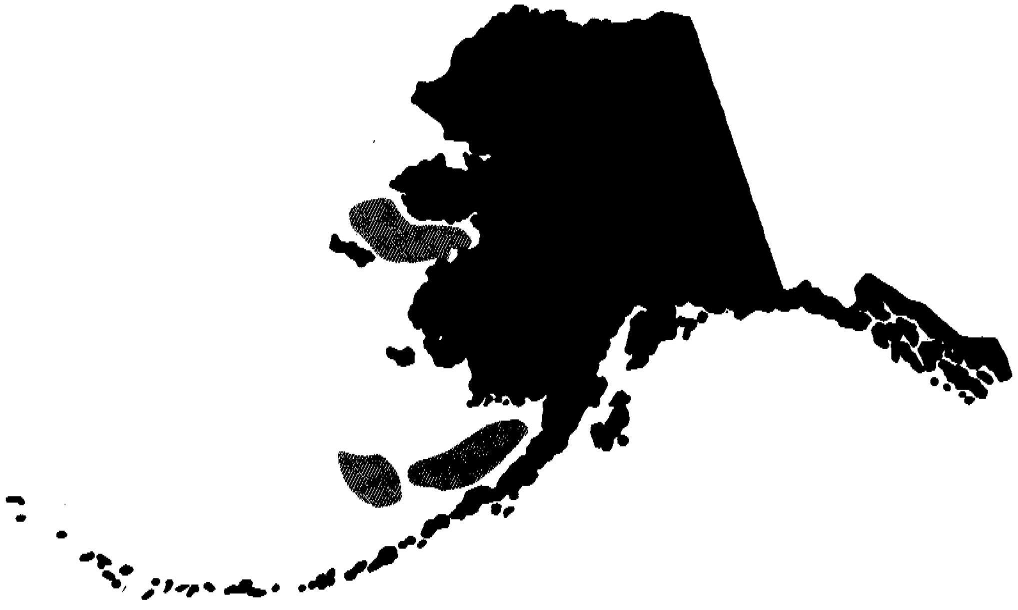
CRD1

TECHNICAL DEVELOPMENT PLANS - FY 79

Environmental Assessment of the Alaskan Continental Shelf



Bering Sea

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

TECHNICAL DEVELOPMENT PLANS

BERING SEA

NORTON SOUND
BRISTOL BASIN
ST. GEORGE
NON-SITE-SPECIFIC

FISCAL YEAR 1979

COORDINATED BY
LEASE AREA COORDINATORS:

Bering Sea-Leland Hepworth
Non-Site Specific-Douglas Wolfe

This TDP is a document prepared for FY 79 program planning. Inclusion of a project description and funding level is not to be construed as a commitment to any project or agency. Requests for current information on program content and official funding should be addressed to the undersigned.

Director, OCSEAP

OUTER CONTINENTAL SHELF ENVIRONMENTAL ASSESSMENT PROGRAM
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
BOULDER, COLORADO

PREFACE

The Alaska Outer Continental Shelf Environmental Assessment Program (OCSEAP) covers nine lease areas extending from the Northeast Gulf of Alaska to the Beaufort Sea. The program thus focuses on a vast geographic area where environmental working conditions are extremely severe. Because of the harsh environment and the emphasis on open ocean research during the period from 1955 through 1968, less research has been conducted on the Alaska Outer Continental Shelf (OCS) than on any other coastal area of the United States. It was recognition of this lack of environmental data that resulted in the request by the Bureau of Land Management (BLM) that the National Oceanic and Atmospheric Administration (NOAA) institute a program to supply the information needed prior to and during exploration and development of the OCS as an energy resource.

Before the initiation of OCSEAP studies in 1974, conferences involving about 300 scientists were held to develop an understanding of the existing data, which were found to be based primarily on fragmentary studies and to lack continuity in time and space. The primary goal of the Alaska OCS environmental studies program is to provide background information for management decisions that may be necessary to protect the OCS marine environment from damage during oil and gas exploration, development and production. Therefore the program must develop meaningful data in a timely manner so that considered decisions and corrective actions can be taken before serious or irreversible impacts occur. In response to this program goal and the objectives of BLM environmental programs in all OCS areas, including Alaska, the investigations of the Alaska OCS Environmental Assessment Program must address the scientific objectives and sub-objectives listed in all Technical Development Plans (TDP's).

The research effort from FY 75 through FY 78 was implemented with broad-scale surveys known as reconnaissance studies. These reconnaissance studies have supplied the initial information to define circulation systems, contaminant trajectories, ice hazards, seafloor faults, seismic activity, and areas of sediment instability, needed for selection and design of studies addressing specific sites and environmental processes. They also provided initial data on hydrocarbon and trace metal concentrations and on biological populations, as well as locations of critical habitats and environmental processes. More intensive studies are now required to understand their vulnerability to impingement from oil and gas development. Site specific amd environmental process studies in FY 79 will develop supplemental information to fill major data gaps in nearshore processes and trophic relationships of the biological communities.

The total program for FY 79 is co-funded by the BLM, NOAA, and the U.S. Coast Guard.

	FY 79 Million $
Direct funds from BLM (Planned)	$ 17.4
Ship time furnished by NOAA (Estimated)	6.3
Ship time from USCG (Estimated)	0.5
TOTAL Direct Costs	$ 24.2

In addition, NOAA's Environmental Data Service supports some of the data management effort and the Pacific Marine Environmental Laboratory supplements the effort in some research projects conducted by that laboratory. The total program except for the logistics, management, and syntheses functions, is described in these TDPs, covering nine lease areas and general non-site-specific studies.

These funds have been distributed among lease areas in accordance with the lease schedule and known deficiences in environmental information. The planning recognizes that there will be successive sales in the same lease area, and that even after development proceeds, a study and monitoring effort will be essential.

1.0 INTRODUCTION

1.1 BACKGROUND

Expeditious development of the Outer Continental Shelf (OCS) is essential to meet the energy needs of our Nation during the remainder of this decade and throughout the next. The Alaskan OCS oil and gas deposits are potentially the largest national source of petroleum during a time of critical need. In each OCS area for which development is proposed, extensive environmental studies must be conducted before such development is allowed. If these studies show that development of specific areas will result in unacceptable environmental risks, those areas will not be leased. As manager of the Outer Continental Shelf Leasing Program, the Bureau of Land Management (BLM) of the Department of Interior (DOI) has initiated the Outer Continental Shelf Environmental Assessment Program (OCSEAP) as an essential part of its management responsibility in order to ensure that the Alaskan marine environment is not deleteriously disturbed. Study programs for the nine lease areas of Alaska and one additional general or non-site-specific studies group are planned and conducted under interagency agreement for BLM by the OCSEAP offices of the National Oceanic and Atmospheric Administration (NOAA), U. S. Department of Commerce.

There are ten annual Technical Development Plans for the Alaskan Outer Continental Shelf program, one for each of the nine lease areas and one for studies that are "non-site-specific". The essentials of these plans were developed by the interdisciplinary staff of the NOAA-OCSEAP Office, with input from the Bureau of Land Management, the State of Alaska, and a Users Panel composed of representatives from several Federal and State agencies and from private environmental groups. The planned effort herein described begins with environmental studies already underway.

In May 1974, the Bureau of Land Management requested that the National Oceanic and Atmospheric Administration initiate a program of environmental assessment in the Northeastern Gulf of Alaska in anticipation of possible oil and gas lease sales in the region early in 1976. These studies were initiated in July 1974.

