscosities respond to these various vertical and horizontal dispersion processes?

3. GENERAL STRATEGY AND APPROACH

3.1 Subtask 1.1 - Vertical Migration

3.1.1 Technical Discussion

The behavior of oil spilled beneath solid ice cover has been the subject of a number of field and laboratory studies performed over the past seven years. One of the first studies directed towards the investigation of the behavior of oil spilled in cold regions was performed by the U.S. Coast Guard off the north coast of Alaska in July of 1970. Numerous spills of small amounts of oil were made to investigate a number of oil/ice interactions. The investigation of the behavior of oil beneath ice resulted in the conclusion that the oil pocketed into a single mass which remained stationary in the calm water test area. Ice pockets as small as one inch in diameter were filled with oil, and the investigators were led to speculate that a large surface relief in the ice sheet, and the presence of pressure ridges and other ice features, would result in the containment of a significantly large volume of any oil spilled beneath ice cover.

Laboratory investigations carried out by Hoult of the Massachusetts Institute of Technology [3] resulted in the conclusion that oil entrapped beneath a sheet of growing ice would be sandwiched in the ice, forming an oil lens. Laboratory experiments conducted by Keevil and Ramseier [4] with oil beneath fresh water ice also resulted in the formation of an oil lens within the growing ice sheet.

The major field test program concerned with the vertical migration of oil through ice was conducted in the winter of 1974-75 at Balaena Bay, NWT as part of the Canadian Beaufort Sea Project. This test of fuel spilled beneath first year ice in an area having no significant currents confirmed the formation of an oil lens in growing ice in the field. The oil entrapped within the oil lens was found to be essentially stable throughout the winter season, with the oil penetrating into the ice sheet to a depth of only 5 to 10 cm in the loose skeletal layer. As the ice sheet warmed in the spring and the brine channels enlarged, the oil began to migrate upward through the ice sheet. The rate of migration increased with increases in the level of solar radiation and the ambient temperature. Upon reaching the surface of the ice, the oil further reduced the solar albedo, which further accelerated the melting process. In this field test program, it was found that areas of oiled ice deteriorated to an ice-free condition from one to three weeks earlier than unoiled ice areas.

Laboratory experiments conducted by Rosenegger [6] revealed that the equilibrium thickness of Swan Hills and Norman Wells crude oil beneath level ice cover was 0.80 cm and 0.88 cm respectively. It was also concluded that any dissolved salts in the oil, if any do exist, would not cause the under-ice surface to deteriorate. Rosenegger found that when the oil encountered an oversized brine channel of approximately 0.7 mm in radius, limited penetration of the oil into the brine channel was likely. Rosenegger concluded that as melting proceeds in the spring and the brine drainage channels open, a significant amount of oil penetration into the ice sheet should be expected.

Much of the more recent major work in this area of study has been performed by Dr. Seelye Martin of the University of Washington, who will act as a consultant to ARCTEC, Incorporated for the vertical migration portion of the program proposed herein. Since 1974, Martin has participated in a number of laboratory and field test programs concerned with the vertical migration of oil through ice [7]. Martin's investigations included participation in the Balaena Bay oil and ice experiments during the 1974-75 ice growth season, field experiments of unoiled first-year ice growth during the 1975-76 ice growth season, and laboratory studies performed in 1976 on the growth of oiled and unoiled sea ice. His investigations included a broad range of ice conditions including columnar, frazil, ice grown from sea water mixed with snow, and recrystallized snow. Martin concludes that the drainage of surface salt in the first-year ice is very important because it results in the generation of top-to-bottom brine drainage channels through the entire thickness of the ice sheet, it helps form the porous snow-ice at the sea ice surface, and it generates void spaces above the freeboard of the sea ice. His observations further revealed that as the oil migrates upward in the brine channels, it then distributes itself within the brine channel network and throughout the porous surface ice. The amount of oil trapped within the ice by this mechanism was found to range between 1 and 5% by volume. Martin concluded that the entrapment of oil within the porous surface ice and the containment of oil within the brine and feeder channels would result in the release of oil spilled beneath first-year ice as a slow but continuous process throughout the spring and summer melt season.

NORCOR [8] recently completed a study of the probable behavior and fate of a winter oil spill in the Canadian Beaufort Sea by superimposing a postulated oil release upon historical records of actual ice conditions. Additional information on the experimental results obtained in the Balaena Bay field tests is revealed in this report. In particular, the rate of the vertical migration of oil through the first-year ice is defined by three data points. The oil which was initially discharged under the first-year ice between October and April began to appear on the surface of the ice on 9 May. By 3 June, it was estimated that 50% of the oil had migrated through the ice to collect in pools on the ice surface. It was then further estimated that nearly 100% of the oil reached the ice surface by 20 June. These three data points are plotted in Figure 1. To the best of our knowledge, they represent the total of the quantitative data presently available to the general public on the vertical migration of oil spilled beneath first-year sea ice. While this quantitative information is more than has previously been available for the treatment of the vertical migration of oil through first-year sea ice, and while it is recommended by NORCOR as a first gross approximation for general use in first-year sea ice, it is extremely limited in that the functional relationship is presented in terms of calendar days rather than governing physical parameters such as, for example, depth of the oil lens, oil properties, initial ice salinity, initial ice temperature, radiation levels, and thawing degree days. Another severe limitation is the fact that the relationship can be used only if the first day of oil surfacing is known. A generalized model of vertical oil migration in ice should provide for the determination of initial oil surfacing as a functional dependency of physical and environmental parameters such as those mentioned above.

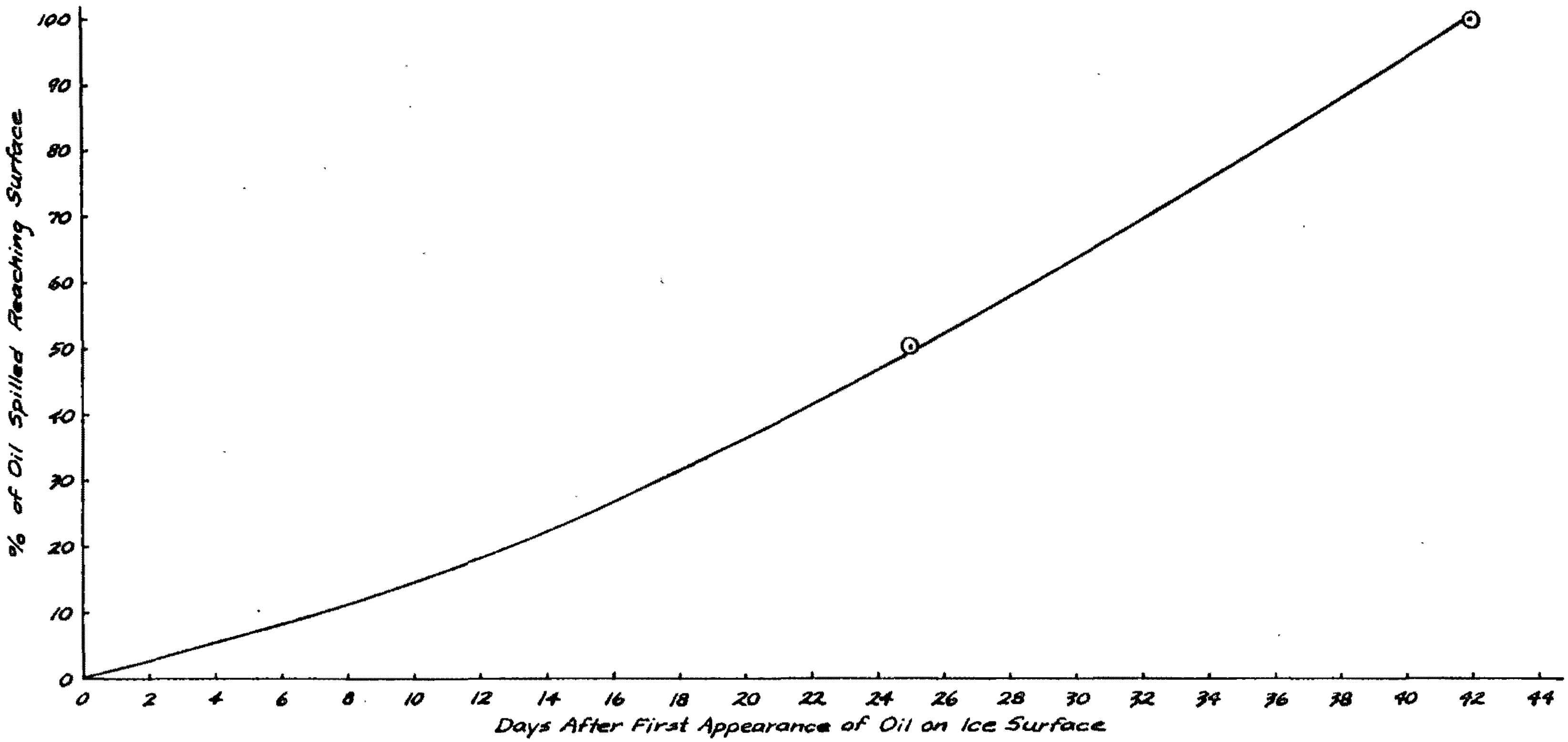

Figure 1. Vertical migration of oil through first year sea ice at Balaena Bay (after Norcor, [8])

All of the research summarized in the preceding paragraphs has been devoted entirely to the study of the vertical migration of oil in first-year sea ice. These studies of first-year ice have resulted in speculation as to the time it would take for oil to migrate upward through multi-year ice, but no experimental work has yet been devoted toward the study of vertical oil migration in multi-year ice. The speculation associated with vertical oil migration in multi-year ice has covered an extremely broad range, from the position that all the oil will surface in multi-year ice as rapidly as it does in first-year ice, to the other extreme, where no oil is expected to surface in multi-year ice in the first summer, with the time for surfacing equivalent to the multi-year ice depletion rate which has been identified as from 1 year to 11 years, with an average time of 4 years.

The first serious consideration of the vertical migration of oil in multi-year ice has recently been reported by Milne [9]. Milne investigated four multi-year ice floes of opportunity in the vicinity of Resolute Bay, NWT for their permeability with respect to sea water in August and September of 1976. The tests were conducted during this period because the ice floes were expected to be warmest at this time, and therefore most porous to brine drainage. The primary testing technique consisted of measuring the flow rate of water which filled blind holes drilled to various depths in the ice. All the holes flooded, but at varying rates depending upon the particular floe examined and the depth of the drilled hole. While no oil was used in these tests, Milne states that the test results lead him to conclude that most, if not all, of the oil which is trapped in and under multi-year ice should surface before mid-September if it was spilled under the ice during the previous winter and spring. In view of the broad range of speculation associated with prior thoughts on the vertical migration of oil through multi-year ice, it is expected that Milne's conclusion will be the subject of a great deal of controversy and discussion in the immediate future. However, Milne's work remains as the most concentrated effort on the subject to date.

The state of knowledge regarding the vertical migration of oil through first-year and multi-year sea ice can therefore be briefly summarized as follows. Investigations conducted in both the Canadian and Alaskan Beaufort Sea indicate that the roughness of the under-ice surface can be approximated for both first-year ice and multi-year ice by a simple sinusoidal model having an irregularity depth approximately equal to 20% of the mean ice thickness. Oil released into a water column under such ice cover will rise and gather in pools or lenses at the high points of the ice surface. During the ice growth season, a new layer of ice will form beneath the oil in a matter of days. This oil lens will then be immobilized until brine drainage is increased by the warming of the sea ice from increased air temperatures and short-wave solar radiation. As the brine channels reach the oil lens, the brine is replaced by the buoyant oil which, being dark in color, enhances the absorption of the sun's radiation to accelerate the upward percolation of the oil through the ice. Following this migration process, the oil floats on the surface of melt pools on the ice sheet, is subject to atmospheric weathering, and is accessible for cleanup operations. This generalized picture of the vertical migration of oil through sea ice applies equally to first-year ice and multi-year ice. However, the formation of brine channels and the corresponding rate at which oil can vertically migrate through the ice could be quite different in the case of multi-year ice.

Sea ice is a thermodynamically complex, heterogeneous mixture of pure ice crystals in layers of varying crystallography with pockets of entrapped salt brine. The entire ice sheet is in a temperature gradient, and the brine pockets have an equilibrium ion activity at each temperature so that the concentration of the brine pockets varies with the temperature gradient. Below the first meter of ice in still water, the varying brine pockets are formed from similar initial brine conditions with the result that their size and spacing varies inversely as the temperature of the ice. This relationship continues to the under-ice surface where the ice is at 0°C, and the large volume of low concentration brine forms a skeletal layer of ice. Since the pure ice crystal has a structurally preferred growth direction, geometric selection arranges the ice within each crystal into platelets with intervening brine inclusions. The spacing of these inclusions or brine pockets which join in melting to form brine channels is a function of the ice crystallographic type, the salinity of the initial sea water, and the rate of growth of the ice. As the ice deteriorates through warming, the brine pockets grow to form channels. Each of the ions in the brine has its own heat of dilution as it forms neutral ligands with the water molecules entering the brine.

Another process which should greatly affect oil migration through ice cover is the desalination of the upper surface of the ice as the ice sheet ages. Four primary mechanisms have been proposed which result in the desalination of the upper surface, including brine pocket migration, brine expulsion, gravity drainage, and flushing [10]. In brine pocket migration, the salt diffuses from the colder dense end of the ice to the warmer less dense end in order to reach an equilibrium state. As a result of this diffusion process, the concentration of brine in the lower portion of the ice sheet becomes greater. Thus, the brine pocket migrates to the warmer portions of the ice sheet which are usually in the direction of the ice-water interface. The phenomena of brine expulsion is postulated to result from freezing occurring on the interior of the brine cavities such that the brine composition can reach a more concentrated value required for phase equilibrium. With this phase change, as the volume increases a pressure gadient is produced which drives the brine down and ultimately out of the ice. The gravity drainage mechanism includes all processes where brine under the influence of gravity drains out of the ice sheet into the underlying water. The flushing process is actually a form of gravity drainage of brine above sea level, however, unlike the gravity drainage mechanism, flushing responds to the hydrostatic head which is produced when either snow or ice melts on the ice surface.

These desalination processes can result in substantial differences in the characteristics of the ice. For example, the salinity of young sea ice decreases from roughly 20 ppt immediately after its formation to 5 ppt after a period of 2 to 4 weeks. Young sea ice consistently has a high salinity, as well as a "C"-shaped salinity profile. As the sea ice grows and the desalination process occurs, the "C"-shaped profile becomes less pronounced, becoming almost flat in the spring. The salinity of multi-year ice is substantially different from first-year ice in that it gradually changes from a fraction of 1 ppt at the top to normal salinities in the lower portion of the ice sheet.

It has, therefore, been speculated that in multi-year ice with a brineless upper layer, the vertical migration of oil will be severely restricted in comparison to first-year ice, due to the relative absence of brine channels to facilitate the vertical migration. This line of reasoning results in the conclusion that the rate at which oil surfaces from multi-year ice will be closely related to the extent of surface melting. The recent work of Milne, discussed above, disputes this conclusion.

3.1.2 Research Plan

The objective of Subtask 1.1 as stated in the RFP is to determine how and at what rates oil moves upward in multi-year ice to the surface. Based upon the preceding background discussion, it is apparent that this objective must be expanded to include quantitative descriptions of vertical oil migration through both first-year and multi-year ice. More specifically, relationships are required to relate the onset of oil migration for both ice conditions to ice physical characteristics, oil properties, and environmental conditions, and a second relationship is required to relate the rate of vertical migration of oil to these same parameters. Since both relationships are required for both ice conditions, we anticipate the quantification of four relationships for the characterization of the vertical migration of oil in ice as follows:

1. Quantitatively relate the onset of vertical oil migration in first-year ice to oil properties, ice characteristics, and environmental conditions.

2. Quantitatively relate the onset of vertical oil migration in multi-year ice to oil properties, ice characteristics, and environmental conditions.

3. Quantitatively relate the rate of vertical migration of oil in first-year ice to oil properties, ice characteristics, and environmental conditions.

4. Quantitatively relate the rate of vertical oil migration in multi-year ice to oil properties, ice characteristics, and environmental conditions.

The Canadians have also recognized the current deficiencies in our knowledge of the vertical migration of oil through first-year and multi-year ice and have recently initiated two programs, one each for studying first-year ice and multi-year ice. As a part of the Canadian Arctic Marine Oil Spill Program (AMOP), ARCTEC CANADA, Limited, the affiliate of ARCTEC, Incorporated, located in suburban Ottawa, Ontario, is under contract for laboratory studies concerned with the behavior of oil and gas released beneath artificial first-year sea ice under simulated ice formation and ice decay conditions. This test program includes the testing of reference cells containing uncontaminated and oil contaminated ice which will be used for comparison with existing field data. This laboratory test work should be underway within the next two months.

The second Canadian program, organized under the continuing R&D program of the Canadian Environmental Protection Service, is concerned with the extension of the work recently completed by Milne which was summarzed in the preceding technical discussion. Since no oil was used in Milne's program, and since he concludes that it is likely that most, if not all, of the oil trapped within and under multi-year ice will surface before mid-September if it was spilled under the ice in the previous winter and spring, it is planned to check this preliminary conclusion using discharges of crude oil beneath multi-year ice in field tests conducted in the spring of 1978. While the results of these two test programs are not likely to provide the amount of data required in order to establish the four quantitative relationships judged necessary for the complete definition of the vertical migration of oil in ice, these programs will certainly increase the level of knowledge for both the first-year ice and multi-year ice cases, and will likely result in a second level approximation of the vertical migration of oil in first-year ice, and a first level approximation of the vertical migration of oil in multi-year ice.