In October 1974, a major expansion of the environmental assessment program was requested by BLM to encompass four additional areas of the Continental Shelf of Alaska during the FY 1975-1976 period. After an intensive planning effort, including workshops, public comment and consultations with scientists and other concerned persons, a program proposal equivalent to a plan was published. This document was entitled "Environmental Assessment of the Alaskan Continental Shelf, First 18-month Program - Gulf of Alaska, Southeastern Bering and Beaufort Seas, April 1975."

Since that document was approved, scientific efforts have been extended into the northern Bering Sea, Chukchi Sea, and Lower Cook Inlet. Many of these efforts are simply geographic extensions of the work underway in earlier areas and already subjected to wide review and comment.

A Program Development Plan, which brings into one document the planned program for all nine proposed lease areas of the Alaskan OCS including work underway and planned, was completed in December 1976. The nine areas, extending from the Northeastern Gulf of Alaska (NEGOA) in the south to the Beaufort Sea in the north, are shown in Figure 1-1 and their characteristics are briefly described in their respective TDPs.

1.2 OBJECTIVES OF THE ALASKA OCS ENVIRONMENTAL ASSESSMENT PROGRAM

The primary objective of the Alaska OCS environmental studies program is to provide background information for management decisions that may be necessary to protect the Alaskan marine environment from damage during oil and and gas exploration and development. The protection of the marine and coastal environment is a direct outgrowth of the National Environmental Policy Act of 1969. The program must develop meaningful data, in a usable form, in a timely manner, so that any required corrective actions can be taken before serious or irreversible impacts occur.

The objectives of the BLM environmental studies program for all OCS areas, including the nine Alaska areas and non-site-specific lease area studies are:

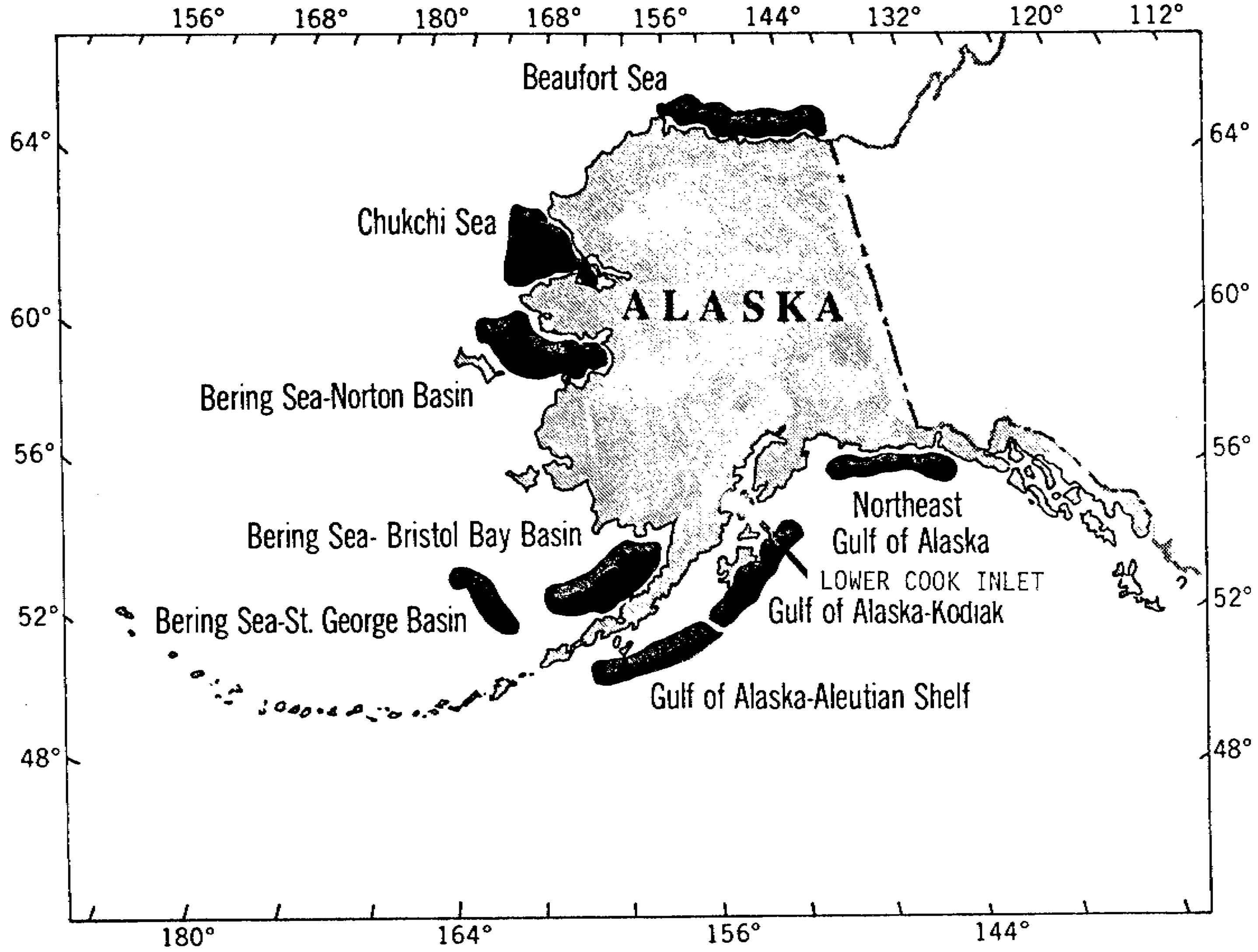


FIGURE 1-1. ALASKAN OUTER CONTINENTAL SHELF LEASE AREAS.

75X 3233

1. To provide information about the OCS environment that will enable the Department of the Interior and the Bureau of Land Management to make sound management decisions regarding the development of mineral resources on the Federal OCS.
2. To acquire information that will enable BLM to identify those aspects of the environment that might be impacted by oil and gas exploration and development.
3. To establish a basis for prediction of the impact of OCS oil and gas activities on the environment.
4. To acquire impact data that may result in modification of leasing regulations, operating regulations, and OCS operating orders in order to permit more efficient resource recovery with maximum environmental protection.

In response to these program objectives, the environmental investigations of the Alaska OCS Environmental Assessment Program must address scientific objectives (henceforth referred to as Tasks) which are to determine:

A. Contaminant References - Determination of the predevelopment distribution and concentration of potential contaminants commonly associated with oil and gas development.

B. Sources - Determination of the nature and magnitude of contaminant inputs and environmental disturbances that may be assumed to accompany exploration and development on the Alaskan continental shelf.

C. Hazards - Identification and estimation of the potential hazards posed by the environment to petroleum exploration and development.

D. Transport - Determination of the ways in which contaminant discharges move through the environment and how they are altered by physical, chemical and biological processes.

E. Biological Receptors - Determination and characterization of the biological populations and ecological systems that are subject to impact from petroleum exploration and development.

F. Effects - Determination of the effects of contaminants and other insults on individuals, populations, and ecological systems.

1.3 TASKS A-F

A schematic overview of the implementation and integration process utilized in the technical approach of the program is illustrated in Figure 1-2. Information in the forms described later in Section 1.6 (End Products and Deliverables) is necessary for BLM to make their predictive assessment. These end products and information are the output of the six major tasks. To obtain these end products requires the synthesis and integration of a hierarchy of tasks, subtasks, and research units addressing those subtasks. Figure 1-2 shows the interrelationship of research units leading to assessment.