Recognizing the current state of knowledge and the current research activity associated with the vertical migration of oil in both first-year and multi-year ice, ARCTEC, Incorporated recommends that the objectives of Subtask 1.1 be met through the approach outlined in the task flowchart of Figure 2. The initial effort in accomplishing the work of this subtask will be directed towards the development of preliminary preferred forms of quantitative vertical migration models for the onset of migration and the subsequent rate of migration for both first-year ice and multi-year ice. These preferred formulations will be approached through a parametric analysis whereby the major parameters associated with the oil, the ice, and the environmental conditions will be identified, and the parameters judged to be most significant to the migration phenomena will be selected for further investigation. Since the ultimate application of these vertical migration models will be in the numerical model of oil spill trajectories, the preferred forms of the vertical migration models will be developed with frequent reviews with the program coordinator and the numerical modeling contractor. After the preferred forms of the vertical migration models have been developed in a preliminary manner, past and current major investigators in this field of research will be contacted in an effort to obtain additional data which has not been publicly released. Arrangements will also be made to observe and participate in the two ongoing Canadian research programs. Dr. Seelye Martin of the University of Washington will be a consultant to ARCTEC, Incorporated throughout this subtask, working closely with ARCTEC's principal investigators. The major organizations to be contacted include the Canadian Environmental Protection Service, the Canadian Institute of Ocean Sciences, NORCOR Engineering and Research Limited, and ARCTEC CANADA, Limited. The objective will be to obtain all available data suitable for consideration in the development of preferred forms of vertical migration models.

Based upon this comprehensive search of existing and newly acquired data from other programs, the next work item in the proposed program consists of developing the best form of vertical migration models possible based on the available data. It is expected that the form of the vertical migration

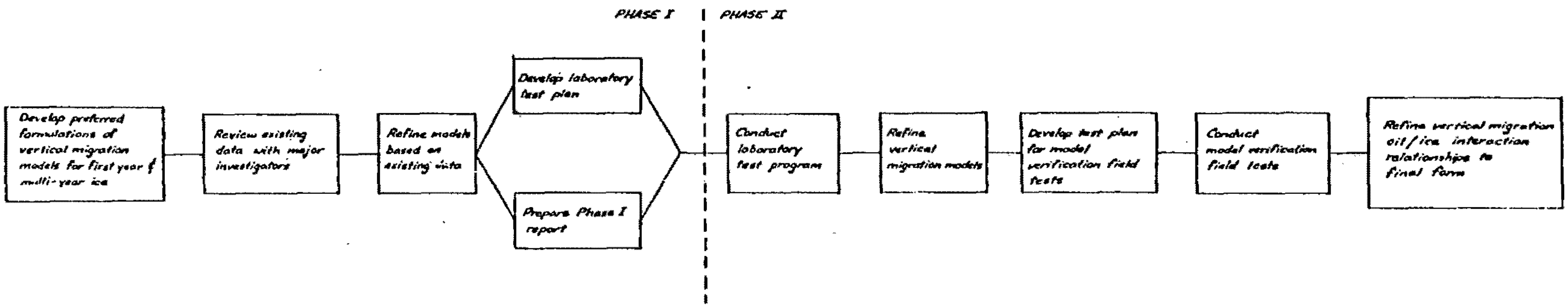

Figure 2. Flow chart of Sub-task 1.1

models which can be developed at this point will fall substantially short of the preferred form, but will provide a significant advancement over present capabilities. Since both of the current Canadian programs should result in a significant advancement in our state of knowledge of the vertical migration of oil in ice, it is proposed that the results of these programs be analyzed and evaluated prior to undertaking futher laboratory or field test programs under the OCSEAP oil-in-ice program. As a result, the effort devoted to studying the vertical migration of oil in ice in the first eighteen months of the proposed program, hereinafter referred to as the Phase I effort, does not include any field or laboratory tests. After the completion of the current Canadian programs, and the development of the preliminary forms of the vertical migration models based upon the available data, the proposed program then calls for the development of a comprehensive laboratory test plan. This work item, along with the preparation of the final report, is the final work item proposed related to the study of the vertical migration of oil in ice during the first eighteen months of the proposed program.

The Phase 2 effort associated with the study of the vertical migration of oil in ice is proposed to get underway with the performance of full-scale laboratory tests in ARCTEC's Ice Model Basin. It is proposed that ARCTEC's Ice Model Basin, measuring 100 x 12 x 6 feet in length, width, and depth respectively, be partitioned into test cells for the controlled testing of the vertical migration of oil in ice for both simulated first-year ice and simulated multi-year ice. Ice will be grown in ARCTEC's Ice Model Basin using a combination of the mechanical refrigeration system normally used for holding the temperature in the model basin during testing, and ARCTEC's patented cryogenic freezing system, which is normally used for the freezing of model-scale ice sheets for the testing of ships and offshore structures in ice infested waters at model scale. The use of ARCTEC's Ice Model Basin for full-scale testing of the vertical migration of oil in first-year and multi-year ice will provide a level of parameter control which is impossible to achieve in the field. Since the controlling parameters can be closely regulated and carefully monitored throughout the test program, the data base upon which the vertical migration models can be built will be greatly expanded.

Upon the completion of the full-scale laboratory test program in ARCTEC's Ice Model Basin, the vertical migration models would be further refined and a test plan directed towards model verification would be developed if necessary for field tests. It is then proposed that model verification tests be conducted in the field, and the vertical migration oil/ice interaction relationships be refined to their final form. ARCTEC, Incorporated has made arrangements with Crowley Environmental Services of Anchorage, Alaska to participate in the Phase II field test programs, if they are required, under subcontract. Crowley's experience in field testing, field operations, Arctic marine transportation, and Arctic oil spill response will be of great value in the conduct of the proposed field tests.

3.1.3 Level of Technical Effort

Name	Title	Hours
L. Schultz	Program Manager	64
P. Deslauriers	Environmental Engineer	160
S. Martin	Consultant	40

3.2 Subtask 1.2 - Interaction with Pressure Ridges

3.2.1 Technical Discussion

With the exception of a very narrow belt of shorefast ice near the coast, the ice cover of the Arctic Ocean is in continual motion with mean annual drift rates varying from 0.2 to 2.6 nm/day [11]. The deformation of the ice sheet that accompanies this ice drift results in the formation of hummocks and pressure ridges which have long been recognized as the principal impediment to the movement of both surface and subsurface shipping in the Arctic. Using the nomenclature recommended by the World Meteorological Organization [12], a typical ice deformation process can be described as follows. As pressure in the ice sheet increases, a point is reached at which permanent deformation occurs, and the ice is said to fracture. The process by which the fractured sea ice is forced into ridges is called ridging. The specific type of ridging which occurs varies with the relative thickness of the interacting ice sheets and the nature of the local motion, which can either be in compression or shear. After fracturing has occurred, and if the local motion is primarily compressive, thinner ice sheets usually inter-finger, forming rafted ice sheets where each floe thrusts fingers alternately over and under the other. As the deformation process continues, sea ice piles haphazardly, one piece over the other, to form an uneven surface which is termed a hummock. A hummock is defined as a hillock of broken ice which has been forced upwards and downwards by pressure. Hummocks are relatively discrete regions of ice deformation. In contrast, a pressure ridge is a line or wall of broken ice forced upward and downward by pressure in the ice sheet. The submerged volume of broken ice beneath the ridge forced downwards by pressure is termed an ice keel while the portion forced upward above the surrounding ice surface is termed the ice sail. Most ridges develop as a result of the deformation of the thinner ice that forms in lead systems between older, thicker ice floes. With primarily compressive relative ice motion, the thinner ice sheet will repeatedly fail in bending, causing a pile of ice blocks of the thinner ice to accumulate next to the edge of the thicker sheet. As continued failure of the thinner sheet causes the ridge to develop, the general compressive motion will push a portion of the growing ridge up onto the upper edge of the thicker ice sheet. Eventually the edge loading of the thicker ice sheet will cause a segment of it to fail. This segment is then gradually rotated and incorporated into the growing ridge. This process is repeated a number of times as the ridge grows. Only after the more readily deformed new ice has been pressured into ridges does ridging involve the thicker multi-year ice. It has been speculated that isolated hummocks are produced by the crushing of localized pressure points along the irregular initial region of interaction between two floes, while ridges are produced by more extensive inter-floe contact. Pressure ridges and hummocks may be unconsolidated or consolidated, in which case the base of the ridge or hummock has refrozen together.

In addition to these ice features of rafted ice, hummocks and ridges, fields of broken ice are also of importance in determining the trajectory of oil spilled in ice infested waters. For the purposes of this discussion, the most important characteristic of broken ice fields are the thickness of the ice pieces comprising the broken ice field, the areal coverage, and the concentration of the ice. The concentration is typically defined as the ratio of the sea surface actually covered by ice to the total area of sea surface, both ice covered and ice free, at a specific location or over a defined area.

The work of Subtask 1.2 must, therefore, include not only the determination of how and at what rates oil gets incorporated into pressure ridges formed from ice of various thicknesses, but also how and at what rates oil gets incorporated into rafted ice, hummocks, and broken ice fields. The research program designed to meet the program objectives must be concerned both with the containment and transport characteristics of these ice features.

In 1975, full size tests of oil spill recovery devices in ice infested waters were conducted for the U.S. Coast Guard at ARCTEC's Ice Model Basin [13]. As part of the preliminary work associated with this program, ARCTEC investigated the spreading characteristics of a crude oil selected to simulate Prudhoe Bay crude and No. 2 fuel oil in both open water at low temperatures and in broken ice fields. These spreading tests indicated that thin oils will quickly spread to a very thin layer whether in open water or in broken ice cover of very high concentration. In contrast, heavy oils spilled in broken ice cover will achieve a natural equilibrium thickness many times greater than the open water equilibrium thickness due to the partial containment of the oil by broken ice pieces. The natural slick thickness obtained for the crude oil used in this test program in cold open water was 0.73 cm. For the release of the same crude oil in broken ice cover of high concentration, the tests indicated that the equilibrium thickness was a function of the concentration of the broken ice field and the size distribution of the ice pieces comprising the broken ice field.

The most extensively studied oil spill incident in ice infested waters to date was the grounding of the barge Bouchard #65 on 28 January 1970 in the waters of Buzzards Bay, Massachusetts. This release of over 81,000 gallons of No. 2 home heating oil occurred when the waters of Buzzards Bay were ice covered to a concentration of 90%. In its report [14] on the physical behavior of the Bouchard #65 oil spill in ice infested waters prepared for NOAA, ARCTEC, Incorporated identified a number of oil behavior mechanisms. The presence of broken ice fields resulted in an initial degree of containment of the spilled oil, and, after ice breakup, resulted in the distribution of the oil as the ice floes were transported by winds and currents and gradually deteriorated. This transport of spilled oil contained in broken ice fields was identified as a possible mechanism for the long-range transport of oil which could be very important in Arctic oil spills. Therefore, while the general containment potential of broken ice fields has been identified, and the potential for the greater transport of spilled oil contained in broken ice fields has been recognized, neither the containment nor the transport mechanisms have been quantitatively defined.

The major role played by rafted ice in determining the behavior of oil spilled in ice infested waters was first observed and reported by Deslauriers [14] in connection with the studies of the 1977 Buzzards Bay oil spill. The ice in Buzzards Bay at the time of the spill was heavily rafted due to pressure in the ice sheet generated by winds, currents, and ship traffic. Approximately 30% of the spilled oil was found to be contained in deep pools formed by the rafted ice. The sequence of sketches shown in Figure 3 identifies a possible oil capture scenario. As the current carried the oil under the ice, the oil encountered the bottom of the rafted formations and would collect and be sheltered from the currents in the lee of the submerged part of the rafted ice. The buoyant oil would then rise through the opening between the two ice sheets to replace the heavier sea water in the pond. Once on the surface, the oil was then protected from the currents. As the tidal current oscillated back and forth, the oil which was not protected from the currents would then be swept away. Since this oil containment mechanism has just recently been discovered through field observation of an actual spill, no quantitative information regarding the containment capability of rafted ice is available.

Figure 4 is an idealized sketch of a cross-section of a pressure ridge using the approach of Weeks and Kovacs [15]. Weeks [16] states that the ratio of sail height to keel depth is typically 1 to 5, and the mass of the ice above and below the waterline is in approximate hydrostatic equilibrium. When ridges first form, the ice blocks making up the ridge are separated from one another by air spaces and water spaces called voids. From field observations, Weeks determined that approximately 30% of a young pressure ridge is void space, making the ridge highly permeable to oil.

Hummocks are generally similar to ridges but lack the more clearly defined form, consisting of a haphazard pile of ice pieces which results in an uneven surface. Parmerter and Coon [17] have shown that hummocks also have a sail height to keel depth ratio of 1:5. Young hummocks presumably will also have a high void content similar to that defined for ridges, thereby making them similarly permeable to oil.

Based upon observations made at the 1977 Buzzards Bay oil spill in ice infested waters, ARCTEC investigators have developed two scenarios for the interaction of spilled oil with pressure ridges and hummocks. Oil can become incorporated in hummocks and ridges when the oil is present during the formation process itself. This would happen when contaminated ice pieces are compressed together into a ridge or hummock, or when oil in a lead along an ice edge is caught up in the hummock or ridge formation process. Alternatively, oil can flow into previously formed hummocks and ridges as shown schematically in Figure 5. The porous ridges and hummocks present numerous small crack systems for the oil to fill in through hydrostatic forces, with the oil remaining relatively stable within the void spaces once it gets there.

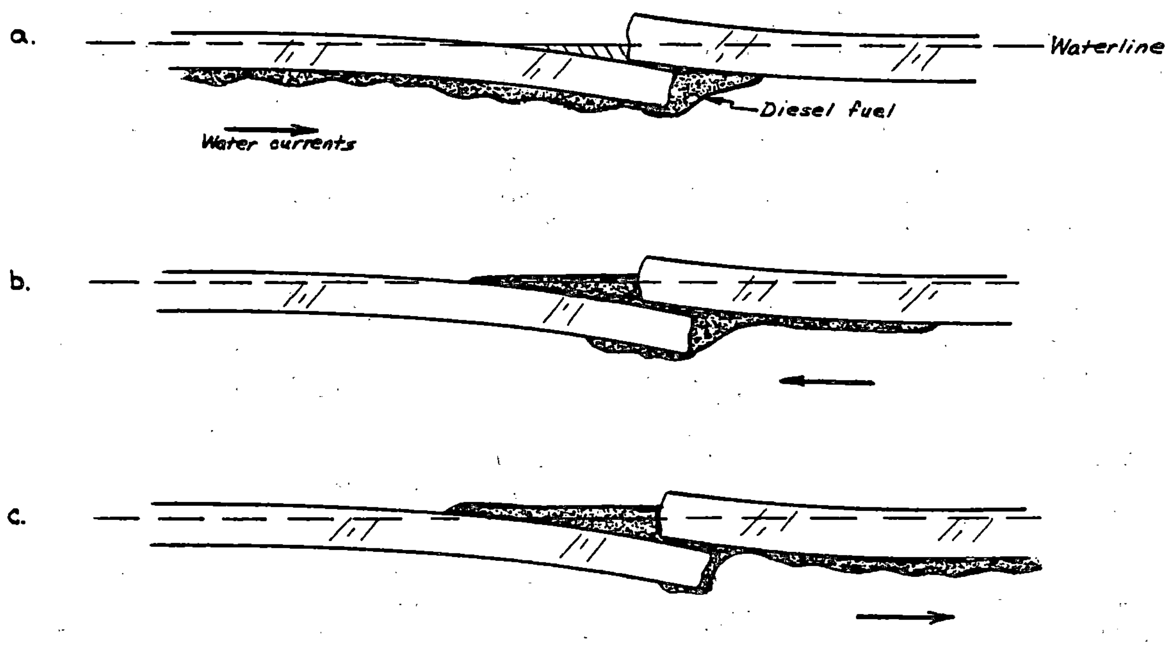

Figure 3. Flow of Oil in Rafted Ice a) Oil Flowing Underneath The Ice Comes in Contact with Rafted Ice, b) Current Reversal Encourages Oil Filling Into Rafted Ice Pocket, c) Reversal of Current Sweeps Unsheltered Oil Away [14].

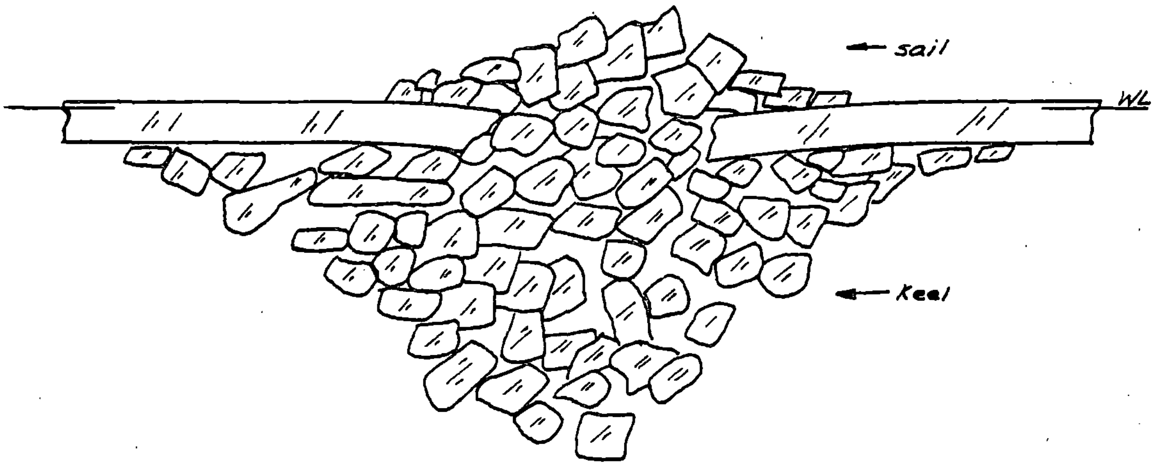

Figure 4. Idealized Sketch of the Cross Section of a Pressure Ridge (after [15]).