The six tasks and respective subtasks have a natural relationship to one another in the way in which they lead to assessment capability, as suggested by the curving arrow in Figure 1-2. An assessment requires a) a reference value, b) estimation of the nature and magnitude of the contaminant or insult, c) information to set design standards in order to reduce releases and insults, d) ways to calculate the path and modification of released contaminants, e) identification of the biota that will be affected by exposure downstream, and f) the effects on the biota and ecosystem from these exposures.

The six major tasks were originally derived from consideration of the information required. Research units are determined annually for

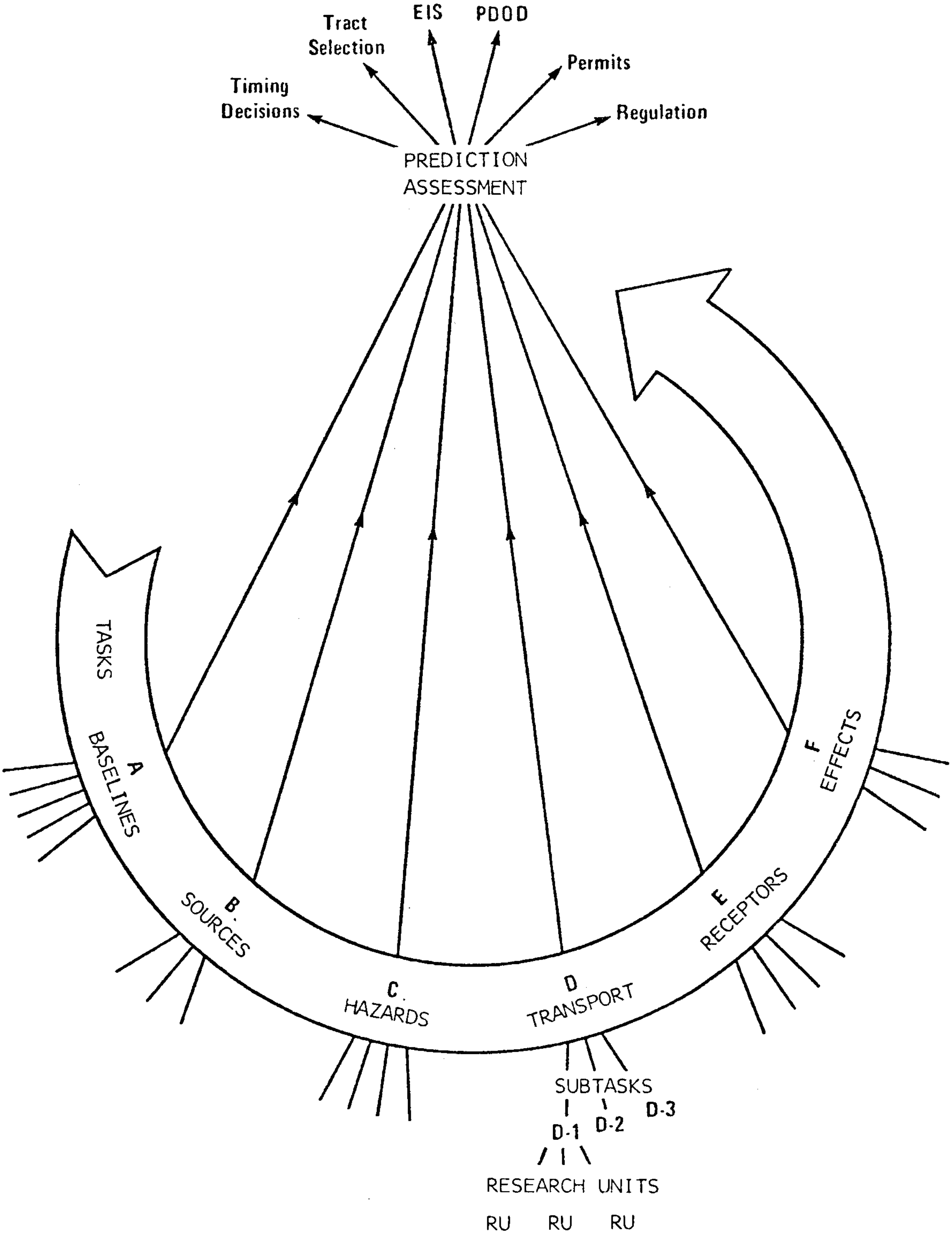


FIGURE 1-2 RELATIONSHIP BETWEEN INDIVIDUAL RESEARCH UNITS (RU) AND THE ASSESSMENT PREDICTION FUNCTION OF BLM. ALSO, THE SEQUENTIAL RELATIONSHIP AMONG THE SIX TASKS, ALL OTHER TASKS FEEDING INTO EFFECTS AND THENCE TO ASSESSMENT.

each lease area according to the special problems of the lease area and existing information. These research units are described in Section 4.0.

The prediction and assessment capability created by the six tasks is an integral part of timing decisions, tract selection process, environmental impact statements, permits, regulations and other management decisions, of the DOI. The following text amplifies the six tasks.

1.3.1 Task A (Contaminants)

The distribution of potential petroleum-related contaminants should be described before further development of petroleum resources; later changes, if any, in a contaminant's concentration or occurrence can then be detected and examined for possible correlation with concurrent ecological changes. The Alaskan research program emphasizes the high-molecular-weight petroleum hydrocarbons and trace metals in each lease area. In addition, it determines the ambient concentrations and distribution of light hydrocarbons and explores the feasibility of using C_1-C_4 concentrations as a monitoring indicator of hydrocarbon contamination. Inorganic nutrients are being measured only to the extent necessary to evaluate reconnaissance of microbial populations and planktonic primary production.

The contaminant studies are essentially complete. Future chemistry efforts will be concentrated on processes controlling contaminant distribution and modifications. Some site-specific surveys may be conducted where planned facilities are to be located.

1.3.2 Task B (Sources)

To guide the studies undertaken in succeeding phases of the Alaskan OCS program, a general understanding of the nature and magnitude of potential contaminants and environmental disturbances is required. It is necessary for program planning to obtain and continually update estimates of the location, nature, and timing of platform, pipeline, and facility development in each lease area, to estimate the quantity and physical and chemical nature of contaminants from each potential source, and to estimate the nature and amount of possible environmental disturbance likely to accompany development.

The data required in this task will be furnished to NOAA by BLM in a timely manner, or contracted for with BLM approval.

1.3.3 Task C (Hazards)

It is important to identify environmental hazards early in the decision-making process. Such information can be used by the Department of the Interior: (1) to determine which OCS areas are less environmentally hazardous than others and thus contribute to a risk/benefit analysis of areas to be leased; (2) to exclude particular tracts from leasing; and (3) to develop appropriate OCS orders, regulations, and stipulations to control the safety of energy development on the shelf. Consequently, hazard studies receive priority emphasis early in the program.

The approach is to achieve an initial broad regional understanding of the geologic, ice, and oceanographic hazards that might affect development. In subsequent studies, the level of detail will be increased with the objective of quantifying the particular risks of specific proposed actions. Geographically, the progression is (1) regional reconnaissance of the entire lease area, (2) more detailed studies of the lease area to enable tract hazard evaluations, and (3) studies related to hazards in oil transport corridors.

1.3.4 Task D (Transport)

In order to relate or "connect" the oil (or other contaminant) released from operations with the effects on the environment, an assessment must contain the trajectory, dilution, and changes in composition of the oil along the pathway. These items are treated in transport studies, which include winds, water currents, ice movement, mixing and weathering.

1.3.5 TASK E (Receptors)

A major incentive for conducting studies of biological populations is to determine which populations, communities, and ecosystems are at risk from either acute or chronic impacts. Estimates of the distribution and abundance, migration, feeding sites, and behavior of populations are among the first studies undertaken to establish potential vulnerability. At a later stage, the locations of the populations at each life-stage and activity are related to predicted paths of petroleum and incidence of disturbance to determine whether risk may exist. Further, the criteria of uniqueness, importance to the ecosystem, sensitivity, and aesthetic considerations must be examined to define a species or community fully, and to assess the significance of the effects from the potential impacts. When vulnerability is indicated, detailed site-specific studies will be undertaken to focus on processes, positions in food webs, population dynamics, sensitivity to disturbance, ability to recover from disturbances, mobility, habitat dependence, feeding dependence, and physiological characteristics. The latter involve studies of the direct effects of hydrocarbons, trace elements, and sediment characteristics on the physiology and behavior of target organisms (Task F). Also used in the design of biological studies is the information obtained in the biological baseline studies on habitat dependence and population dynamics.

1.3.6 Task F (Effects)

Knowledge of the effects of petroleum on marine organisms is an essential ingredient in the environmental assessment process. The OCSEAP will attempt to determine the deleterious effects of petroleum exposure and the threshold concentrations causing these effects. The initial studies use acute toxicity exposures in order to better define the more susceptible species and mechanisms, and thus provide input to the design of more realistic studies using chronic exposures levels. The laboratory efforts are addressed in the non-site-specific TDP.

This approach is limited, however, in that controlled laboratory conditions and real field conditions are dissimilar, and there is much uncertainty about the interaction of added stress from contaminant exposure with other biological/ecological stresses, such as those associated with reproduction, growth, and predation (including fishing pressure by man). Once the most important species of the marine ecosystem have been surveyed for lethal and sublethal effects of contaminant exposure, tests will be made for applicability of the results to a field situation through the use of controlled perturbation experiments.

The controlled perturbations studies will include not only oil spills but also noise and other disturbance experiments. These controlled studies, designed to have no lasting effects on the environment, are essential to verify the results obtained from the laboratory effects studies, and to verify the impact models obtained from the ecological process studies. Until such verification is accomplished, confidence in assessments will be low.

Of course, knowledge of effects on the individual organism provides only a part of requirements for assessing effects on the environment. Knowledge is also needed about the relationship between the individual of a species and his species population, and between the species and its environment. Impacts from oil and gas development are selective in their points of interaction ("pressure points"), and certain species and processes in the environment are more vulnerable and more important with regard to whether or not the ecosystem can tolerate the pressure. These species and processes are selected for study in "ecological process studies". The Ecological Process Studies that address these issues are classified as effects studies.

1.4 END PRODUCTS AND DELIVERABLES

The OCSEAP studies are designed and managed to provide in a timely manner products that are directly and immediately applicable to BLM needs for prediction, assessment, stipulation, and regulation. These products are identifiable both within the reports routinely submitted by investigators, and as separate volumes, operational capabilities, and items "on the shelf" but on call. Identifiable products from these studies include:

- Models
  - a. For calculating oil transport on water, including vertical mixing, evaporation, weathering, biodegradation, and dispersion. This model permits the transition from an oil spill to the prediction of characteristics and concentration of oil exposing biota downstream.
  - b. For changes in wind with distance from mountainous shore lines, for use in calculating oil transport on water.
  - c. Of oil transport in ice-covered areas. Oil moves both in leads and with the ice when trapped beneath it. The ice movement differs from that of the water currents, so special models are needed for ice conditions.
  - d. For estimating and quantifying biological damage. These models can be used in tandem with the transport models to obtain assessments.
  - e. Of processes in ecosystems and the relationship between species, used for assessing and predicting impacts from released oil and recovery rates.
  - f. Of the modification of permafrost by man's activities. These models make it possible to estimate the hazards of permafrost to OCS development.
  - g. Of ice strength and movement, for use in letting permits and in judging industry technology.

- Maps and Charts
  - a. Of sediment character and stability, potential slump areas, etc., for use in selecting tracts and in specifying further studies needed in advance of permits.

b. Of earthquake epicenters and of faults, active and inactive, for the same purposes as above.

c. Of permafrost distribution, for the same purpose as above.

d. Of location, character, and movement of sea ice.

e. Of biological parameters, including food and nutrient distribution, habitats, migratory routes, spawning areas, mortality, major colonies and hauling grounds, seasonal distributions of threatened, endangered and commercial species, and others, for the purpose of selecting sites and assessing impacts, and for design of monitoring programs.

f. Of ocean currents, for use in predicting oil transport through the use of models and for use in determining passive migration of plankton and juvenile fish through the lease area.

g. Of petroleum, toxic compounds, and metal distributions in the water column, biota, and sediments, for use as references for future assessment of effects.

h. Of possible sources of oil in the environment for use in assessing impact and designing monitoring programs.

i. Of sea floor topography.

- Statistical Probability Distributions

a. For wave heights.

b. For storm surges, for use in facility siting and for estimating transport of marine oil onto the land.

c. For depth and frequency of ice gouging in prospective pipeline corridors.

d. For wind speed, including extreme winds.

e. Of usual climatological parameters, for use in planning operations and siting.

f. Of atmospheric stability, for use in assessing air pollution from oil and gas development.

g. Of effects on different species from different hydrocarbons and metals associated with oil and gas development, for use in setting standards for concentrations and in regulating sources.

h. Of types and incidence of mortality and disease in biota, for later use as background information when monitoring the effects of production.

i. Of ice forces.

- Data Sources and Collations

  a. Of data that should be digitized in standard format. These data will be available for future analysis to meet BLM needs as yet unidentified.

  b. Of data that should not be digitized, but which will be kept in raw form or in smoothed form according to its nature, to meet future BLM needs.

  c. Of biological and physical specimens, for future use in verifying conclusions of investigators, for use in possible legal actions and in obtaining new chemical analyses.

- Data Summaries and Collations

  a. Collected, summarized, graphed, and plotted data, sometimes subjected to statistical analysis and smoothing, for use in DEIS, FEIS, PDOD, permitting, etc.

  b. Special data products or presentations on request to BLM, such as required input to impact assessment computer models and data syntheses reports.

- Engineering Input Data

  a. Strength, location, movement, and character of sea ice useful for judging the adequacy of the design submitted by industry and for setting stipulations.

b. Depths and frequencies of bottom gouging by sea ice for input to pipeline specifications.

c. Properties of permafrost drilling cores.

1.5 STUDY SEQUENCE, TYPICAL LEASE AREA

The sequence of study progression in the Alaskan program reflects the BLM concepts of baseline, special studies, and monitoring as three program elements. In Figure 1-3, these three elements are posed in six Tasks A-F and portrayed against the time scale for a typical lease area. Development scenarios that provide understanding of the nature and magnitude of potential contaminants and environmental disturbances, to be updated and supplied by BLM periodically under Task B, may produce modifications to the current plan of studies in any lease area.

Figure 1-3 shows the time progression of the program keyed to BLM needs. It also shows a continuing program in the lease area throughout the production phase (1) to provide information for identification and regulation of effects from the production resulting from the first sale, and (2) for assessments in advance of successive sales in the same lease area. It is recognized that the information needed for impact statements, tract selection, and permits for exploratory drilling is, in many aspects, different from that needed to regulate production activities. In general, during exploration, local effects are transient, and, unless the habitat is altered, ecosystems will return approximately to their original state after the local disturbance is removed. Therefore, in advance of leasing and exploratory drilling, BLM will require:

1. Enough information on the distribution, dynamics and interdependence of biota to be assured that the particular sites to be leased and developed are not critical habitats or do not contribute substantially to the survival of a population (such as a principal spawning ground or food source).