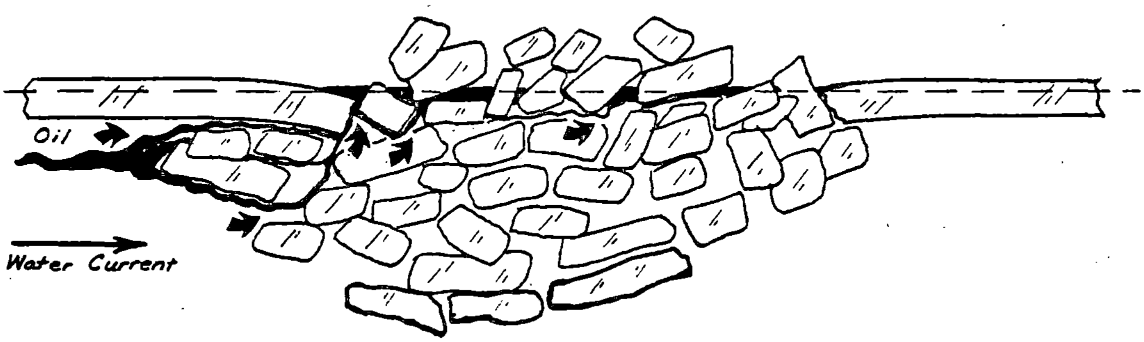

Figure 5. Oil Flowing Into an Idealized Cross Section of a Hummock.

The degree of retention, or containment, of the oil within the void spaces of a hummock or ridge has been the subject of considerable controversy and, in all probability, depends upon oil properties, ice properties and characteristics, ridge or hummock porosity, and the prevailing currents. No quantitative investigation of this phenomena has yet been made.

In addition to the containment offered by the incorporation of oil within the void spaces of a pressure ridge, the keel penetration of the ridge itself presents the possibility of additional containment on the upstream side in a manner similar to conventional oil containment booms. This containment mechanism applies to both unconsolidated and consolidated pressure ridges. While the possibility for the containment of spilled oil by pressure ridge keels has long been recognized, no investigations have been conducted to date to quantify the containment capabilities of ridge keels. The problem of oil retention by barriers in open water conditions has, however, been the subject of an extensive amount of work. This work serves as a valuable introduction to the problem of oil spill containment beneath ice cover by pressure ridge keels or by artificial barriers.

A typical oil retention barrier is shown in Figure 6 along with common terminology. There is an interface between the oil and the water, and the oil-water system has a free surface. The oil slick itself is divided into a head wave region, a mid-slick region and a barrier region. The thickness of the oil slick is some function $t(x)$, and the oil retention barrier draft is denoted by d. Foremost among the barrier stability studies are the work of Wilkinson [18, 19], Wicks [20] and Hale et al. [21]. Two regions are considered in Wilkinson's work, the head wave and the mid-slick region. Wilkinson developed expressions for the profiles of these two regions and showed that the mid-slick profile is a function of stresses being applied to the main stream by other boundaries. Wilkinson considered two different types of barrier failure mechanisms. The simplest type, called drainage failure, refers to the case where the slick thickness exceeds the barrier draft. The second type of failure, called entrainment failure, refers to the growth and breaking of interfacial gravity waves at the mid-slick region interface. When the waves break, the oil is injected into the ambient free stream and then swept under the barrier. The interfacial waves arise through an instability mechanism of the Kelvin-Helmholtz type which is governed by a densimetric Froude number. Wilkinson derived a critical Froude number based on ambient free stream conditions for the entrainment failure of the barrier. He also predicts the critical volume of oil for given free stream conditions that a barrier can retain before drainage failure occurs. In deriving these critical conditions it is implicit in Wilkinson's work that the oil slick cannot dissipate or dampen a significant amount of the water's energy, i.e., the Reynolds number of the oil motion is high enough so that there is no appreciable amount of viscous damping.

Wicks considered the slick to be composed of three parts, a head wave, a mid-slick region and a near boom region. Wicks developed profiles for each region as a function of Froude number based on ambient stream conditions and the interfacial stress applied to the mid-slick region of the oil, and allows for two types of barrier failure, drainage failure and

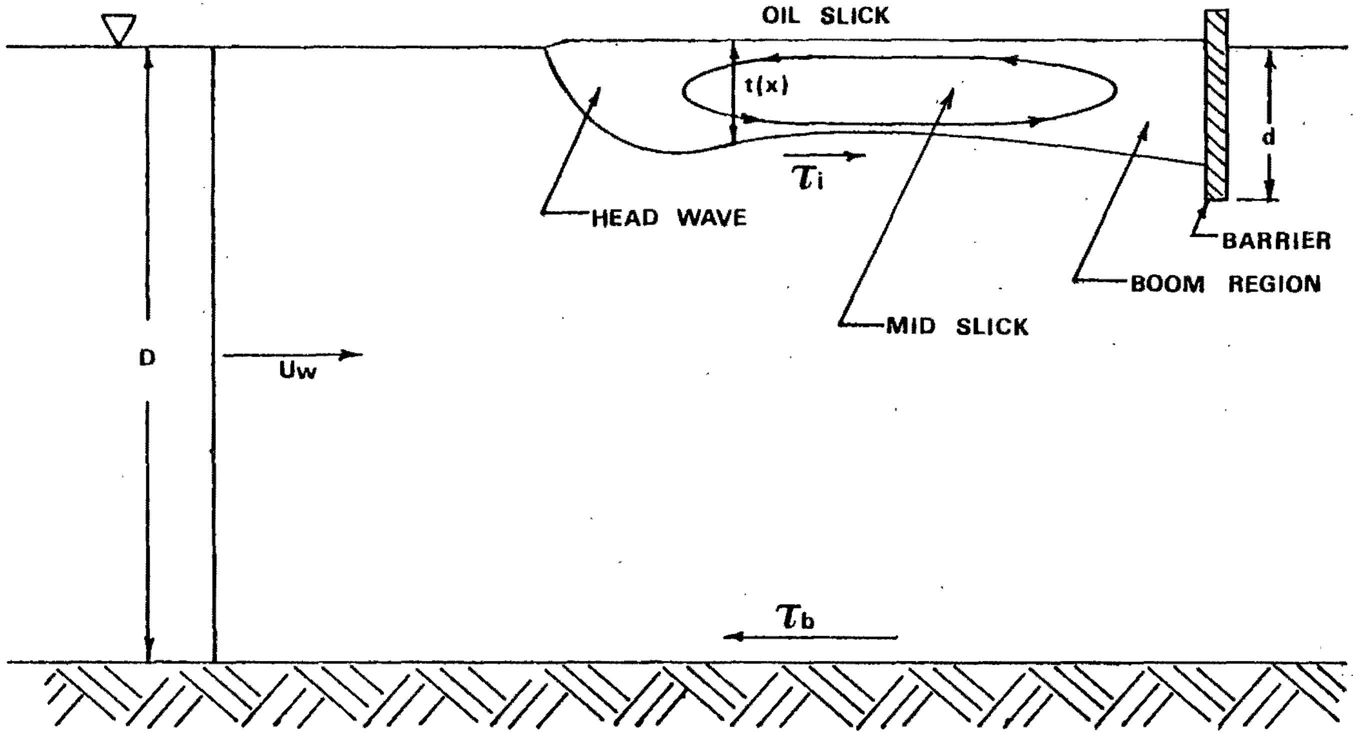

Figure 6. Sketch of the Oil Boom Problem showing Common Terminology.

entrainment failure, with an allowance for entrainment both at the mid-slick region interface and at the rear of the head wave. The first type of entrainment results from an instability governed by Froude number, whereas the second type of entrainment is determined by a critical Weber number. In the latter type of entrainment, the water suffers a significant acceleration in going "around" the head wave. This causes a vertical acceleration, and the water literally rips drops of oil off of the head wave. The drops are then swept downstream and under the barrier by the ambient current. For the mid-slick region, Wicks developed a profile for the oil slick based on a force balance between viscous effects, hydrostatic pressure gradient, and turbulent drag by the free stream. For this region, Wicks found the critical Froude number for the onset of the instabilities at the oil-water interface that lead to entrainment failure. For the mid-slick region, Wicks predicted the velocity profile in the oil by assuming a plane Couette flow with continuity of stress at the interface and zero net mean flow through the vertical cross section of the slick. According to Wicks, the near boom region extends five barrier drafts upstream of the barrier.

Hale et al. present a comprehensive review of existing work on the problem of oil retention by a barrier. In their study, the slick is divided into three regions and the effects of two types of forces on the oil slick being retained by a barrier are considered. These two forces are those due to waves and those due to currents, acting either alone or in combination. The same two types of failure mechanism are considered in their study, entrainment and drainage. Entrainment at the head wave and entrainment at the interface are both considered, and for each type of entrainment several drop types are investigated. The entrainment failure at the head wave was shown to be governed solely by a critical Weber number (as in Wicks). The thickness of the head wave was shown to be a strong function of Froude number and a weak function of Reynolds number. For the mid-slick region, it was concluded (similar to Wilkinson and Wicks) that the thickness of the mid-slick region ($t[x]$) grew as the square root of the distance along the slick. The viscous dependence of entrainment at the interface could not be so quantitatively described.

All of the previously described work was done at normal room temperatures with the water having a free surface. It remains to investigate variations in the two failure mechanisms that are related to cold ambient temperatures and the presence of ice cover. Wilkinson indicates that viscosity influences the failure mechanisms when he stated that the onset of interfacial turbulence was indicated by wave breaking and this was inhibited if the viscosity of the oil was high. For some oils, like crude oil and residual fuels, viscosity is a strong function of temperature, and it is possible to see changes in viscosity of three orders of magnitude for a temperature change on the order of 25°C (i.e., freezing to room temperature). An oil like No. 2 fuel oil exhibits a factor of 1.5 change in viscosity over a similar temperature span. Hale infered that viscosity could have a large influence on interfacial stability since higher viscosity fluids tend to develop waves of large wave length having less of a breaking tendency, and more of a tendency to damp out short wave motions. Both of these effects would imply a smoother interface, which in turn implies a reduced friction factor and interfacial stress coefficient. It is noted that all investigators have found that in the mid-slick region the slick thickness growth ($t[x]$) is proportional to the friction factor since the force balance in this region is between the turbulent drag on the oil and the viscous drag at the oil-water interface. It is concluded that the effect of changes in viscosity are directly visible by reducing interface motions, and indirectly visible since the smoother interface reduces the effective friction factor. In addition to the above, the presence of the ice sheet is important because the oil-ice interfacial spreading coefficient is negative. Surface tension effects are also important for the entrainment failure at the head wave via the Weber number.

The effect of the ice sheet can be identified as an additional drag on the oil slick. Wicks predicted a velocity profile for the recirculating oil slick in the presence of a free surface. Hale, based on continuity of stress at the oil-water interface and empirical values of the recirculation oil velocity at the air-oil interface, predicted velocity profiles through a vertical cross section of the oil slick. Typical values of the air-oil interface velocity were approximately 0.1 to 0.25 times the oil-water interface velocity, which in turn scaled with the free stream velocity times the ratio of the viscosity of water to the oil viscosity. Based on these estimates, a qualitative estimate of the velocity profile of the oil with a smooth ice sheet as one boundary is shown in Figure 7. An order of magnitude estimate of the wall stress (τ_w) can be made using stress continuity across the oil and water as follows:

$$U_{\text{oil}} = \frac{\tau_i}{\mu}\,\frac{h}{2} \quad .$$

Therefore:

$$\tau_w \approx \mu_o\,\frac{U_o}{h/2} = \mu_o\,\frac{\tau_i\,h/2}{\mu_o\,h/2} = \tau_i \quad ,$$

or the wall drag, τ_w is of the same order of magnitude as the interface drag, τ_i. The effect of a rough ice sheet on these estimates is to increase the wall stress, τ_w. Uzuner [22] gives formulas for calculating Manning coefficients which in turn can be expressed as roughness heights. Manning coefficients of the order of 0.050 have been found for some rivers, indicating roughness heights several feet for deep rivers. Ice sheet roughness effects on oil transport will be discussed in greater detail in following sections of this proposal.

Assuming that $\tau_w = \beta\tau_i$ and that $\beta \sim O(1)$ we can derive the effect of τ_w on the mid-slick region thickness using Wilkinson's force balance where τ_b is replaced by $\tau_b - \tau_w$ and τ_i is replaced by $\tau_i + \tau_w$:

$$\Delta\,\rho g\,\frac{\partial\delta}{\partial\chi} = \frac{\tau_i + \tau_w}{1 - \Delta} + (\tau_b - \tau_w)\,\phi$$

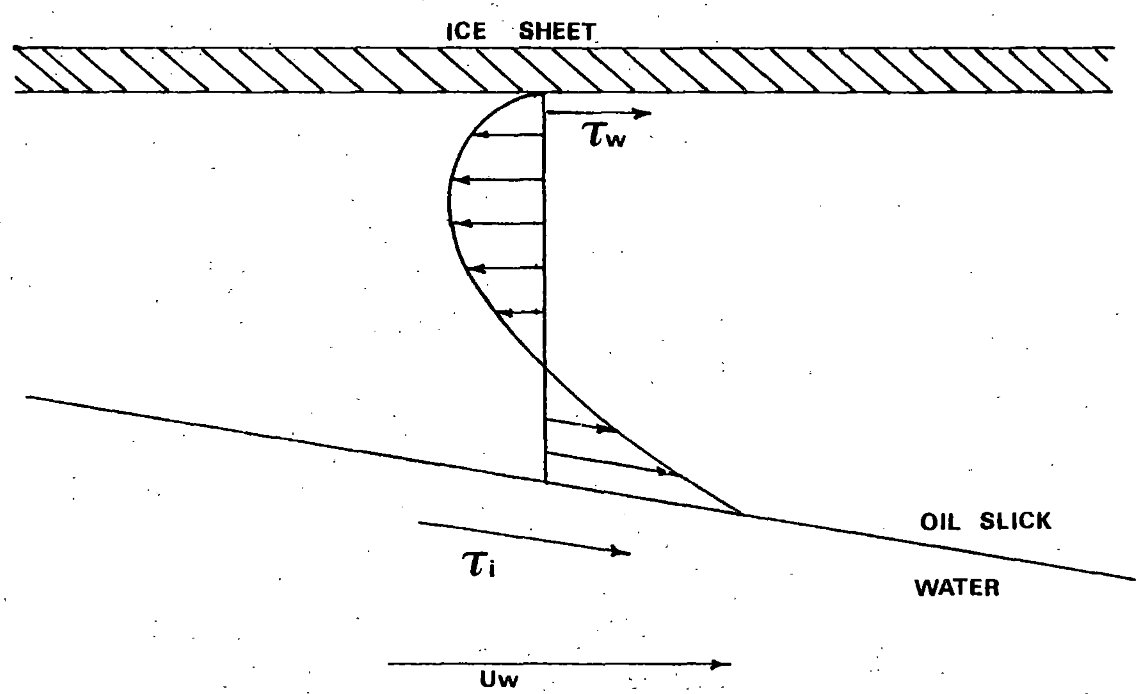

Figure 7. Qualitative estimate of the velocity profile in a barrier-retained oil slick under a uniform ice cover.

where:

δ = oil slick thickenss in the mid-slick region

= 1-s, where s = specific gravity of oil

= δ/D, where D = depth of water upstream of slick.

Considering the deep water case where ϕ is small, the rate of growth of the mid-slick region thickness $\frac{\partial\delta}{\partial\chi}$ is increased by a factor of $(1+\beta)$, since $\tau_w=\beta\tau_i$. If $\beta\sim 0$ (1), one can expect the mid-region slick thickness to increase proportionately faster, indicating a corresponding decrease in critical volume for the slick.

A similar conclusion is reached if one uses the "deep water results" of Hale:

$$\rho g \; \Delta \; \delta \frac{d\delta}{d\chi} = \tau_i + \tau_w = (1 + \beta) \; \tau_i.$$

As mentioned previously, β will be a function of the relative roughness of the oil-water interface, the roughness of the ice sheet, and the velocity profile of the oil. While additional analysis of oil spill containment beneath uniform ice cover by ridge keels or artificial surfaces is required, the preceding discussion serves to set a promising direction for further work.

Moir and Lau [23] performed brief exploratory studies of the behavior of an oil slick retained by an ice ridge at the Canada Centre for Inland Waters in early 1975. Their efforts were directed towards determining if there was very much difference between the capability of an ice ridge for retaining oil and that of a containment boom in open water flow conditions. The investigators concluded that ice ridge keels will indeed retain oil, and that the conditions for containment are generally similar to those related to oil slick retention by containment booms in open water. They also determined, however, that slicks contained behind sloping surfaces are prone to long term leakage. Based on the performance of some tests with a simulated upstream ice cover, Moir and Lau concluded that the presence of the ice sheet upstream of a barrier does not significantly alter the oil slick profile or the maximum volume of oil contained in comparison to the open water case. While these test results are informative, they are not judged to be conclusive, or quantitatively valuable, since the model pressure ridges were constructed from plexiglass and the simulated upstream ice cover was constructed from sheets of expanded foam wrapped in a vinyl covering. In tests conducted in ARCTEC's Ice Flume, it was determined that the behavior of an oil slick beneath real ice cover differed substantially from the behavior obtained with plexiglass simulating the ice cover. These tests, which will be discussed more completely in the next section of this proposal, therefore raise serious questions regarding the validity of the tests conducted by Moir and Lau.

As part of the Beaufort Sea Project, NORCOR [24] conducted qualitative tests to determine the interaction of crude oil with a pressure ridge keel in the presence of a current. In these tests conducted in the Cape Parry area, the released oil flowed in the direction of the current and towards the irregular pressure ridge which had a keel depth of 1 to 2 m. Within several meters of the discharge point, the flow became unstable and long figures broke from the main body of the oil. A series of troughs were detected running parallel to the pressure ridge having dimensions up to 0.5 deep and 8 m wide. As the oil reached these troughs, it flowed parallel to the pressure ridge and gathered in a pool. There, the oil stabilized and did not appear to be affected by the current. As a result, the oil never interacted with the pressure ridge itself. The investigators speculated, however, that even in the presence of considerable currents, the trough and pressure ridge keel combined "would hold back an enormous volume of oil." The investigators also felt that the tests provided an indication of the great importance of under-ice surface roughness and under-ice topography on the behavior of oil spilled beneath ice.

While the results of these Canadian laboratory and field test programs are qualitatively informative, neither program produced quantitative data which would be of value in developing the oil/ice feature relationships required of the proposed program.