2. Enough information to identify geological hazards to structures so that hazardous tracts may be identified and licensing and regulatory agencies can assess the adequacy of the industry designs and plans for platform foundations, blowout preventers, etc.
3. Enough knowledge of wave, wind, and ice so that rig and platform design can be evaluated.
4. Enough knowledge of trajectory pathways so that, for hypothetical blowouts or other large spills, the hazard to specific habitats at some distance can be assessed.
5. Enough knowledge of vertical mixing, oil behavior and interaction with suspended and bottom sediments to predict the characteristics of contaminant plumes at a distance, and to predict the extent of exposure to biota throughout the water column along the trajectory.

Development and production activities present somewhat different circumstances to be evaluated. Local effects from development activities, construction and operation of pipelines and facilities, acute effects from accidents at well sites, and chronic effects from lesser environmental concentrations of oil and other contaminants over long production periods must be assessed.

Therefore, for assessments in advance of development, BLM requires the following additional information:

1. Identification of "critical" habitats between individual wells and potential gathering and loading points, as well as of habitats onshore, so that alternate routes and sites can be found, as necessary. "Critical" is a relative term and somewhat subjective as it is based upon the best scientific opinion relative to the following considerations: a) sensitivity to impact relative to other habitats; b) rate of recovery once impact is removed; and c) status as to requirements for maintaining populations of economic or esthetic species, or of rare or endangered species.

2. Storm surge and wave data in the area of shore facilities.
3. Chronic physiological and behavioral effects levels for important species possibly reached by source plumes from the production area. (Acute toxicity levels give a preliminary estimate of the maximum limits for chronic toxicities; thus acute toxicity research precedes chronic effects research.)
4. Identification of all "important" species within reach of development impact: threatened, endangered, and commercial species; those species present in the foodchain of the preceding species; those providing cover or serving other beneficial purpose; those having aesthetic value; and those playing significant roles in important ecosystems.
5. Knowledge of the ecosystem and of the population dynamics of each important species, for assessing the significant effects that changes in particular populations might have on the rest of the environment and on man.
6. Sufficient data on pre-production concentrations of oil, trace metals, and other potential pollutants in the biota and their environment so as to provide a perspective or context for viewing concentrations after production begins.
7. An understanding of source, transport and uptake, so that regulatory agencies can predict what concentrations are to be expected and develop an appropriate and economic monitoring program.

Thus, preliminary information from studies that are still incomplete may be sufficient to proceed with exploration, provided that the decision is reversible should later results from the environmental studies show the decision unwise. More complete study results with higher confidence levels are necessary for assessment of the production phase. Further assessment in advance of successive sales in the same lease area will benefit from data derived from continuing study and monitoring effort following the first sale. With successive sales, the total impact in an area will increase, and refinement of earlier gross estimates of effects will be essential.

The study sequence calls for a survey of contaminants (Task A) and biological elements (Task E) to be commenced as soon as possible. The results of the survey studies are to be used both as reference for the future and as input to design of site-specific studies and specific ecosystem studies. These specific studies are determined after information is available on the probable location of impact from oil and gas development, as obtained from the EIS, sale, and input from Task B. Also needed in the design of ecological studies is the information obtained in the biological reference studies on habitat dependence and population dynamics (Task E).

Task C on hazards is emphasized very early in each lease area since the output is critical to the choice of tracts, to stipulations on drilling and production, and to siting and design of facilities. Ice nearshore is studied first because technology still needs to be developed for oil drilling in pack ice.

In order to provide data for BLM to assess probable impacts, the program requires source term information (Task B), transport data such as winds and currents (Task D), and data on effects (Task F). Initially the transport studies are conducted offshore to provide a context and boundary conditions for the later mesoscale and inshore work. Addition of inshore work is much more difficult and calls for a different combination of size and nature of platforms. The biological program also tends toward more emphasis on the inshore areas with time, although this is not shown explicitly on the figure.

The effects studies (Task F) consist of both laboratory and field work. The initial studies use acute toxicity exposures in order to better define the more susceptible species and mechanisms and thus give input to design of more realistic studies using chronic effects level exposures. The effects field work is of two types: ecological process studies and controlled perturbation experiments.

The ecological process studies are conducted using representative lease area ecosystems. They are designed to understand the impact resulting from the insults and perturbations caused by oil and gas development (these are not complete ecosystem studies, but are tailored according to the expected insults from the development). Both the ecosystem and the insults vary within and among lease areas, so that if funding permits there will be one or more of these studies for each lease area. Figure 1-3 shows a transition from emphasis on location of critical habitats toward emphasis on understanding effects on the scale of entire lease areas.