The problem of oil containment and transport beneath smoothly undulating and randomly rough ice is the subject of the following subtask, as defined in the RFP. The remaining ice conditions not addressed in either that subtask or the subtask presently under discussion is the case of oil interaction with leads, cracks, and open water ice edges. The effects of leads and open water ice edges located perpendicular to, parallel to, and at an angle to the current flow, will play an important part in determining the trajectory of oil spilled in ice infested waters. The problem is currently being studied by the Canada Center for Inland Waters (CCIW) under the sponsorship of the Canadian Petroleum Association, the Petroleum Association for the Conservation of the Canadian Environment, and the Canadian Environmental Protection Service. The model scale laboratory tests are designed to examine the effectiveness of slots cut in the ice for containing oil over a range of water velocity, water depth, slot width to ice thickness ratio, oil type, and slot angle. Initial findings indicate that slots with width to ice thickness ratios ranging from 2:1 to 4:1 angled at approximately 60° to the current flow should provide the optimum recovery configuration. Additional model testing is also under way to investigate the possibility of diverting oil towards collection areas with slots, deflectors, and air bubble barriers oriented at small angles to the current flow. The laboratory results are expected to be refined with full-scale tests planned for late this winter.

3.2.2 Research Plan

The approach proposed for meeting the objectives of Subtask 1.2 of the RFP is outlined in the flow chart of Figure 8. The first work item

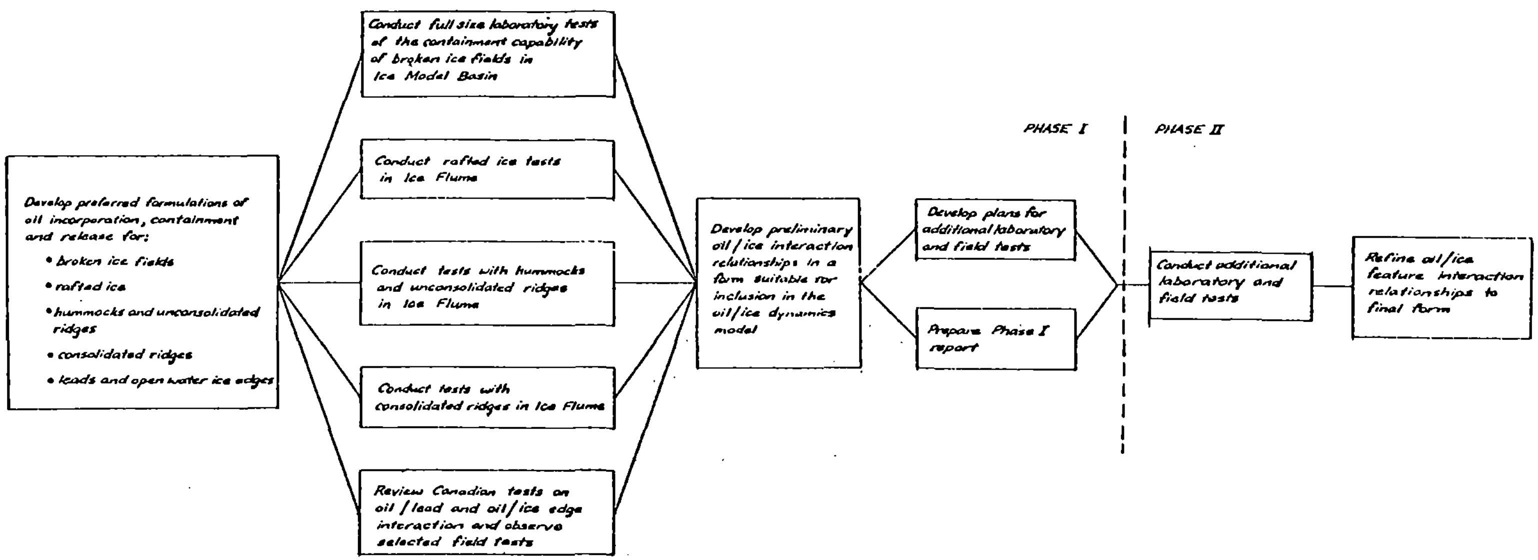

Figure 8. Flow chart of Sub-task 1.2

consists of the development of preferred formulations of oil incorporation, containment, and release for oil spilled in the presence of broken ice fields, rafted ice, hummocks, unconsolidated pressure ridges, consolidated pressure ridges, leads, and open water ice edges. These preferred formulations will be based upon discussions with the program manager, program coordinator, and the numerical modeling contractor, after the completion of a thorough review of the technical literature and discussions with past and current researchers in the field. These formulations will then provide the basis for preparing more detailed test plans for the laboratory tests comprising the following work items.

The proposed tests of the containment capability of broken ice fields will be performed in ARCTEC's Ice Model Basin. This one week long test series, summarized in Table 1, would be directed toward the definition of a curve of ice concentration vs. oil viscosity which would distinguish between cases where there is containment of the oil by the broken ice field, and cases where there is no containment and the oil spreads to its open water slick thickness. Tests will be conducted in still open water and in ice fields of four concentrations. Three refined oil products will be used in order to obtain a controlled range of oil viscosity. The three oils will be a No. 4 having a viscosity of 16 cs, a light No. 5 burner fuel having a viscosity of 50 cs, and a heavy No. 5 burner fuel having a viscosity of 120 cs. Prior tests conducted in ARCTEC's Ice Model Basin have shown that No. 2 fuel oil is not contained by ice fields of 100% concentration. The possible use of No. 6 fuel oil is eliminated since it typically has a pour point of 35°F. All tests will be conducted with fresh water ice at an ambient temperature of 32°F. Measurements will be made of slick areal coverage and thickness.

Proposed tests directed toward the quantification of oil interacting with discontinuous ice conditions are outlined in Table 2. The primary questions addressed by these tests are associated with the incorporation and containment of oil in the ice features, and the subsequent release of the oil. These tests will be conducted in ARCTEC's Ice Flume over a period of three weeks.

Two configurations of rafted ice, distinguished by the depth of the overlapping ice sheets, will be studied oriented both upstream and downstream to the flow for three types of oil and for three current velocities. The rafted ice test series will result in the production of 36 data points.

Two configurations of hummocks and unconsolidated pressure ridges will be tested in both an unoiled and oiled condition at three velocities for three types of oil. A total of 72 data points will be produced from these tests. Tests of consolidated pressure ridges will be conducted for two ridge keel angles and three ridge keel depths using three types of oil over three water current velocities. These tests will result in the production of 54 data points.

Since Canadian laboratory tests concerned with the interaction of spilled oil with leads and open water ice edges are currently underway, and field tests are planned for the immediate future, it is proposed that the

TABLE 1. SUMMARY OF PROPOSED BROKEN ICE FIELD TESTS

Test	Oil Type	Ice Concentration, %
1	No. 4	0
2	Light No. 5	0
3	Heavy No. 5	0
4	No. 4	25
5	No. 4	50
6	No. 4	75
7	No. 4	100
8	Light No. 5	25
9	Light No. 5	50
10	Light No. 5	75
11	Light No. 5	100
12	Heavy No. 5	25
13	Heavy No. 5	50
14	Heavy No. 5	75
15	Heavy No. 5	100

TABLE 2. SUMMARY OF ICE FLUME TESTS FOR DISCONTINUOUS ICE CONDITIONS

Test Type	Configuration	Oil Types	Velocities	Data Points
Rafted Ice	Two, each upstream and downstream	3	3	36
Unoiled Hummocks and Ridges	Two hummocks and two ridges	3	3	36
Oiled Hummocks and Ridges	Two hummocks and two ridges	3	3	36
Consolidated Ridges	Two angles, three depths each	3	3	54

preliminary formulation of these phenomena be based upon a review of the Canadian test data and a discussion with the principal investigators. In addition, arrangements will be made to observe selected future tests.

The next proposed work item consists of the development of the preliminary oil/ice interaction relationships based upon the laboratory test results in a form suitable for inclusion in the oil/ice dynamics numerical model. Along with the development of the preliminary relationships, inadequacies will be identified, and plans will be developed for any additional laboratory and field testing that may be required. The work proposed for Subtask 1.2 during the first eighteen months of the program concludes with the preparation of a Phase I report. The Phase II effort then continues with the performance of the additional laboratory and field tests, and the refinement of the oil/ice feature interaction relationships to their final form. The laboratory tests identified for inclusion in Phase I of the proposed effort for Subtask 1.2 are intended to primarily address interaction limits and transition points for the various phenomena under investigation. Functional relationships will be obtained to the greatest extent possible, however, it is anticipated that the final functional relationships will be dependent upon additional laboratory and field testing of a more comprehensive nature, which is planned for Phase II of the proposed program.

3.2.3 Level of Technical Effort

Name	Title	Hours
L. Schultz	Program Manager	120
P. Deslauriers	Environmental Engineer	440
T. Kao	Consultant	24
R. Shelsby	Senior Technician	160
H. Huber	Technician	160
W. Hennessy	Technician	160
L. Schnebelen	Technician	160
S. Wallace	Technician	120

3.3 Subtask 1.3 - Horizontal Transport Under Ice

3.3.1 Technical Discussion

With the preceding treatment of the vertical migration of oil through first-year and multi-year ice, and the oil/ice interaction in areas of ice discontinuities including broken ice fields, rafted ice, hummocks, unconsolidated pressure ridges, and consolidated pressure ridges, it remains only to determine the oil/ice interaction for continuous ice cover including smooth ice sheets, smoothly undulating ice sheets, and rough ice sheets, for both still water conditions and for regions subject to significant water currents.

The spreading of an oil slick on calm, warm water has been investigated by Fay [25] and Hoult [26]. They concluded that the spreading of oil in calm water undergoes three phases. During the initial phase, gravity forces are balanced by the inertial forces. The second phase is the viscous phase where the gravity forces are balanced by viscous forces. The final phase is a surface tension phase, when the oil slick is very thin, and viscous forces balance the surface tension forces. The combined spreading laws for the case of an oil slick spreading on calm temperate waters are summarized in Figure 9.

The spreading of an oil slick on or under smooth ice cover in still waters has been investigated by Glaeser and Vance [27] and McMinn [28] under field conditions, and by Chen [29] and Hoult [30] in the laboratory. Glaeser and Vance identified two spreading regimes in a gravity-inertia force balance, and a gravity-viscous force balance. McMinn concluded that only the gravity-inertia regime would be found under field conditions. Hoult reviewed the existing data on oil spreading rates over and under sea ice and concluded that there is only one phase in this type of spreading, characterized by a balance of gravity-induced spreading forces and a frictional retarding force proportional to the area of roughness seen by the leading edge of the spreading oil slick. Chen investigated the gravity-viscous spreading phase of crude oil on three artificially prepared ice surfaces for five different types of crude oil. He found that all of the information could be correlated by a single relationship and drew the conclusion that the important parameters governing the spreading of oil on ice are the surface roughness of the ice, the volume of oil released, and the temperature conditions. The equations developed for predicting the oil slick radius for oil spilled on or beneath smooth ice cover by these investigators are summarized in Table 3. Variations in the form of the relationships are seen to be substantial, and an example clearly demonstrates a wide variation in the results predicted by these relationships. For example, the input data given in Table 4 results in predictions of the oil spill radius of 74 m using McMinn's relationship, 1.3 m using Chen's realtionship, and 11 m using Hoult's relationship. This variation in predicted oil slick radius approaching two orders of magnitude clearly demonstrates the need for additional analysis of the problem of oil spill behavior beneath uniform ice cover in still waters.

Having discussed the spreading of an oil slick on calm open water and the spreading of an oil slick under smooth ice in still waters, we next address the problem of predicting oil spill behavior beneath a uniform ice cover in the presence of a current. Other than the work currently under way related to ice sheet slotting at the Canada Center for Inland Waters discussed in the previous section of this proposal, the only data available on the behavior of oil spilled beneath uniform ice cover in the presence of a current was obtained by ARCTEC, Incorporated in late 1975 under contract to the Environmental Protection Agency's Arctic Environmental Research Laboratory [31]. This introductory program of limited scope included both a theoretical analysis and experiments conducted in ARCTEC's Ice Flume (Figure 10). This ice flume, the only known completely glass-walled ice flume in existence, has a test section measuring 45 x 3 x 2 feet in length, width and depth respectively, and incorporates ARCTEC's patented cryogenic freezing process. In the introductory EPA test program, five gallons of oil was injected from a specially designed pressurized injection chamber just below the bottom surface of the ice sheet through a 2 cm diameter hole at a rate of 1.8 gallons per minute. Two types of oil were used in this test program, a light No. 2 home heating

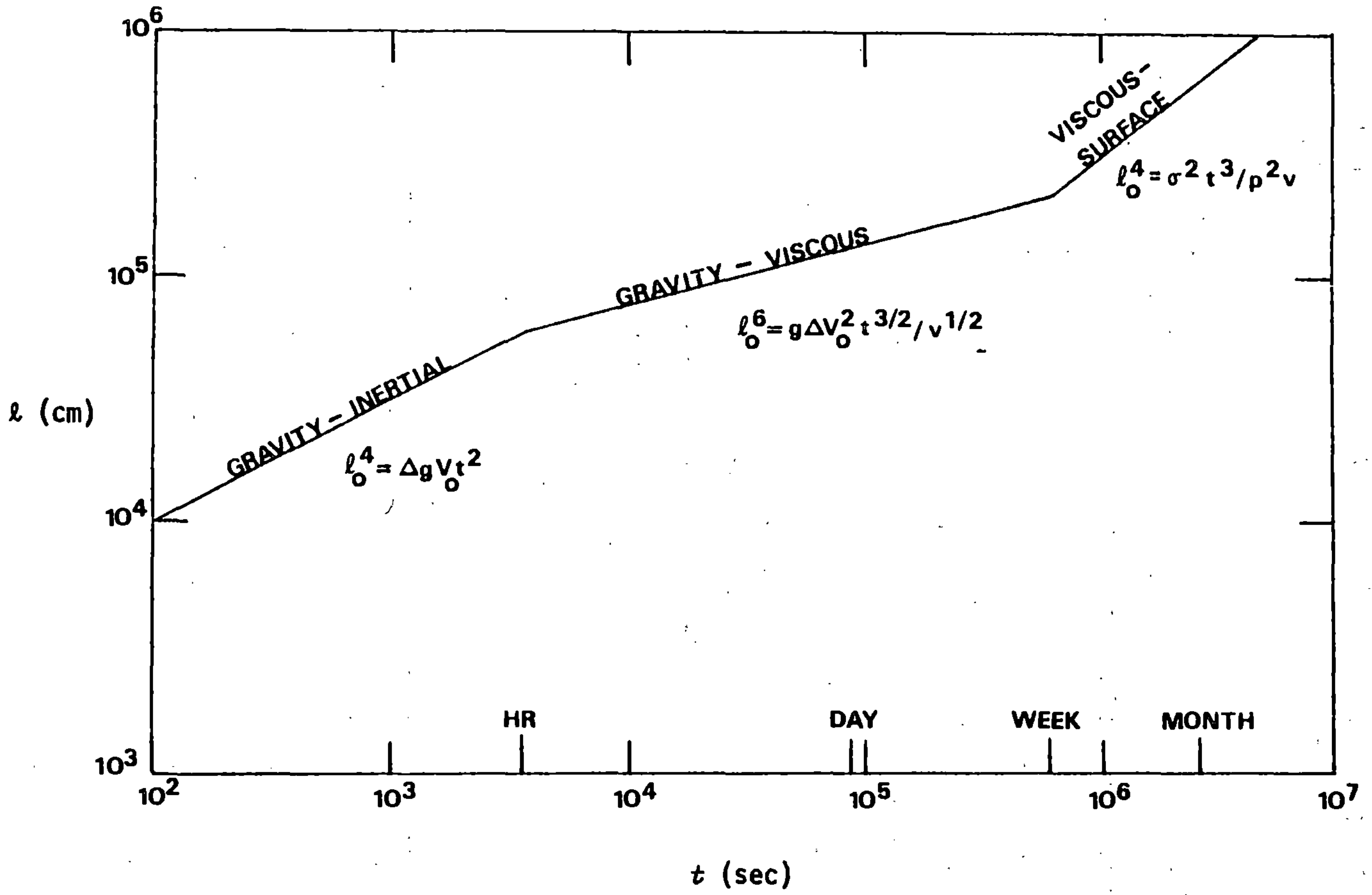

Figure 9. Combined Laws Governing Oil Spill Spreading on Calm Water

TABLE 3. EQUATIONS FOR OIL SPREADING RATE ON OR BENEATH AN ICE COVER

AUTHOR	EQUATION
Glaeser and Vance [27]	$\ell_0 \sim (g\mathcal{V}_0)^{\frac{1}{4}} t^{\frac{1}{2}}$ (gravity-inertia) $\quad \ell_0 \sim (g\mathcal{V}_0^{\,2}t^2)^{\frac{1}{7}}$ (gravity-viscous)
McMinn [28]	$R_0 = 0.756\ (gQ_0)^{\frac{1}{4}}\ t^{\frac{3}{4}}$ $\pi R_0^{\,2} h_0 = Q_0 t$
Chen, et al. [29]	$R = K\ (\rho_0 g \mathcal{V}_0^{\,2})^{\frac{1}{5}}\ (\frac{t}{\mu_0})^{\frac{1}{5}} + C\mathcal{V}_0^{\frac{1}{3}}$ $K \cong 0.24$ $C \cong 0.30$
Hoult [30]	$R = 0.25\ (\frac{\Delta g Q_0^{\,2}}{h_0})^{\frac{1}{6}}\ t^{\frac{2}{3}}$

TABLE 4. COMPARISON OF PREDICTED OIL SPILL RADIUS FOR OIL SPILLED UNDER ICE

$$\Delta = 0.127 \text{ g/cm}^3$$

$$\rho_w = 1.027 \text{ g/cm}^3$$

$$\rho_0 = 0.90 \text{ g/cm}^3$$

$$\mu_0 = 10 \times 10^4 \text{ cp}$$

$$g = 980 \text{ cm/sec}^2$$

$$Q_0 = 200 \text{ cm}^3\text{/sec}$$

$$h_0' = 1 \text{ mm} = 0.1 \text{ cm}$$

$$t = 3600 \text{ sec (1 hr)}$$

$$\forall_0 = 72 \times 10^4 \text{ cm}^3$$

McMinn $\quad R_0 = 0.756\ (gQ_0)^{\frac{1}{4}}\ t^{\frac{3}{4}} = 74 \text{ m}$

Chen et al. $\quad R = 0.24\ (\rho_0 g \forall_0^{\,2})^{\frac{1}{5}}\ (\frac{t}{\mu_0})^{\frac{1}{5}} + 0.30\forall_0^{\frac{1}{3}} = 1.3 \text{ m}$