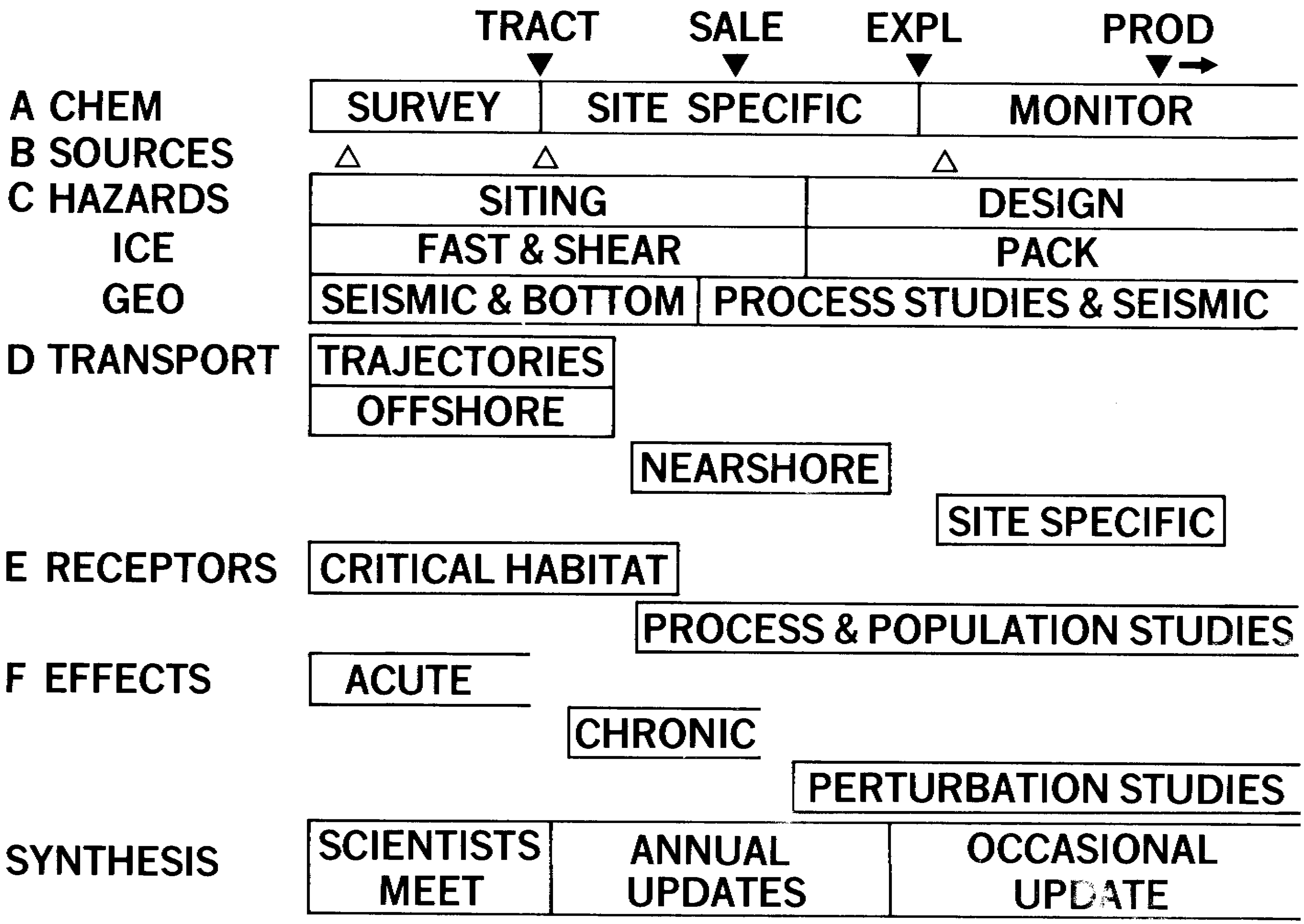

TRACT
SALE
EXPL
PROD
A CHEM
B SOURCES
C HAZARDS
ICE
GEO
D TRANSPORT
E RECEPTORS
F EFFECTS
SYNTHESIS
SURVEY
SITE SPECIFIC
MONITOR
SITING
DESIGN
FAST & SHEAR
PACK
SEISMIC & BOTTOM
PROCESS STUDIES & SEISMIC
TRAJECTORIES
OFFSHORE
NEARSHORE
SITE SPECIFIC
CRITICAL HABITAT
PROCESS & POPULATION STUDIES
ACUTE
CHRONIC
PERTURBATION STUDIES
SCIENTISTS MEET
ANNUAL UPDATES
OCCASIONAL UPDATE

Figure 1-3.

2.0 RATIONALE FOR ALASKA EFFORT

2.1 ALASKAN OVERVIEW

2.1.1 Introduction

The Alaskan OCS region can be divided into three natural geographic areas: the Beaufort and Chukchi Seas; the Bering Sea; and the Gulf of Alaska, including Lower Cook Inlet, the Alaskan Peninsula, and the Aleutian Islands. Ice and its temporal fluctuations are the dominant feature governing environmental processes and levels of biological activity in the Beaufort and Chukchi Seas. Physical processes over the extensive shallow Bering Sea shelf are governed by a seasonal ice pack, intrusions of warm Pacific Ocean water and weak, fluctuating circulation patterns. These conditions foster high biological production and make the Bering Sea one of the world's leading fishery regions.

The dominant environmental features in the Gulf of Alaska are the high seismic activity throughout the area and the strong cyclonic oceanic circulation along the shelf break with highly variable and weak circulation over a relatively narrow shelf. This region is characterized by a subarctic climate which leaves the waters ice-free with the exception of certain inshore waters such as Cook Inlet. This latter area is a large tidal estuary and has features which differentiate it from the remainder of the Gulf of Alaska (such as significant fresh water input, a heavy suspended sediment load, and high turbidity). Since each of these three geographic areas has different environmental mechanisms governing the ecological processes, the research emphasis varies from one to the other.

The material to follow will present the major highlights and rationale for past, present, and projected OCSEAP-sponsored research on the major tasks identified in Section 1.5. Studies are described separately within each of the three regions discussed above whenever it is felt that this will add to the clarity of the material. More detailed presentations of the status of knowledge and research priorities for specific lease areas within each of these three regions are given in Section 3.

2.1.2 Contaminants

The OCSEAP chemistry effort began in FY 75 as a program in the NEGOA lease area intended to establish pre-development light and heavy hydrocarbon and trace metal concentrations. In FY 76 the southern Bering and Beaufort Sea areas were added to the program. In FY 77 the chemistry program was further expanded to include the Lower Cook Inlet, Norton Sound and Chukchi Sea lease areas.

The initial programs in the NEGOA and southern Bering Sea involved extensive sampling along carefully designed station grids in an attempt to determine hydrocarbon and trace metal baseline concentrations. The addition of new lease areas to the program as well as large natural and analytical variability resulted in the replacement of the baseline concept with that of a reconnaissance program. This modified program emphasis, employed in the latter part of FY 76 and in FY 77, attempted to provide a broad-scale description of potential contaminant levels in the lease areas of concern. Hydrocarbon concentrations observed during the reconnaissance effort in Alaska were generally lower than in other OCS areas elsewhere and reflected the essentially undeveloped nature of the Alaskan coastal zone. Trace metal concentrations in offshore waters were about the same as open ocean mean concentrations. Concentrations in Alaskan coastal waters were not higher than in other coastal OCS areas.

During the planning for FY 78 contaminant studies, it became obvious that continuation of the reconnaissance program would not significantly improve understanding of OCS chemical problems. Therefore, in FY 78 the reconnaissance program was directed toward addressing a few large information gaps, including hydrocarbon and trace metal analyses of Beaufort Sea biota and sediment hydrocarbon analyses in the Kodiak and Norton Sound areas. A significant portion of the FY 78 chemistry program is directed toward process-oriented studies designed to give insight into the processes that control the distribution of hydrocarbons in the Alaskan OCS. Such studies yield information of predictive value and provide a framework for interpreting concentrations. Studies designed for FY 78 will provide information on diel and seasonal variability of hydrocarbon and trace metal contents of water, biota, and sediments of Lower Cook Inlet in relation to either microbial activity and high biologic productivity (Kachemak Bay) or microbial activity and exposure to petroleum production activities (Redoubt Bay). This effort will continue in FY 79.

The first chemistry program review was held in September 1977. The review committee endorsed the concept of process-oriented studies. The committee also questioned the need for continued inclusion of trace metal analysis in the program, since injection of metals from drilling materials or oil was at most a localized problem. The negative results obtained from other research projects seeking metals released from oil-impacted sediments also argued strongly for a cessation of trace metal work. Consequently, trace metal analyses will not be conducted after FY 78.

The FY 79 chemistry program is designed to provide greater understanding of the processes controlling hydrocarbon distribution and weathering. Three major projects are planned:

1. Continuation of the Lower Cook Inlet studies initiated in FY 78. These studies will give some insight into the impact of biological activity and petroleum production of hydrocarbon content of water, sediments, and biota.
2. Study of the Norton Sound hydrocarbon seep. The composition of the hydrocarbons escaping from the seep will be determined, and subsequent dispersal and weathering will be documented.
3. Small, contained oil spills will be conducted out of doors. These experiments will allow quantification of hydrocarbon weathering processes under nearly natural conditions.

The chemistry program beyond FY 79 will continue to emphasize site-specific field investigations (specific areas of exploration and production, activities, hydrocarbon sources such as seeps, spills, and chronic discharge) and field weathering and dispersal studies.

2.1.3 Hazard Assessment

Proper assessment and understanding of environmental hazards are important before and after leasing. Such information is used by the Department of the Interior to determine which OCS areas are more environmentally hazardous than others, to exclude particular tracts from leasing, and to develop appropriate OCS orders, regulations, and stipulations to control the safety of petroleum development on the shelf.

Geologic hazards to petroleum-related operations in the arctic and subarctic Alaska waters center around seismicity, surface and near-surface faulting, sediment instability, erosion and deposition, subsea permafrost, ice forces and gouging, stratigraphic hazards, and severe meteorological and oceanographic events.