Hoult $\quad R = 0.25\ (\frac{\Delta g Q_0^{\,2}}{h_0'})^{\frac{1}{6}}\ t^{\frac{2}{3}} = 11 \text{ m}$

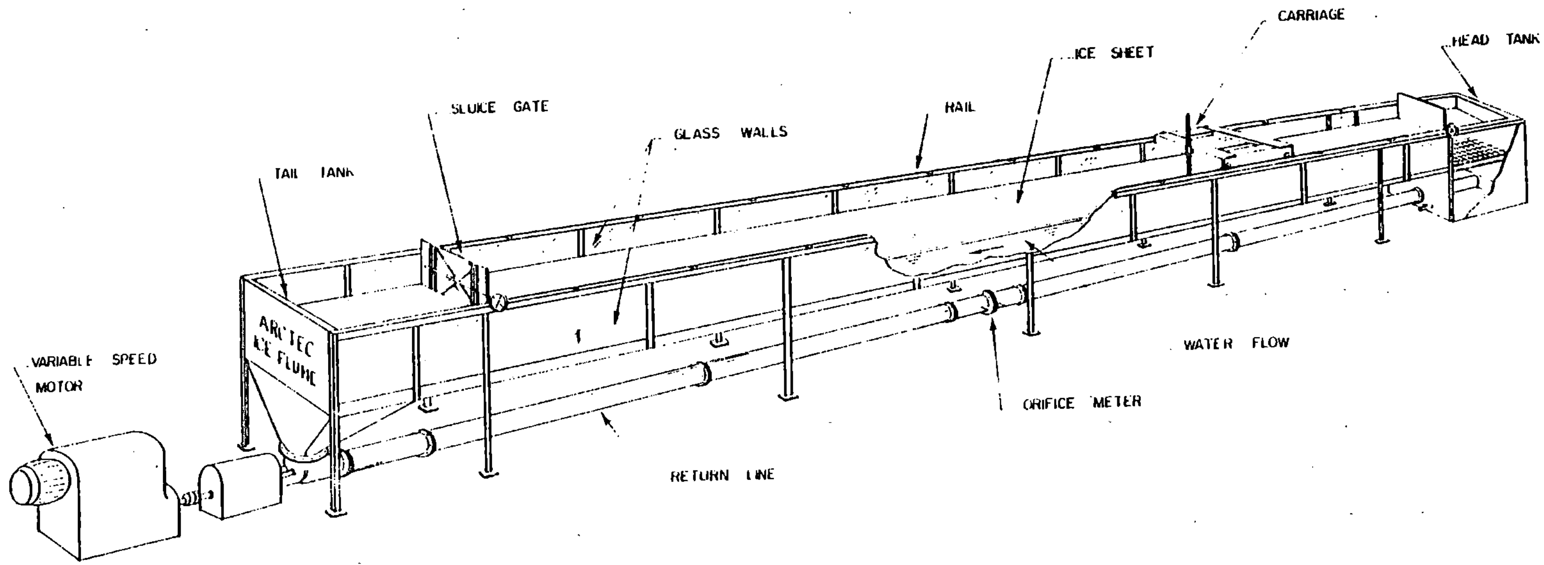

Figure 10. Schematic Depiction of ARCTEC Ice Flume

fuel and a heavy crude oil having properties similar to the properties of Prudhoe Bay crude. Thirty-one data points were collected over a water velocity range of 0.1 to 0.7 knots (5 to 36 cm/sec).

Acknowledging some scatter in the test data and the need for additional tests to more completely define the curves shown, the results of ARCTEC's test program are summarized in the curves of Figure 11. These curves identify the velocity of the oil slick as a function of the water current velocity for No. 2 home heating fuel and for a crude oil having properties similar to Prudhoe Bay crude. The test results indicate that for a given water current velocity, the No. 2 fuel will have a higher slick velocity than the more viscous crude oil. The threshold velocity for No. 2 fuel oil was determined to be about 3.5 cm/sec, while the threshold velocity for crude oil was determined to be substantially higher at 10 cm/sec. While the results of this test program begin to fill a vast void in our knowledge of the behavior of oil spilled beneath smooth level ice cover, the parametric range studied in this test program should be expanded to further define the curves of Figure 11 and the threshold velocity as a function of oil viscosity, and to identify the entrainment velocity at which the turbulence level results in the entrainment of oil particles from the slick into the water column as a function of oil viscosity.

The major conclusions drawn from this introductory series of tests conducted in ARCTEC's Ice Flume are summarized as follows:

1. Oil did not adhere to the underside of either fresh water ice sheets or salt water ice sheets in the presence of a moving current.

2. While the plot of oil slick velocity versus water current velocity shows a generally similar shape for both No. 2 fuel oil and the crude oil, differences in the behavior of the oil were observed during the tests. The fuel oil slick has a tendency to take a long skinny shape as it moves downstream beneath level ice cover, while the crude oil slick tends to orient itself perpendicular to the floe, becoming short and wide.

3. Observations made during the tests indicated that the fuel oil had a tendency to roll along beneath the level ice surface while the crude oil had a tendency to move more as a solid. These observations indicate that different physical phenomenon are controlling the slick motion for the two types of oil.

4. At velocities exceeding about 30 cm/sec, the No. 2 fuel oil slicks exhibited interfacial waves at the slick/water interface which could potentially lead to breakup of the slick at even higher water velocities. This could result in the emulsification and distribution of oil throughout the water column.

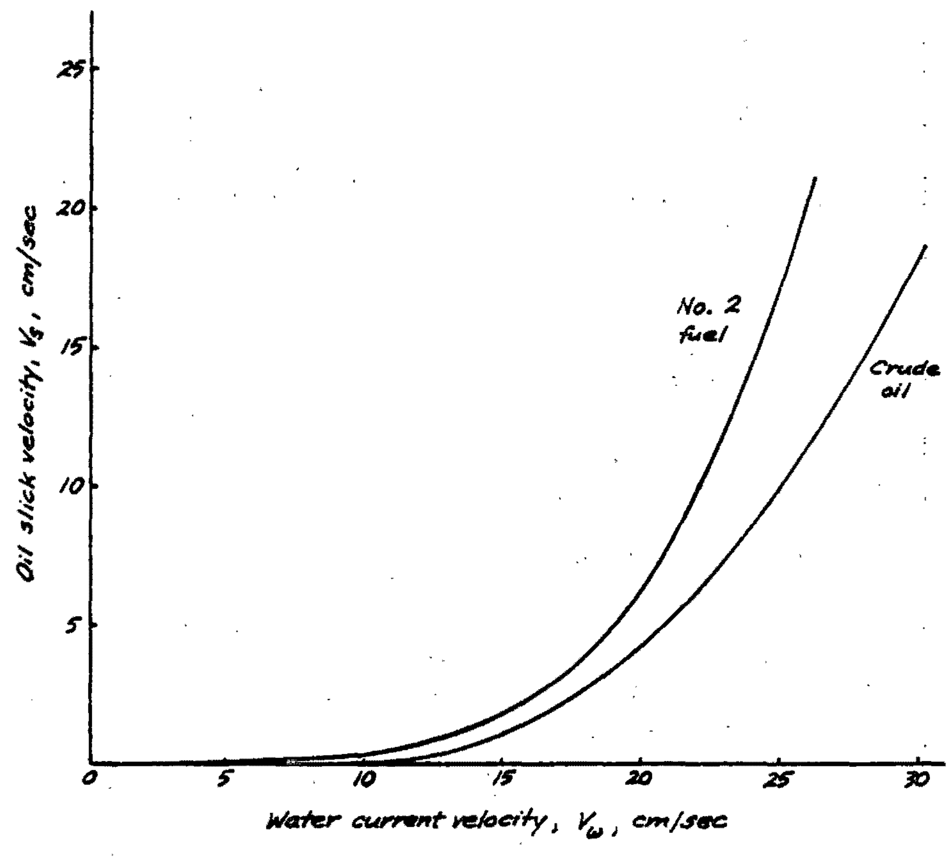

Figure 11. Results of late 1975 tests on oil transport beneath ice conducted in Arctec's Ice Flume.

5. It was observed that it was relatively easy to anchor a crude oil slick with a discontinuity in the ice sheet such as a protrusion below the ice, or a slot cut in the ice.

6. A single test conducted with a simulated ice sheet fabricated from plexiglass revealed that the oil slick adhered to the plexiglass as it moved downstream with the result that totally erroneous experimental results would be obtained by conducting tests with plexiglass simulating the ice sheet.

While the ARCTEC Ice Flume tests provide a valuable starting point for further work associated with the behavior of oil spilled beneath level ice cover in the presence of a current, no work has yet been devoted towards defining the behavior of oil slicks spilled beneath rough ice cover and smoothly undulating ice cover in the presence of a current. Independent field tests conducted in both the Alaskan and Canadian Beaufort Sea have revealed a distinct variation in the thickness of first-year sea ice with irregularities tending to be sinusoidal and of a depth approximately equal to 20% of the mean ice thickness. Canadian investigators have further extended this conclusion to cover both first-year ice and multi-year ice [8]. Consequently, the ability to project the trajectory of oil spilled beneath first-year ice and multi-year ice must include the ability to project oil spill behavior beneath both level ice cover and irregular ice cover having a sinusoidal variation of the bottom surface. Still another concern is the effect of under-ice roughness on the oil spill trajectory. Variations in bottom surface roughness range from a relatively small scale due to the large volume of low concentration brine which forms in the under surface skeletal layer of the ice, to relatively large scale variations in regions of very dynamic ice conditions where the under-ice surface could be very rough and very irregular due to projecting broken ice pieces.

For ice cover, as for any other surface, a hydrodynamically smooth surface exists if the average height of the protrusions, k, is within the laminar sublayer. This is achieved if:

$$k < \frac{4\nu}{u_*} \quad ,$$

where ν is the kinematic viscosity and u_* is the friction velocity. The friction velocity, in turn, is defined as:

$$u_* = \sqrt{\tau_0/\rho_w} \quad ,$$

where τ_0 is the shear stress at the wall and ρ_w is the density of the water. The shear stress at the wall, in turn, can be expressed in terms of the bulk fluid velocity, U, through a friction factor, f, or a drag coefficient as in the standard forms of:

$$\tau_0 = \frac{f}{4} \rho_w \frac{U^2}{2} \quad ,$$

or

$$\tau_0 = C_f \rho_w \frac{U^2}{2} \quad ,$$

where the friction factor decreases with the Reynolds Number. The reference velocity at the region of the wall is then u_* and the reference length scale is U/u_*.

For a hydrodynamically "fully rough" surface, it is usual to have:

$$k > \frac{100\ \nu}{u_*} \quad .$$

The friction factor then depends only on the roughness and is independent of the Reynolds Number. The reference velocity and the reference length in the wall region then become u_* and k.

It is important to recognize that:

$$u_* \sim (\overline{u'\ v'})^{1/2} \quad ,$$

where u' and v' are the turbulent velocity fluctuations, so that if the turbulence is totally isotropic, u' is on the same order as v', and u_* is therefore on the order of the turbulent intensity since:

$$u_* \sim (\overline{u'^2})^{1/2} = \overline{u'} \quad .$$

Furthermore, for the fully rough case, the size of the turbulent eddy at the wall is of the order of k, so that the turbulent Reynolds Number must be greater than 100. Recognizing that u_* is related to U through the friction factor by:

$$\left(\frac{u_*}{U}\right)^2 = \frac{f}{8} \quad ,$$

for laboratory tests to be "fully rough", the Reynolds Number based on the roughness height must be greater than:

$$100\sqrt{\frac{8}{f}} \quad ,$$

which, for a friction factor of 0.08, yields:

$$\frac{Uk}{\nu} > 1000$$

For example, applying this test to our experience in the ice infested waters of Buzzards Bay, the current speed of approximately 1.0 knot and the typical roughness height of 1.5 feet results in $Uk/\nu = 1250$, so that in this situation the ice surface would be termed "fully rough". The conclusion to be drawn from this discussion is, therefore, that for laboratory experiments to achieve dynamic similarity, it is only necessary to achieve $Uk/\nu > 1000$.

When a volume of oil, V, is present under the ice cover, the problem becomes more complicated. Denoting the density of the oil by ρ_0 and its kinematic viscosity by ν_0, the relevant parameters are then the buoyancy, or reduced gravity, $g(\Delta\rho/\rho_w)$, where $\Delta\rho = \rho_w - \rho_0$, the thickness of the oil layer, d_0, and the adhesion coefficient, ω (energy per unit area). For ice and oil, ω can be expressed in terms of the interfacial surface tension between oil and water, σ_{wo}, as follows:

$$\omega = \sigma_{wo} \, (1 + \cos\theta)$$

where θ is the contact angle which serves as a measure of the adhesiveness. Based upon the introductory tests conducted in ARCTEC's Ice Flume, it appears that a distinction based upon oil viscosity will have to be made in this case. The tests conducted with smooth ice cover revealed the adhesiveness of the crude oil was apparently shear dependent since the crude oil moved as a solid, while the fuel oil was observed to be always wetting the ice and rotating along the under surface of the ice.

A dimensional analysis then results in the dimensionless terms of:

$$\frac{k}{d_0} \, , \quad F_* = \frac{u_*}{\sqrt{\frac{\Delta\rho}{\rho_w} g \, d_0}} \, , \quad W_* = u_* \sqrt{\frac{d_0 \rho_o}{\omega}} \quad .$$

Physically, k/d_0 is the ratio of the roughness height to the oil layer thickness, while F_* is the number measuring the ratio of the shearing force to the buoyancy force, and W_* is a measure of the ratio of the shearing force to the adhesive force. When the oil layer thickness becomes smaller than the roughness height, then k/d_0 is no longer a relevant parameter, and d_0 should be replaced by k in the definitions of F_* and W_*.

The critical velocity of the water current that will result in the scouring of oil from an ice pocket of depth k is then given by:

$$\frac{U_c}{u_*} = f\ (F_*,\ W_*)\quad .$$

It is entirely possible that, in many cases, either the buoyancy force or the adhesion forces predominate, eliminating the necessity for including other forces. In these cases, we then have either:

$$\frac{U_c}{u_*} = f\ (F_*)\quad ,$$

or

$$\frac{U_c}{u_*} = f\ (W_*)\quad .$$

These functional relationships can be determined through laboratory experiments, and are applicable for the larger scale field situations provided that the Reynolds Number based on roughness height is greater than 1000.

The case of sinusoidal irregularities in the bottom ice surface requires special consideration. In this case, the slope of the irregularities, h/L is important, where h is the height of the irregularities and L is the wave length of the irregularities. Depending upon the gentleness of the slope, flow separation may or may not occur. If no separation occurs, the surface behaves in the same manner as a smooth surface. If the irregularities have relatively sharp crests, then separation will generally occur. Experimental measurements conducted in 1976 by Ling and Kao [32] indicated that for the case when flow separation does occur, the situation can be regarded as a fully rough case with a roughness height equal to approximately 10% of a randomly rough surface. The case of sinusoidal bottom ice surface irregularities then becomes a part of the rough surface case.

The foregoing analysis, therefore, presents the approach to be used in developing the scaling for a model test program, and applying the results of the program to field applications for oil spilled beneath smooth ice cover, rough ice cover, and sinusoidally varying ice surfaces.

3.3.2 Research Plan

The work directed towards meeting the objectives of Subtask 1.3 is outlined in the flow chart of Figure 12. The work of this subtask will get underway with the development of preferred formulations for oil spill transport beneath smooth, undulating, and rough ice surfaces in close cooperation with the program manager, the program coordinator, and the numerical modeling contractor. These preferred formulations will be prepared for oil spills beneath smooth ice cover with and without currents present, and the oil spill transport beneath undulating ice and rough ice in the presence of a current.

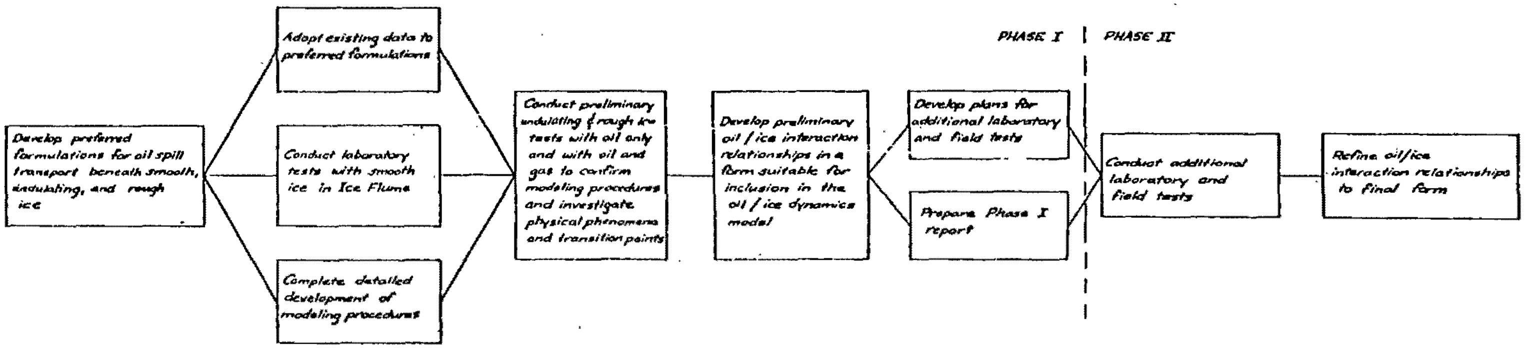

Figure 12. Flow chart of Sub-task 1.3

In addition, preferred formulations will also be developed for the case of a combined gas and oil release beneath undulating and rough ice surfaces. This combined release of gas and oil would be associated with a very realistic oil spill scenario consisting of an oil well blowout. The filling of voids in the under-ice surface by gas will significantly effect the behavior and transport of the spilled oil. The results of the tests currently underway at ARCTEC CANADA, Limited for the Canadian Arctic Marine Oil Spill Program, while concerned only with the case of combined gas and oil release beneath rough ice cover in still water situations, will provide a base of data and information for further development.