Many of the hazards present in Alaskan lease areas also occur in other shelf areas of the United States. However, in Alaska these problems are unique in terms of both severity and complexity. A knowledge of the nature, frequency, and intensity of severe environmental events is essential since the greatest hazards to production-related structures and activities as well as the greatest effect on the environment will more than likely occur in conjunction with environmental extremes.

The nature of the major environmental hazards to OCS development, and consequently to OCSEAP research emphasis, differs from one OCS region to another. For example, in the Gulf of Alaska seismicity and related events present the dominant natural environmental hazards. In the Bering Sea seismicity is less important, the major risks being associated with faulting, sediment instability, and ice (the latter limited to Norton Sound). In Arctic OCS areas sea ice and sub-sea permafrost present the greatest hazards.

In the planned OCSEAP study sequence the initial approach has been to achieve a broad regional understanding of the geologic, ice, and oceanographic hazards that might affect development. In subsequent studies, the level of detail is increased with the objective of quantifying the particular risks of specific proposed actions. In terms of spatial resolution, the progression is (1) regional reconnaissance of the entire lease area, (2) more detailed studies of the lease area to enable tract hazard evaluations, and (3) studies related to hazards in oil transport corridors, and (4) topical studies of processes and causal factors to improve predictive capabilities.

Gulf of Alaska

Earthquakes and related events represent the most serious natural hazard to OCS development in any of the Gulf of Alaska lease areas. Alaska is one of the world's most seismically active regions, with most earthquakes occurring along a narrow arcuate strip extending from Prince William Sound to the western tip of the Aleutian Islands. All lease areas proposed for the Gulf of Alaska lie within this zone.

Earthquakes resulting from regional or local uplift, subsidence, or tilting may damage facilities directly and may create secondary impacts, such as tsunamis and sediment failure, which can have catastrophic consequences. In the Alaskan areas, volcanic activity such as that of Mt. Augustine in Cook Inlet, may be of particular local importance. The severity of earthquakes resulting from crustal movement is difficult to predict. The knowledge of deformational character is highly variable; seafloor fault breaks, broad crustal warping, and seismic sea waves have characteristics that commonly are unique to specific areas.

OCSEAP-sponsored seismic studies in the Gulf of Alaska, as in other Alaskan OCS areas, have consisted of two phases: (1) a historical summary of all reported Alaskan earthquake epicenters from the late 19th century to the inception of OCSEAP studies and (2) ongoing specific regional field programs to supplement the historical seismic data base by providing additional information on the locations, magnitudes and recurrence rates of all significant earthquakes and their relationship to active onshore and offshore faulting.

OCSEAP-sponsored seismic field studies in the Gulf began in FY 75 and 76 as supplements to existing studies being funded by other agencies. For example, in the NEGOA, OCSEAP is directly funding a portion of the seismograph work in an ongoing USGS study employing a land-based network of seismograph stations.

In the Western Gulf of Alaska the OCSEAP effort is a part of a combined DOE-NOAA study of the seismotectonics of the Alaska Peninsula and Aleutian chain. The OCSEAP funding has permitted the extension of the seismic network to give better coverage of the Gulf of Alaska and Bering Sea continental shelves.

The major objective of the seismic studies program is to determine a probability scale for earthquake hazards with reference to petroleum exploration and development. A requisite for accomplishing this objective is the improvement of the statistical reliability of the existing data base through continuation of present observational programs and the use of additional or improved instrumentation, such as ocean bottom seismometers (OBS) and strong-motion accelerometers. In recognition of this long-term need, OCSEAP has adopted the philosophy that seismic field studies will receive strong support in the Gulf of Alaska (including those lease areas that no longer appear on the OCS Planning Schedule) throughout the lifetime of the program.

A potential improvement in the FY 78 NEGOA program is the inclusion of several OBS units to improve resolution of centers offshore thus decreasing the observation time required to generate statistically reliable location and recurrence estimates. Unfortunately, all the seismic studies conducted to date have resulted in a predictive capability with an uncertainty that is no smaller than the expected lifetime of OCS activity. Significant reduction of this uncertainty will require the routine detection of smaller earthquakes than has been possible in the past. Even with improved earthquake detection methods, a serious information gap continues to exist insofar as actual ground motion is concerned. It is therefore anticipated that the OCSEAP-sponsored seismic effort in FY 79 and beyond will show an increased emphasis toward the use of bottom-mounted seismometers and determination of ground motion associated with major events. The latter will permit the spatial correlation of earthquake magnitude and the actual ground motions that OCS-related structures will be required to withstand.

In addition to seismic activity are natural hazards resulting from volcanism, faulting, sediment instabilities, and seismic sea waves. In the western Gulf of Alaska volcanism presents a significant environmental hazard. The Aleutian, Kodiak, and Lower Cook Inlet lease areas contain a chain of active and potentially active volcanos extending along the Alaska Peninsula. Consequently, volcanism studies have been, and will continue to be, integral parts of the seismic programs in these lease areas. These studies emphasize improved characterization of eruptive styles, ejecta composition and ranges of influence, and estimates of recurrence rates. The major objective of the volcanism program is the generation of reliable volcanic risk maps that describe the nature of the hazards associated with particular volcanos, the spatial distribution of these hazards and the probable recurrence rates. An ultimate goal is the development of a geophysical monitoring and warning system, primarily through a strengthening of the existing seismic net. As in the case of seismicity, volcanism is a dynamic phenomenon with major events occurring at large time scales. Therefore, the OCSEAP effort is again guided by the rationale that studies should be of the maximum duration practicable and that future emphasis should be placed on the utilization of additional and more sensitive instrumentation (e.g., OBS units) to improve the capability of making useful predictions with the data base realistically achievable. A shortcoming of the current seismicity/volcanism program is an inadequate level of coordination among seismicity studies performed by different institutions. During FY 78, OCSEAP and the appropriate geological investigators will devise a coordinated plan for instrument calibration and reporting, which will be reflected in the FY 79 field program.

Shallow faulting, sediment instability, and erosion/deposition constitute significant potential threats to safe OCS petroleum development. The Gulf of Alaska is tectonically complex, and numerous faults have been identified, most notably in the NEGOA and Kodiak lease areas. Fewer faults have been found in Lower Cook Inlet, and the Aleutian lease area is yet to be investigated. Some of these faults may be active, and displacements can affect man-made structures, such as drilling platforms, drill casings, and pipelines. Further hazards in the Gulf of Alaska are associated with sediment instability. High rates of sedimentation of fluvial and glacial outwash materials occur along parts of the coast (e.g., the Icy Bay and Copper River Delta regions of NEGOA), producing large unconsolidated sediment deposits. Some of these deposits have undergone extensive slumping and others have been identified as potentially unstable. Slumping may be triggered by low magnitude earthquakes resulting from fault movement.

The likelihood of sediment failure actually occurring in areas identified as potentally unstable can be evaluated only by studies of the sediment geotechnical properties. For example, slumping that has occurred in an area will result in a sediment mass that is either more stable now as a result of slumping, or less stable, depending on the amount of water incorporated, the degree of consolidation, and style of movement. Knowledge of the geotechnical properties of sediment in critical areas was identified as a major information gap at the geology program review held Jan 31-Feb 3, 1978 in Menlo Park. OCSEAP plans to initiate studies of this type beginning in FY 79.