Once the preferred formulations have been developed in conjunction with all project team members, the next work item consists of adapting the existing data to these preferred formulations to the greatest extent possible. Concurrently with this work item, laboratory tests for the smooth ice condition can be performed in ARCTEC's Ice Flume in order to extend the range of parameters studied in the introductory test program, and to more fully define the transport of oil spilled beneath smooth ice cover as a function of oil viscosity and current velocities. A one-week long test program in ARCTEC's Ice Flume is planned for the conduct of the smooth ice tests as outlined in Table 5. These tests of four oils, the same three as used in the previously proposed tests with the addition of No. 2 fuel oil having a viscosity of 3 cs, will be conducted at five velocities. Due to the great inconsistency in the predictions of still water slick radius for oil spilled under ice based upon presently available formulations as previously discussed, a zero velocity test will be performed for each oil. Two additional test velocities will be the threshold velocity, defined as the water current at which the oil slick starts in motion, and the entrainment velocity, at which point the oil slick starts to break up and become entrained in the water column. Tests will also be conducted at three intermediate velocities, expected to be in the range of 10, 20, and 30 cm/sec. This new smooth ice oil transport data will provide a functional relationship between oil viscosity and threshold velocity, entrainment velocity, and the intermediate oil slick velocity as a function of water current velocity. A total of 24 data points will result from this test series. Concurrently with the preceding two work items, the development of modeling techniques for the undulating and rough ice cases will be completed.

Upon completion of the smooth ice laboratory tests and the development of the modeling procedures, preliminary tests will be conducted in the ice flume for the undulating and rough ice cases, and for the case of combined oil and gas release. The objective of these preliminary tests will be to confirm the modeling procedures, investigate the basic physical phenomena occurring, and to identify and define transition points as related to these physical phenomena. A two-week long test program in ARCTEC's Ice Flume is proposed for the preliminary irregular and rough ice tests as outlined in Table 6, with one week each devoted to undulating and rough ice surfaces. The test plan outlined in Table 6 will be performed for two types of undulating surfaces selected to encompass the range of likely full-scale conditions, and for two values of ice roughness similarly selected to span field conditions. The

TABLE 5. SUMMARY OF PROPOSED SMOOTH ICE TEST PROGRAM

Test	Oil Type	Current Velocity, cm/sec
1	No. 2	0
2	No. 2	Threshold
3	No. 2	10
4	No. 2	20
5	No. 2	30
6	No. 2	Entrainment
7	No. 4	0
8	No. 4	Threshold
9	No. 4	10
10	No. 4	20
11	No. 4	30
12	No. 4	Entrainment
13	Light No. 5	0
14	Light No. 5	Threshold
15	Light No. 5	10
16	Light No. 5	20
17	Light No. 5	30
18	Light No. 5	Entrainment
19	Heavy No. 5	0
20	Heavy No. 5	Threshold
21	Heavy No. 5	10
22	Heavy No. 5	20
23	Heavy No. 5	30
24	Heavy No. 5	Entrainment

TABLE 6. SUMMARY OF PROPOSED TEST SERIES FOR BOTH UNDULATING ICE TESTS AND ROUGH ICE TESTS

Test	Ice Surface	Oil Type	Current Velocity, cm/sec	Gas
1	1	No. 2	0	No
2	1	No. 2	Threshold	No
3	1	No. 2	10	No
4	1	No. 2	20	No
5	1	No. 2	30	No
6	1	No. 2	Entrainment	No
7	1	No. 2	0	Yes
8	1	No. 2	Threshold	Yes
9	1	No. 2	10	Yes
10	1	No. 2	20	Yes
11	1	No. 2	30	Yes
12	1	No. 2	Entrainment	Yes
13	2	Heavy No. 5	0	No
14	2	Heavy No. 5	Threshold	No
15	2	Heavy No. 5	10	No
16	2	Heavy No. 5	20	No
17	2	Heavy No. 5	30	No
18	2	Heavy No. 5	Entrainment	No
19	2	Heavy No. 5	0	Yes
20	2	Heavy No. 5	Threshold	Yes
21	2	Heavy No. 5	10	Yes
22	2	Heavy No. 5	20	Yes
23	2	Heavy No. 5	30	Yes
24	2	Heavy No. 5	Entrainment	Yes

tests will be conducted with the two oils representing the extremes of the viscosity range under consideration, No. 2 and Heavy No. 5. Tests will be conducted for still water conditions, and for five values of water current velocity. Half of the tests will address oil only, while the remaining half will include the incorporation of gas released with the oil. Twenty-four data points will be obtained for the undulating ice condition, with another 24 obtained for the rough ice case.

Upon the completion of this work, preliminary oil/ice interaction relationships can be further developed for all of the under-ice oil spill transport situations addressed in this subtask in a form suitable for inclusion in the oil/ice dynamics numerical model. Upon the completion of these relationships, and their review and acceptance by the program manager, the program coordinator, and the numerical modeling contractor, work will begin on the Phase I report, and plans will be developed for any additional laboratory tests that may be required and for any field confirmation tests that may be judged desirable by the program manager and the program coordinator.

The Phase II portion of the work included in Subtask 1.3 consists of the conduct of the additional laboratory and field tests, and the refinement of the oil/ice interaction relationships to their final form for incorporation into the oil/ice dynamics numerical model.

3.3.3 Level of Technical Effort

Name	Title	Hours
L. Schultz	Program Manager	112
P. Deslauriers	Environmental Engineer	400
T. Kao	Consultant	56
R. Shelsby	Senior Technician	120
H. Huber	Technician	120
W. Hennessy	Technician	120
L. Schnebelen	Technician	120
S. Wallace	Technician	120

3.4 Coordination and Integration

While the need for coordination and integration of the work proposed herein in response to Task 1 of the RFP has been individually addressed by subtask in the previous sections of this proposal, the great importance of successfully coordinating and integrating the Task 1 results with the Task 2 and Task 3 portions of the program requires that this function be emphasized in a separate section of this proposal. ARCTEC, Incorporated recognizes that the work proposed herein is to some degree subservient to the needs of the program coordinator and for this reason the laboratory and field test programs proposed herein are outlined in general terms rather than in great detail, and are understood to be subject to revision after discussion with the program manager and program coordinator.

The program outlined in the foregoing sections of this proposal addressing each of the three subtasks of Task 1 includes a working session between ARCTEC's program manager and the program coordinator early in the program for the purpose of ensuring the coordination of the Task 1 work within the framework of the Task 2 and Task 3 work, and the overall program objectives. Close coordination will be maintained throughout the program with the program coordinator through frequent informal and formal communications as needs dictate. More detailed test plans for all test work associated with the Phase I program will be reviewed with the program coordinator prior to the commencement of work. As described in the program plan for each subtask, the preliminary and final formulations of the oil/ice interaction phenomena will be reviewed with the program coordinator, the contractor selected for the numerical modeling portion of the program, and the Contracting Officer's Technical Representative as the work of each subtask progresses. The Phase I final reports proposed herein for each subtask will also be submitted to the program coordinator and the Contracting Officer's Technical Representative for review, comment, and approval before being issued in final form.

ARCTEC, Incorporated recognizes the need for providing assistance to the program coordinator in carrying out his responsibility for the following specific items:

1. The submission of quarterly, annual, and final reports for all components of the project in accordance with project deadlines.

2. The integration of all component reports into coherent quarterly, annual, and final reports for the program.

3. The conduct of regular meetings of program investigators to ensure the proper exchange of technical information and the smooth integration of all program elements directed toward overall program objectives.

4. The response to any OCSEAP management requests on behalf of the project, including data management and others.

ARCTEC is prepared to cooperate closely with the program coordinator in meeting all of these contractural responsibilities to OCSEAP management. ARCTEC's program manager is prepared to travel to the OCSEAP project office at least twice during the contract year to review project status and progress.

Working as part of a multi-organizational research team has been quite common for ARCTEC, Incorporated since its formation in 1970. ARCTEC, Incorporated has participated in these multi-organizational programs both in the leadership role, and in subordinate roles. ARCTEC's participation in joint study efforts has spanned the entire range of organizational possibilities including joint efforts with government research organizations, the academic community, and other commercial organizations. ARCTEC, therefore, anticipates no difficulty whatsoever in working closely, and in a fully cooperative spirit, with the program coordinator and the Contracting Officer's Technical Representative throughout all phases of the proposed program.

4. ANTICIPATED PROBLEMS

The technical problems associated with the program proposed herein have been discussed in detail in each of the subtask work statements. For every problem identified, a solution was proposed or a promising approach toward solution was proposed. We therefore anticipate no major difficulties associated with conducting the work proposed herein, and meeting the objectives of the program.

As discussed in the preceding section, ARCTEC, Incorporated anticipates no problems in program management, coordination, and integration.

5. DELIVERABLE PRODUCTS

If a contract is awarded to ARCTEC, Incorporated in response to the submission of this proposal, ARCTEC is committed to produce a set of data products on oil migration through ice, oil containment within ice, and oil/ice trajectories. More specifically, ARCTEC, Incorporated will develop, to the extent the data allows, quantitative formulations of oil/ice interaction as a function of oil properties, water current velocities, and ice conditions and characteristics as follows:

1. The vertical migration of oil in first-year ice.
2. The vertical migration of oil in multi-year ice.
3. The incorporation, containment, and release of oil in broken ice fields of various ice concentrations.
4. The incorporation, containment, and release of oil interacting with rafted ice.
5. The incorporation, containment, and release of oil interacting with hummocks and unconsolidated pressure ridges of various size.
6. The containment of oil by consolidated pressure ridges of various size.
7. The interaction of oil with leads and open water ice edges.
8. The transport and equilibrium thickness of oil spilled in calm waters beneath smooth, undulating, and rough ice sheets.
9. The transport of oil in the presence of a current beneath smooth, undulating, and rough ice sheets.
10. The transport and equilibrium thickness of oil spilled in combination with gas in calm waters beneath smooth, undulating, and rough ice sheets.
11. The transport of oil spilled in combination with gas in the presence of a current beneath smooth, undulating, and rough ice sheets.

The quantitative formulations of oil/ice interaction listed above will be developed in preliminary form upon the conclusion of the first eighteen months of the proposed program which comprises Phase I. Additional laboratory and field testing is planned for the follow-on Phase II program which will result in the refinement of these preliminary oil/ice interaction relationships to final form for incorporation into the numerical model of oil/ice dynamics and subsequent application to the proposed oil spill scenarios.

Any new test data developed during the course of the program and the compilation of previously existing data upon which the oil/ice interaction formulations are based will be submitted in a form acceptable to the project coordinator and the program manager in accordance with OCSEAP data format requirements. The Phase I reports will include a description of all procedures related to instrumentation calibration, data collection, processing, and analysis. In all of its laboratory and field test programs, ARCTEC, Incorporated routinely uses instrumentation meeting ASTM specifications, and conducts all instrument calibration and data collection in compliance with ASTM specifications.

In accordance with contractural requirements, ARCTEC, Incorporated will submit ten copies of quarterly reports to the Project Contract Monitor by the last working day of each quarter. The quarterly report due for April will be an annual report summarizing the work performed and the results achieved for the previous year. A final report on the Phase I efforts which span the first eighteen months of the proposed program will be prepared upon the completion of the Phase I work.

6. INFORMATION REQUIRED FROM OTHER INVESTIGATORS

The proposed program requires that substantial information be obtained from other investigators who are not associated with the proposed research program. Arrangements have been made for visiting other principle investigators as described in more detail in the work statement discussions for each subtask. This outside information will be gathered from Canadian and U.S. investigators concerned with the vertical migration of oil in ice, the horizontal transport of oil beneath ice, and under ice morphology. Because of ARCTEC's continuing informal relationship with all investigators active in the field of cold regions oil pollution, no difficulties are expected in efficiently gathering information and data from sources outside of the proposed program.

7. QUALITY ASSURANCE PLANS

As previously described, all instrumentation used by ARCTEC in its field and laboratory test programs meets ASTM specifications, and all calibration procedures and data collection procedures used by ARCTEC are likewise in accordance with ASTM procedures. Instrumentation which cannot be calibrated in-house is routinely sent to approved testing laboratories in the greater Washington, D.C. - Baltimore, Maryland area for calibration prior to the commencement of major test programs.

8. SPECIMEN ARCHIVAL PLANS AND LOGISTIC REQUIREMENTS

There are no requirements for the storage and archival of special samples or specimens in connection with either Phase I or Phase II of the proposed program. There are no requirements for logistic support associated with Phase I of the proposed program, however, logistics will be a major requirement for the field test programs proposed in a preliminary manner for Phase II of the program. Since these field test program requirements will not be defined until the completion of the Phase I effort, no reasonable estimates of these logistics requirements can be made at the present time.

9. MANAGEMENT PLAN

9.1 Organization and Personnel

Lawrence A. Schultz, Vice President of ARCTEC, Incorporated will be assigned as project manager for the proposed program reporting to the Contracting Officer on contractural matters, the Contracting Officer's Technical Representative on technical matters, and the program coordinator on matters of program integration. Mr. Schultz has served as project manager for several major Arctic oil pollution projects including field programs, laboratory studies, and planning programs. Mr. Schultz will be assisted throughout the program by Paul C. Deslauriers in the role of Project Engineer. Mr. Deslauriers has been involved in most of ARCTEC's Arctic pollution programs including the 1975 Ice Flume tests conducted at ARCTEC, Incorporated related to the transport of oil beneath smooth level ice cover. Mr. Deslauriers also served as Project Manager for a survey study of oil spill equipment and oil behavior in cold regions conducted for the U.S. Environmental Protection Agency through the University of Alaska, and for ARCTEC's on-site support services to NOAA in the 1977 Buzzards Bay spill and lower Hudson River spill in ice infested waters. Technicians supporting the laboratory testing portion of the proposed program will be working under the direction of Mr. Deslauriers. All consultants and subcontractors contributing to the program, including Dr. Seelye Martin of the University of Washington, Dr. Timothy W. Kao of the Catholic University of America, and Allen A. Allen of Crowley Environmental Services Corporation-Alaska, will report directly to Mr. Schultz as project manager.

Due to the great amount of interaction required between ARCTEC's program manager and the other individuals associated with the program including the Contracting Officer's Technical Representative, the program coordinator, the numerical modeling contractor, the consultants and subcontractors identified in the proposed program, and the outside investigators from whom data and information will be obtained for inclusion in the proposed program, ARCTEC's program manager must be skilled in interpersonal and interorganizational relationships in order to maintain a positive team effort throughout the proposed program. The selection of Mr. Schultz as project manager recognizes this need. Mr. Schultz has demonstrated his ability to manage complex situations under adverse conditions on numerous occasions.

Over the past three years, the project management and control procedures in effect at ARCTEC, Incorporated have been refined to a high degree of dependability. All project managers as a matter of routine are required to prepare detailed manpower and cost projections upon initiation of a contract covering the entire term of the contract. Based upon this plan, manpower and cost projections are used as input into the contract control function, and serve as the basis of comparison with actual performance throughout the course of the project. The project performance is reviewed on a weekly basis, with project labor and cost summaries prepared by the project accountant no later than Wednesday for the preceding week. Each project manager is supplied with a computerized weekly statement of the status of his projects. In addition, a project cost summary is posted in the firm's Management Information Center for the information of the entire staff, and the weekly project cost summaries are reviewed to ensure that all projects are maintained on schedule and within budget by the firm's Financial Director. As soon as there is any indication of deviation between the project performance and project plan, meetings are held between the Production Director, Financial Director, and the project manager for that particular project to identify any problems that may have arisen in the course of the project and to outline alternative solutions and take immediate remedial action. ARCTEC, Incorporated has, since its establishment in 1970, prided itself on its ability to complete programs on schedule and within budget. These relatively recently refined cost and schedule review procedures for each project have further contributed to the firm's having an exceptionally favorable record on completing work on schedule and within budget. Consultants and subcontractors will be required to supply ARCTEC with monthly invoices detailing all labor and expense costs associated with their contribution to the project.

While quarterly progress reports will be submitted to the Contracting Officer as required by the terms of the contract, from the preceding description it is clear that the project progress and costs will actually be reviewed by ARCTEC on a weekly basis. While the quarterly progress report will serve as the official review and reporting method throughout the course of the program, the expected close working relationship between the Contracting Officer's Technical Representative, the program coordinator, and ARCTEC's project manager will allow for a much closer review and control of program progress and cost.

9.2 Work Plan and Schedule

The work plan and schedule for the proposed program is summarized in chart form in Figure 13. The proposed research plan has been arranged so as to provide the most efficient program for completing the Phase I work effort within the specified 18-month period. The portions of the program associated with the observation of tests conducted at other research facilities and in the field obviously correspond with the currently anticipated testing schedule for these programs. Since the work of all three subtasks begins with the development of preferred formulations for oil/ice interaction, it is planned to initiate work on all three subtasks at the start of the program. Major milestones associated with the proposed program are also identified in Figure 13.

Due to the near-term scheduling of the Canadian laboratory and field test programs related to the vertical migration of oil in both first-year ice and multi-year ice, the initial emphasis will be placed on Subtask 1.1, Vertical Migration. Attention will then focus on the continuous ice situations

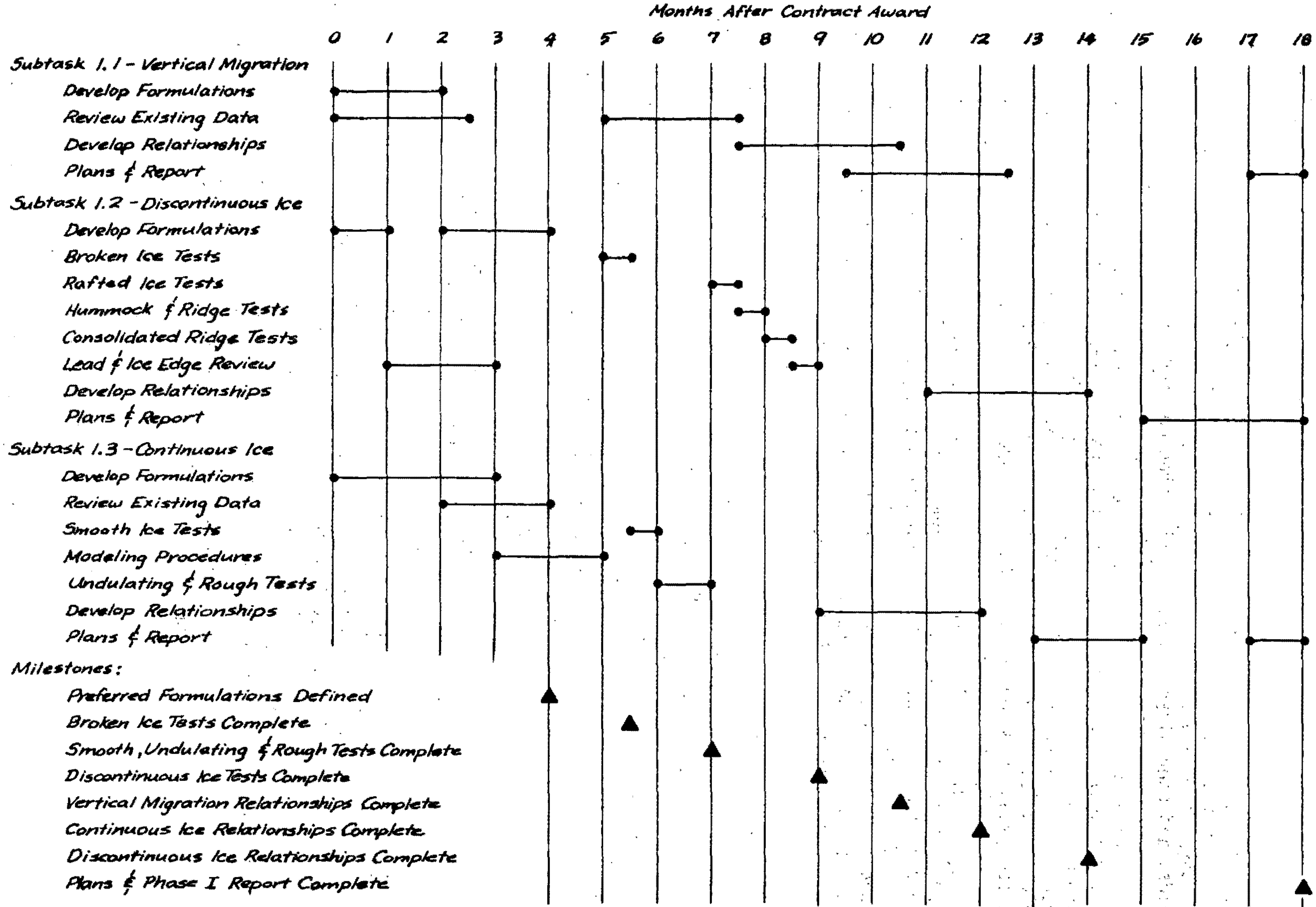

Figure 13. Project Work Plan and Schedule

of smooth, undulating, and rough ice cover comprising Subtask 1.3. The discontinuous ice situations including broken ice fields, rafted ice, hummocks and unconsolidated pressure ridges, consolidated pressure ridges, leads, and open water ice edges, will then be studied.

Based on the contract award date of April 1, 1978 specified in the RFP, the preliminary preferred formulations for the oil/ice interaction phenomena will be defined by August 1, 1978. The broken ice field tests to be conducted in ARCTEC's Ice Model Basin will be completed by mid-September 1978. The Ice Flume tests of smooth, undulating, and rough ice cover will be completed by November 1, 1978, while the tests of discontinuous ice features will be completed by January 1, 1979. The project plan then calls for the completion of the vertical migration relationships by mid-February 1979, the continuous ice condition relationships by early April 1979, and the discontinuous ice condition relationships by early June 1979. All plans for additional research effort that may be required will be completed along with the Phase I final report by the end of September 1979. ARCTEC, Incorporated anticipates no difficulties in meeting the schedule and delivery requirements identified in the RFP.

10. OUTLOOK

Assuming that the research program proposed herein for the initial contracting period of 18 months is successfully carried out, preliminary oil/ice interaction relationships for all of the phenomena being investigated in this program will have been developed in a form suitable for inclusion in the oil/ice dynamics numerical model. The degree of accuracy, and therefore the degree of sophistication, required from these oil/ice interaction relationships depends in large part upon the level of sophistication and capability of the numerical model prepared for the projection of oil spill trajectories. The long-range programs outlined in the subtask work statements included a Phase II effort incorporating both laboratory and field tests which would result in the highest degree of verification reasonable for the oil/ice interaction phenomenon being investigated. This proposal, therefore, addresses the possibility of at least three levels of oil/ice interaction model sophistication. The first level will result from the Phase I effort which spans the first 18 months of the program. A second level of sophistication and confidence would result from additional laboratory tests conducted in the Phase II program. If further verification of the oil/ice interaction formulations is required, the substantially greater effort and costs associated with field test verification programs could be justified. Our present opinion is that the results of the Phase I effort will provide useful and usable functional relationships for the oil/ice interaction phenomena, however, it is presently envisioned that the degree of confidence and level of sophistication of these relationships could be significantly improved through the Phase II laboratory test program which could be scheduled for Fiscal Year 1980 at a cost of approximately $150,000. At the conclusion of this portion of the Phase II program, it is judged likely at the present time that the level of sophistication of the oil/ice interaction phenomena will be up to the level of sophistication of the oil/ice dynamics numerical model, in which case further refinement of the oil/ice interaction phenomena may not be justified. If, however, the research is required and field verification of the relationships is desirable, a field test program could be undertaken in Fiscal Year 1981 which would likely cost in the range of $350,000 to $500,000, including logistics costs.

11. REQUIRED STANDARD STATEMENTS

The following standard statements are incorporated in this proposal in accordance with the requirements of the RFP:

(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) 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.

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

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

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

(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 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.

(8) All publications and presentations of material developed under OCSEAP funds will acknowledge BLM/OCSEAP sponsorship as follows:

> "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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1. THE TRANSPORT AND BEHAVIOR OF OIL SPILLED IN AND UNDER SEA ICE

Solicitation No. NOAA 10-78

Requisition/Purchase Request No. RK-8-0031

Flow Research Proposal No. 7853

Research Unit 568

Co-Principal Investigators: Max D. Coon
Robert S. Pritchard

Project Cost FY 1978: $145,690

FY 1979: $179,310

Institution: Flow Research Company
A Division of Flow Industries, Inc.
P.O. Box 5040
Kent, Washington 98031
(206) 854-1370

Date: January 20, 1978

Earll M. Murman
Vice President, General Manager
Flow Research Company
A Division of Flow Industries, Inc.
P.O. Box 5040
Kent, Washington 98031
(206) 854-1370, Ext. 278
January 20, 1978

Max D. Coon, Program Mgr., Ice Dynamics
Flow Research Company
A Division of Flow Industries, Inc.
P.O. Box 5040
Kent, Washington 98031
(206) 854-1370
January 20, 1978

William Rathman
Treasurer, Controller
Flow Industries, Inc.
P.O. Box 5040
Kent, Washington 98031
(206) 854-1370, Ext. 254
January 20, 1978

Robert S. Pritchard, Dir., Solid Mechanics Dept.
Flow Research Company
A Division of Flow Industries, Inc.
P.O. Box 5040
Kent, Washington 98031
(206) 854-1370
January 20, 1978

IV. Background

The proposed Outer Continental Shelf (OCS) planning schedule for the federal/state lease of the Continental Shelf of the Beaufort Sea for oil exploration shows a final sale date of December 1979 (ref. OCSEAP Bulletin No. 18). Nominations for tracts have already been made and are to be announced by April 1978, the time when this proposed work is scheduled to begin. Between these dates, environmental impact statements, hearings, and other formal proceedings will take place. It is not any too soon to complete the data base needed to provide environmental information adequate to ensure protection of the OCS marine environment from damage during subsequent oil and gas exploration. Although it is probably too late to have an impact on the choice of locations of lease tracts, the results of the proposed study will provide important information on the environmental impact of development in these tracts and shall provide critical information for management decisions on how exploration and development operations may proceed.

During the last four years there have been a number of studies in which investigators have determined the effect of oil spilled in different environments. In reports by NORCOR Engineering and Research, Ltd. (1975)* and by Lewis (1976), the behavior of oil under and in stationary first-year ice is described. These studies have provided useful information on the early processes by which oil rises through the water column (also described in detail by Topham, 1975), spreads by gravity flow and soon becomes incorporated into the ice sheet. Additional work by Wadhams (1975) has provided a description of the under ice topography that strongly influences the size of the area within which ice naturally contains the oil. In additional work, Rosenegger (1975) has considered how oil may move under tilted flat ice, and has concluded that no oil penetration upward through first year ice occurs. On the other hand, Martin (1977) has studied the rise of oil through brine channels in sea ice and subsequent spreading of the oil at the top surface. The proposed work involves further study of this mechanism that is particularly appropriate in multiyear ice.

*All references may be found in Section VIII, Analytical Methods, of the technical proposal.

All of these studies have been concerned with an ice cover in oceans that are stationary. A major purpose of the proposed work, then, is to study the mechanisms by which oil is transported in the Arctic; especially horizontally by the ice motion. We must also determine the behavior of the oil in the ice so that we can determine the conditions under which it becomes incorporated in the ice and remains there, and also those conditions where it is not incorporated and may be spread across the ice.

Other studies have determined how oil is transported by winds on ice free oceans. These results are appropriate in analyzing oil transport on the Continental Shelves of the Beaufort and Chukchi Seas during the summer when the pack ice retreats northward leaving an open ocean several hundred kilometers wide.

Previous experimental research at Flow Research Company (Lin, 1977) for the U.S. Coast Guard to determine sea conditions under which oil is dispersed by the water column so that it is not recoverable shall be useful.

During February 1977, the OCSEA program held a Beaufort Sea synthesis meeting with the purpose of bringing together our knowledge of the environmental impact of oil exploration and development on the Continental Shelf of the Beaufort Sea. In OCSEAP Bulletin No. 15, a draft of our findings at this meeting are presented.

The proposed work involves determining a range of trajectories that sea ice can be expected to take both by numerical modeling and by using drift track data, and determining how the oil behaves as it is being transported by the mobile ice.

The principal investigators, while associated with the AIDJEX program at the University of Washington, have performed research to further our understanding of the dynamics of sea ice in the Beaufort Sea. In addition to the funding of AIDJEX primarily by the National Science Foundation and the Office of Naval Research, we have also been studying the response of the near shore ice in an OCSEAP project titled "Dynamics of Near Shore Ice." As part of this work, we have deployed an array of drifting data buoys in each of 1976, 1977 and 1978 (soon to be deployed) to determine the motion of the ice cover. By also measuring the barometric pressure, we have been able to use the AIDJEX model to simulate ice motion, deformation and stress in the near shore of the Southern Beaufort Sea and to test the performance of this model with the drifting buoy data (Untersteiner and Coon, 1977).

The results of this near shore ice dynamics simulation are convincing at demonstrating that a plastic model of sea ice is valid. Furthermore, only a model that admits discontinuities (or a good approximation thereof) can be used to simulate events on these space scales. The essential property of the mathematical model is that the system of equations be hyperbolic. On-going work by the principal investigators as part of AIDJEX modeling efforts have allowed us to characterize the mathematical properties of the model and to understand better the response that a plastic model produces. We expect to use this plastic model, extending it to describe in more detail the incorporation of thin ice into ridges, and we shall use it in the Chukchi Sea region.

An important feature of the plastic model developed by the AIDJEX modeling group is the use of the thickness distribution to help define its state. This function describes the relative area at each location covered by ice of each thickness. By considering the area covered by ice thinner than, say, 10 cm, we are able to describe open water and leads existing in an area. As the ice cover deforms, the thickness distribution accounts for the conversion of the thin ice in the lead being piled into a thicker configuration in ridges. By considering the redistribution function, we shall be able to describe how oil is incorporated into ridges after accounting for the presence of oil in the ice being ridged.

This proposed work represents an application of the knowledge gained from our previous work to the problems associated with oil spilled under and in the Arctic sea ice cover during exploration and development in the Alaska OCS of the Beaufort and Chukchi Seas. The work proposed, however, also furthers our scientific understanding of the interaction of sea ice with its environment and is therefore an extension of our previous work.

V. Objectives

The goal of the proposed work is to determine the locations to which oil spilled in or under the ice cover near Prudhoe Bay, Alaska, would be transported and, further, to determine the behavior of the oil as the ice cover moves and deforms. More specifically, then, it is necessary to determine the motion of the ice cover as it is driven by the wind and ocean currents. This information shall define the trajectories (a range of trajectories under differing wind and ice conditions) taken by the many floes that make up the ice cover. The other major area of study is to learn how oil is transported and dispersed across the ice and incorporated into the ice. With this additional knowledge we are able to specify how oil is transported through the Arctic environment and to determine how it will behave within the ice cover. This information shall assist management to make decisions that will help protect the OCS marine environment from damages during oil and gas exploration and development.

This proposal is in response to the RFP, Number NOAA 10-78, of December 14, 1977. The general objectives stated above are met by addressing the three tasks specified in this RFP. By restating these three tasks, the following are our specific objectives.

Task 1: To determine by laboratory experiments the physical processes by which spilled oil gets incorporated into and transported in, under or across sea ice.

Task 2: To determine, by numerical modeling and synthesis of the results with manned and drift station data, a range of velocity fields of the ice cover on the Continental Shelves of the Beaufort and Chukchi Seas. These velocity fields shall represent the climatological mean (or most probable) and extreme events. As part of this task, major outbreaks of ice from the Chukchi into the Northern Bering Sea shall be considered. The range of environmental parameters shall include mean climatological winds and the response to extreme events, as well as both light and heavy ice conditions. As part of our effort to describe the behavior of the oil within the ice cover, we shall analyze the mechanisms by which oil is transported and dispersed under, through and above the ice cover and incorporated into it. On the scales of interest in this work it shall be desirable to learn whether or not it is feasible to develop (primarily by extension of the AIDJEX model) a model capable of simulating the ice dynamics on smaller length scales (say, kilometers, rather than the present tens of kilometers).

Task 3: To determine, by combining the relevant information obtained under Tasks 1 and 2, as well as any other relevant information, the sequence of events, likely trajectories and destination points for oil in the following hypothetical scenarios:

<u>Scenario 1</u>: An 8 million gallon release of crude oil over a period of 5 days into pack ice. Three locations for this accident must be considered along the Prudhoe Bay meridian:

(a) in fast ice close to shore
(b) in the shear (transition) zone
(c) near the shelf break

The scenario must also consider these events to occur at two different times:

(a) just before ice freeze-up in fall
(b) just before ice break-up in spring

<u>Scenario 2</u>: A continuous blowout in the shear (transition) zone at the rate of 2 million gallons/day, starting at freeze-up and continuing uninterrupted until mid-August.

VI. General Strategy and Approach

This proposal covers the three tasks described in RFP Number RK-8-0031 and the objectives in Section V above. Because it is felt that Task 3 is the focal point of this proposal, the strategy and approach for this task will be discussed first.

Task 3: The strategy for this task will be to develop an outline for each of the oil spill scenarios given above and to flesh out this outline with all of the available data from the OCSEA Program, as well as other Arctic research projects. The skeleton scenarios will be examined to determine the amount of detailed research required in Tasks 1 and 2 to successfully write the final scenarios as the last task of this proposed work. It is expected that the literature search and outlining process will require the first two or three months of the proposal period and the results will then be used as a guide for the remaining time of the proposal.

The overall approach to be taken in the oil spill scenarios is to follow the oil through four separate time periods: (1) The spread of the oil before it is incorporated into the sea ice. (2) The mechanisms by which oil is entrapped in sea ice. (3) The transport of the oil incorporated in sea ice. (4) The release of oil from the ice and its subsequent behavior. This approach is similar to that used by Lewis (1976). Much of the supporting background information needed in the writing of the scenarios will be obtained from such literature as the Beaufort Sea Project Technical Report Nos. 27, 28, 33 and 36, and from OCSEAP research data.

It is felt that there are three mechanisms by which the oil can be entrapped and incorporated in the sea ice. These are by migration through brine channels which will be studied in Subtask 1.1, or by incorporation through the building of sea ice ridges as studied in Subtask 1.2 and Task 2, or through incorporation by simply resting on the lower surface of an ice sheet until new ice is grown below the oil and thus incorporated into the ice sheet (this will occur whenever freezing is possible on the bottom of the ice sheet). The transport of the oil with the ice cover once it has been incorporated into the sea ice will be one of the major studies of Task 2 of this proposal Finally, when conditions allow the oil to be released from the ice by fracturing and melting during spring and summer, we shall consider the additional problem of dispersion due to ocean currents and ice deformation. Our approach shall be to identify dispersion mechanisms and determine the motion of the oil relative to the ice cover. This motion will then be superposed on the motion of the ice cover.

Task 1

Here, the physical processes by which spilled oil gets incorporated and transported in an undersea ice will be studied under laboratory conditions. During the period of this proposal, plans will be made for possible field experiments to collaborate laboratory results. It is felt that these field experiments could be conducted as a final phase of phase two of such a program.

Subtask 1.1

Laboratory experiments will be conducted to determine how and at what rate oil moves upward through multiyear sea ice to the surface. The upward migration of oil through the brine channels in first year sea ice have been documented by Martin (1977). Multiyear sea ice is characterized by a top layer which is essentially fresh water ice with very low porosity (formed as a result of the Arctic summer) and a bottom layer which is younger sea ice with a well defined system of brine channels. Oil spilled beneath multiyear ice will presumably migrate up through the channel system until it encounters the layer of fresh ice. The continued upward migration of oil during both winter and summer conditions will be the central theme of this experimental study. The sea ice needed for this program will be grown in a cold room in a tank approximately 1 meter square insulated so that the ice will be grown by cooling from the top. Thermistors will be used to determine the temperature profiles of the sea ice sheet and the salinity of the water will be monitored. To simulate the character of the water, a sheet of ice will first be grown to between 15 and 20 centimeters and then to simulate the Arctic in summer the top of the ice sheet will be warmed by a heat lamp. The heating will be maintained until the temperature profile of the sea ice is judged to represent summer conditions. At this time the top layer of the ice sheet will be flooded with 1 to 2 cm of fresh water to represent the melting that occurs in the field situation. The ice sheet will then be refrozen to represent a winter condition. It is possible that this summer-winter simulation may have to be conducted more than one time to obtain an ice sheet with multiyear characteristics. After the sheet of multiyear laboratory ice has been prepared, oils of three different viscosities will be released at different locations beneath the ice sheet. The subsequent migration rate of these oils will be determined photographically by utilizing windows in the side of the tank. If the migrations under these winter conditions stop presumably at the interface between the ice with brine channels and the fresh ice, then summer conditions will again be simulated by heating the top of the ice sheet and any subsequent migration monitored.

For the laboratory work we will attempt to obtain Prudhoe Bay crude oil from ARCO Corporation.

Subtask 1.2

Laboratory experiments will be designed to determine how and at what rates oil is incorporated into pressure ridges formed from ice of various thicknesses. The mechanisms of ridge formation have been studied by Parmenter and Coon (1972) and the dimensionless parameters which control their formation have been determined. Sea ice ridges are formed from primarily young sea ice which is formed during fall freeze-up, or in leads opened during the freezing season. The time required for a ridge to build varies from a few hours to a few days. Any oil that contacts the lower surface of young sea ice will be incorporated into the ice through the brine channels as discussed in Subtask 1.1 and by the formation of new sea ice at the bottom layer of the oil. One of the first experimental results required to understand how oil is incorporated into pressure ridges revolves around the migration of the oil through the block of sea ice after the ridge has been formed. To answer this question, a laboratory experiment will be conducted in which sea ice is grown as in Subtask 1.1 to the thickness of a few centimeters. Oil will be released below this sea ice and allowed to become incorporated in the growing sea ice. This sea ice will then be broken and forced into a small pressure ridge. The rate of migration of the oil through this ridge will then be determined by a sequence of photographs. With information about the rate of this oil migration, it will be possible to design other experiments to determine the final distribution of oil in a sea ice pressure ridge.

Subtask 1.3

Laboratory experiments will be conducted to determine how oil of different viscosities spreads and is moved by ocean currents under sea ice with different underside roughness characteristics. These experiments will be conducted in a room-temperature towing tank utilizing various rigid models with different underside roughnesses. Since the spreading of oil is governed mostly by hydrodynamic forces, it is not necessary to use an ice model in these experiments. At Flow Research Company, we have a towing tank and laboratory personnel which can be utilized in this experiment (Lin, 1977).

Extreme conditions of oil viscosity and currents simulating those on the Arctic outer continental shelf will be used to study how much oil may be trapped in the high spots of the under ice roughness. The number of parameter variations required in this experiment will be determined during the course of the experiment. That is, if it is found that oil originally entrapped under ice high spots remains there under severe conditions, then the experiments will be completed. If, however, it is found that the oil may travel large distances, then a more comprehensive set of experiments will be necessary.

Task 2

We separate the work of determining the oil transport and behavior into two efforts that may proceed relatively independently. These are (i) determine the velocity and deformation fields of the ice cover in the Beaufort and Chukchi Seas, and (ii) determine the mechanisms that allow oil to be either transported across or incorporated into the ice cover. Since the presence of oil is not expected to affect the ice motion, the first of these efforts may be finished independently. Motion of the ice cover on the Continental Shelves of both the Beaufort and Chukchi Seas will be determined by synthesizing results of numerical modeling with existing knowledge of trajectories taken by drifting manned camps and buoys.

Ice drift data are available from the OCS data bank and the AIDJEX data bank (for stations deployed in different programs). These data must be analyzed to allow us to find the motion at different locations and times of the year. It will be useful to study the temporal spectrum of these drift tracks to learn how important long-term averages are relative to the shorter-term responses to individual events.

The numerical model to be used was developed by AIDJEX and is described in Section VIII, Analytical Methods, of this proposal. This model has been used already by the OCSEAP, Research Unit 98, to determine ice velocities in the nearshore Beaufort Sea. The model utilizes an elastic-plastic constitutive law together with an ice thickness distribution to account for the formation of leads and ridges. The numerical modeling is needed because it provides the response to any chosen set of wind conditions. Data from drifting stations, although important in defining ice cover motions, suffer from a lack of control of environmental conditions during the relatively few times stations have been deployed. With the numerical model we shall be able to determine the ice response during mean climatological conditions and extreme events. One significant task to be done early in the work is to determine from NCAR data tapes what are the mean climatological conditions and important extreme events. We shall have to be concerned with the fact that while evaluating wind data it is really the extreme events of ice motion that are important.

Since ocean currents also exert a force driving the ice, it is necessary to learn what ocean currents are to be expected throughout the Beaufort and Chukchi Seas. It shall be desirable to study these data to determine if any modifications to the ocean model are needed.

In the numerical modeling, we shall be able to use our understanding of the motion of the ice cover to use as simple a description as possible. For example, in the summer there is enough open water present so that the ice cover motion may be found by using a free-drift model that neglects ice stress. At these times, there is no need to use the complete model to determine ice motions. Similarly, during winter periods (say January, February and March) the ice is relatively immobile and we shall consider the range of drifting station motions to learn if these alone are adequate to determine mean motions. On the other hand, winter storms can have extreme effects on the fast ice as witnessed just this winter (1977-1978) in Barrow. During the remainder of the year, especially during the relatively long freeze-up period, we expect simulations of ice motions to require the complete ice model. These shall be performed so that both mean climatological and extreme ice motions can be determined for a year-long period. This period would be necessary to determine the range of trajectories that could be taken by the spilled oil.

In addition to determining the mean and extreme trajectories of the ice in the Beaufort and Chukchi Seas, we shall also look closely at the conditions controling breakout of Chukchi Sea ice into the Northern Bering Sea. This model is ideally suited for the study of such conditions because of the plastic nature of the constitutive law used for the sea ice. The analysis shall depend on our understanding of the mathematical characteristics of the model to define material parameters and environmental conditions that can affect or control such breakouts.

On length scales of tens of kilometers, the AIDJEX ice model has provided realistic simulations of the motion, deformation and stress of the ice cover. This model differs significantly from that of Sodhi (1977) who studied the breakout problem as an example of arching. Ice strengths differ by over one order of magnitude even if we increase his wind stress by a factor of ten to be compatable with our value. In addition, we shall study the behavior of the moving ice when there is an effect due to Coriolis acceleration and water drag. This study shall be especially useful at defining the extreme conditions of importance for this breakout problem.

A breakout during January 1976 is documented both by NOAA satellite imagery and buoys that were present in the Chukchi Sea at that time. At present it is thought that this time will be chosen for model runs. During the performance of this work, however, other times will be considered to see if more information could be derived from them. This model study will be augmented by analytical calculations for various extreme conditions to determine the range of ice and atmospheric conditions under which such blowouts could occur and thereby transport oil into the Bering Sea.

During those times of year when air temperatures are low enough to cause ice to grow thicker, it is felt that the spread of oil before it is incorporated into the sea ice will not be extensive (area enclosed in a radius of tens of kilometers). When true, it will not be necessary to consider motion of the oil relative to the ice except at Prudhoe Bay where we assume the oil spill to occur. In this region, specific attention will be paid to the ridging of sea ice under various conditions to determine the percentage of oil incorporated in ridges before it is transported westward.

During the melt season, however, it is necessary to determine mechanisms that will allow the oil to be released from the ice and subsequently moved across the ice. For this portion of the study, it will be necessary to use the results of Task 1 by superposing the dispersion of oil on the ice motion. It shall be necessary to consider these mechanisms along with deformation of the ice cover to describe the behavior of the oil. The effect of storm surges and bottom topography are also of interest at times when oil has been released, but the ice cover remains. We shall attempt to assess the importance of these conditions for future study.

VII. Sampling Methods

Not applicable.

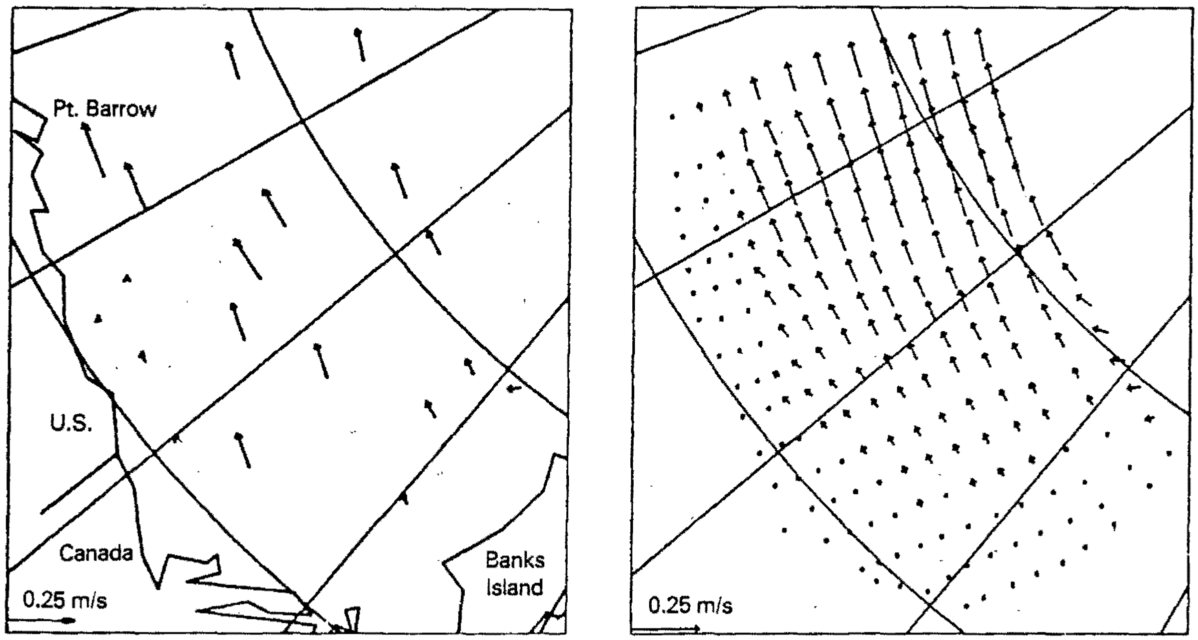
VIII. Analytical Methods

The proposed approach depends on the use of a mathematical model of the motion and deformation of the ice cover developed as part of the AIDJEX program (Coon, et al., 1974; Coon and Pritchard, 1974; Thorndike, et al., 1975; Rothrock, 1975; Pritchard, 1975). This model is based on the description of the mechanisms of deformation of the ice cover as a function of the formation of leads and ridges. It is well-known that the ice cover deforms by forming leads as the ice opens, by freezing the ocean into thin ice, and then subsequently ridging the thin ice as the cover shears and converges.

During the last several years a concentrated effort has been made to evaluate this mathematical model and to determine values of the various parameters in its description. These results have been presented by Coon, et al. (1976) and Pritchard, Coon and McPhee (1977) who showed how the model could be used to simulate the motions in the central Beaufort Sea; by Coon, Hall and Pritchard (1977) and Pritchard, et al. (1977), who showed how the results could be extended to include the near shore regions of the Beaufort Sea, and by Pritchard (1977), who considered an idealized form of the model to allow tuning of the strength parameters.

In the work performed for OCSEAP, this model has been used to simulate the dynamic response of the ice cover in the nearshore region of the southern Beaufort Sea from January 27 through February 3, 1976. During this time period there were seventeen drifting buoys (OCS) as well as three drifting manned stations (AIDJEX) providing data on the ice motion and deformation. We were able to simulate temporal changes in the motion of the ice cover accurately.

During this time a flaw lead formed from Pt. Barrow eastward toward the northern tip of Banks Island. This critical feature dominates the spatial variations of the motion. In Figure 1 we present the daily displacement field during January 30 when the lead extended about half-way across the Beaufort Sea (verified by NOAA-4 infrared satellite images). In Figure 1a, each arrow represents a displacement of the buoy in the direction shown. Distance traveled is scaled by the arrow in the lower left corner which represents 0.25 m/sec (about 25 km/day^{-1}). In Figure 1b the simulated displacement is presented. It is seen that



a) Observed b) Simulated

Figure 1. **Displacement of Southern Beaufort Sea Ice Cover During January 30, 1976 Vectors Show Daily Displacement Proportional to Scale Arrow in Lower Left Hand Corner. The North American Continent is Shown in Part A. Scales Are Identical in Both Parts.**

the flaw lead is represented by a velocity discontinuity at the correct location. Furthermore, the fast ice region is seen and velocity of the moving pack is accurate. A sequence of North South leads also formed at about 140°W longitude. Principal strains presented by Pritchard (1977) show that these leads are formed by uniaxial east-west openings in this region and the model simulated this feature also.

The AIDJEX plastic sea ice model requires a numerical solution technique to determine how the ice cover responds. This scheme has been developed and tested (Pritchard and Colony, 1976). In addition, the complete description of boundary conditions, initial data and atmospheric and oceanographic forcing functions that are required by the model is discussed by Colony (1976).

To learn what properties of the ice and what environmental conditions control break-out of Chukchi Sea ice into the Northern Bering Sea, we support the numerical calculations with a characteristic analysis of the model equations (Courant and Hilbert, 1962). The analysis will allow us to better understand the results of the numerical modeling efforts and to identify critical material parameters and environmental conditions.

X. Deliverable Products

A. Digital Data: None

B. Narrative Reports:

The product for the program will be a set of reports.

Task 1: Reports of the experimental results and how they will be used in the preparation of the oil spill scenarios of Task 3 will be written. Task 1.3 will be reported separately (see milestone chart).

Task 2: A report on numerical modeling of ice trajectories on the Continental Shelves of both the Beaufort and Chukchi Seas will be prepared. This report also will include a study of a major sea ice outbreak from the Chukchi to the Northern Bering Sea. This report will show how the result will be used in the preparation of the scenarios of Task 3 and will be completed by June 1979 (see milestone chart).

Task 3: An outline of the oil spill scenarios will be reported in October 1978. The completed scenarios will be reported in September 1979 (see milestone chart).

C. Visual Data:

Maps of sea ice trajectories for the Continental Shelves of the Beaufort and Chukchi Seas will be prepared.

D. Other Non-Digital Data: None

E. Data Submission Schedule: None

XI. Information Required From Other Investigators

Atmospheric barometric pressure data is required to determine the winds which are input as ice driving forces. These historical data are available from the NCAR data tapes.

Ice motion data from drifting stations deployed by the OCSEAP are available through the OCS data bank. Other drift data are available from the AIDJEX data bank.

Data on the under ice topography that will be useful to determine self-contaminent of the gravity flow of oil are available from Austin Kovacs, CRREL.

Although we have not contacted these sources formally, all data are available to government sponsored researchers.

XII. Quality Assurance Plans

To help ensure that the ice dynamics model is tuned to simulate sea ice motions accurately, we shall compare calculated motions with observed ice drift when environmental driving forces are similar.

XIV. Logistics Requirements

None. There are no field activities planned during this phase of the proposed work.

XV. Management Plan

The general management plan is to have a Senior Research Scientist of Flow Research Company direct the work for each task as shown in Table I. A Manpower Loading Plan for this program is shown in Table II. The responsibility for organization within Flow Research Company and all required reporting (quarterly, annual, and final) will be in Task 3. Because all three tasks are being performed within one organization, it will be natural to interchange the results from each task. An Activity/Milestone chart is shown.

Milestone Chart

RU #: ____________ PI: M. D. Coon, R. S. Pritchard

Δ Planned Completion Date
▲ Actual Completion Date

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

Major Milestones	1978									1979								
	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
Task 3. Scenario Outline Complete Work	—	—	Δ															
Complete Report	—	—	—	—	—	—	Δ											
Scenario Complete Work															—	Δ		
Complete Report																	—	Δ
Task 1.1. Experiment Designed & Running	—	—	—	—	—	—	Δ											
Experiment Complete								—	—	—	—	—	Δ					
Task 1.2. Identify Mechanisms & Design Experiment	—	—	—	—	—	—	—	—	—	—	—	—	Δ					
Report for Tasks 1.1 and 1.2														—	Δ			
Task 1.3. Experiment Designed & Running	—	—	Δ															
Experiment Complete				—	—	Δ												
Report on Task 1.3							—	—	Δ									
Task 2. Define Mean & Extreme Climatological Conditions	—	—	—	Δ														
Develop Ice Trajectories Calculation	—	—	—	—	Δ													
Determine Ice Trajectories						—	—	—	—	—	—	—	Δ					
Analyze Chukchi Ice Break-Out Condition	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Δ			
Numerical Modeling Report													—	—	Δ			
Quarterly Reports			Δ			Δ			Δ						Δ			Δ
Annual Report												Δ						

XVI. Outlook

The essential elements needed to describe the transport and behavior of oil in ice will have been identified. Furthermore, by laboratory testing we will have learned how oil may move under ice and how it is controlled by under-ice topography. The ice trajectories will be determined for mean climatological conditions in the Beaufort and Chukchi Seas. Also, we shall study the range of ice trajectories that may occur due to extreme events. In the Chukchi Sea, we expect to understand the natural properties and environmental conditions that control break-out of ice into the Northern Bering Sea. The work that remains falls into three categories: (a) a field experiment to verify the results of the laboratory studies, (b) further study of the range of extreme events that may occur in the Beaufort and Chukchi Seas, and (c) continued study of a smaller scale ice model to help understand how oil is transported and dispersed across the ice. In this last task we shall possibly need to consider the effect of lead and ridge orientation and distribution and floe size as well as ocean bottom topography. Storm surges need to be studied to learn how they cause the ocean to transport oil.

1. The results of these studies shall add data to our knowledge of oil transport and behavior. The information will be incorporated into the oil spill scenarios developed in the presently proposed work.

2. Significant milestones include completion of field experiments, progress in improving small scale ice description, determination of the effect of storm surges and determination of transport and dispersion of oil by small scale ice deformation.

3. Cost for FY 1980 is estimated to be $250,000.

4. No major equipment is required.

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. 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.

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

5. Data will be submitted within 120 days of the completion of a 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).

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

7. Three (3) copies of all publications 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 for information and for forwarding to the Bureau of Land Management (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.

8. 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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