As described earlier in the general hazards study sequence, OCSEAP shelf faulting and sedimentation studies first seek a regional description of potential hazards so that environmental risks can be minimized, either by outright avoidance or by appropriate regulation of facilities. Certain features identified as potentially troublesome during the regional reconnaissance of the lease area are selected for further detailed study. Nominally the reconnaissance phase constitutes about a two-year effort, with focused studies of special problems taking an additional two years (these time estimates are approximate and vary with the lease area size and the specific nature of the hazards identified).

OCSEAP-funded shelf faulting and sedimentation studies in the Gulf of Alaska began in FY 76 in the NEGOA, Lower Cook Inlet, and Kodiak lease areas. The NEGOA study, begun the previous year by the USGS, has produced basic information at a tract-specific level on the geologic hazards of the area, including the location of probable active faults, potentially unstable sediments and areas of erosion and deposition on the shelf. This information has had a significant influence on tract selection, stipulations and drilling regulations in NEGOA. The work is being continued in FY 79 in response to BLM's request to gather additional tract-specific hazards information to the west of Kayak Island in preparation for the second NEGOA sale currently scheduled for mid-1980.

Reconnaissance geological and geophysical surveys conducted in 1976 over the outer continental shelves of Lower Cook Inlet and Kodiak Island identified, on a regional scale, potential seafloor hazards due to faulting, slumping, erosion, deposition, and large scale bedform movement. Detailed studies of specific problems, such as large fault zones on the Kodiak Shelf, possible weak volcanic sediments in the troughs that cut the Kodiak shelf, and large-scale bedforms in Lower Cook Inlet, were begun in 1977 and will continue into FY 79, with the focus on improved mapping and age determinations on surface and near-surface faults on the Kodiak shelf and areas of sediment instability on both the Kodiak and Lower Cook Inlet shelves.

Shelf faulting and sedimentation studies have not been conducted in the Aleutian lease area. The January 1977 OCS Planning Schedule showed a December 1980 Aleutian sale date, but by August 1977 this lease area had been removed from the leasing schedule. In FY 78 the level of OCSEAP effort was low in response to the new OCS schedule. It is anticipated that a very modest research program with limited objectives will continue in the Aleutian lease area over the next few years. Only studies with long-term applicability and requiring long lead time are being conducted at this time. Hazards studies are presently restricted to OCSEAP's long-term support of seismicity/volcanism research in this region. If leasing does not occur before 1982, as is indicated on the current OCS Planning Schedule, initiation of faulting and sedimentation studies in FY 80 will still allow adequate lead time.

Extreme oceanic and meteorological events, such as high wind waves, storm surges, tsunamis, and severe storms pose hazards to offshore structures, shipping and coastal facilities. OCSEAP-sponsored studies of oceanic and meteorological hazards in the Gulf of Alaska are included in a synthesis of existing data and literature in the form of a climatic atlas of the entire Alaskan coastal region recently completed by the Arctic Environmental Information and Data Center and the National Climatic Center. This atlas summarized the present knowledge of marine and coastal climatology in the Gulf of Alaska, the Bering Sea, and the Beaufort/Chukchi Seas. Information includes statistics (means, extremes and recurrence rates) of such parameters as wind speed, wave height, and storm surges. More detailed studies of severe storm hazards are planned for FY 79 and will include prediction of types and frequencies of extreme storms and storm tracks associated with hindcasts and pack ice response.

Bering Sea

The Bering Sea contains the Bristol Bay and St. George Basin lease areas in its southern part and the Norton Sound area to the north (Figure 1-1). The June 1975 Proposed OCS Planning Schedule showed a first generation Bristol Bay sale at the end of 1977. On the January 1977 schedule Bristol Bay no longer appeared and on the most recent (August 1977) schedule St. George Basin has also been removed. As a result of the changing leasing priorities and the OCSEAP budget reductions over the last two years, the allocated FY 79 funding levels in St. George Basin and Bristol Bay are approximately 40 percent and 10 percent of their respective FY 77 values. The funding reduction in Bristol Bay is the largest of any of the Alaskan OCS areas and reflects in part the lack of a substantial geohazards program, which would normally continue to receive strong support even in the face of budget reductions and a postponed leasing schedule.

With the exception of sea ice distribution, there do not appear to be major geologic or oceanographic hazards in Bristol Bay. Seismic activity is low and no tsunamis or strong storm surges have been reported. Bottom faulting and sediment stability investigations have not been undertaken, however. Assuming that the present Proposed OCS Planning Schedule for Bristol Bay is not changed, these studies, along with ice investigations, can be initiated in FY 80 with sufficient lead time to influence decisions to be made in 1982 or beyond.

Earthquakes and faulting are potential hazards to OCS development in St. George Basin. Seismicity is being monitored coincidentally with the instrumentation from the Aleutian Islands and Alaskan Peninsula described earlier. To date, however, reliable epicenter location has not been possible, since the region contains only one monitoring station north of the Aleutian Islands. OCSEAP is currently evaluating the necessity and feasibility of additional stations. Reconnaissance level seafloor hazards studies, initiated in FY 76, have confirmed the existence of numerous faults and extensive areas of slope instability near the shelf edge. This work is not being continued in FY 79, the rationale being (1) the low leasing priority, (2) the fact that two years of reconnaissance data will have been synthesized by the end of FY 78, and (3) identified regions of seafloor instability have been located on the continental slope but not within the St. George lease area.

Norton Sound is the only Bering Sea lease area remaining on the August 1977 Proposed OCS Planning Schedule. It is also the last of all the Alaskan lease areas presently scheduled for sale (December 1981). Assuming that this schedule is maintained, the results of FY 79 and FY 80 field studies will be available in time to contribute significantly to the EIS.

Marine geological and geophysical reconnaissance surveys conducted through fiscal year 1976 have identified several potential seafloor hazards in Norton Sound, including surface and nearsurface faults, ice gouging, bottom current scour, and gas-charged sediments. Detailed studies of these phenomena were begun in FY 77 and will continue into 1979. These studies will provide critical information for determining the age of recent faulting, recurrence rates and depth of ice gouging, mobility of large bedforms, and stability of gas-charged sediments.

Complex surface processes of the Yukon-Kuskokwim delta region also pose potential hazards and environmental impact problems to onshore development that may occur there in conjunction with offshore oil and gas activity in the northern Bering Sea. These problems include rapidly shifting coastlines and stream channels, permafrost, major flooding associated with breakup, storm-surge erosion, shorefast ice, faulting, and possible volcanism. By the end of the FY 78 field season, sufficient data on such processes will have been generated to define, for the present need, the general nature and distribution of these hazards and to evaluate their implications for siting of onshore processing and transportation facilities. Efforts in FY 79 will be devoted to final data processing and preparation of reports.

Although a first generation Norton Sound sale is not currently scheduled until the end of 1981, it is possible that the recent discovery by OCSEAP investigators of a major submarine oil seep and substantial gas-charged sediments might stimulate sufficient interest that this schedule will be accelerated. In anticipation of this possibility OCSEAP is timing the geohazards studies so that information at a several-tract level of resolution will be available by the end of CY 1980.

Beaufort/Chukchi Sea

The nature of environmental hazards is quite different in the Beaufort and Chukchi Seas from any of the other Alaskan lease areas and therefore the direction and scope of OCSEAP studies there are also different. In the Beaufort and Chukchi Seas sea ice and subsea permafrost are of primary importance. These hazards are so severe that leasing has been restricted so far to a narrow coastal area in relatively safe shorefast ice.

The studies start with a general, area-wide description of these risks and hazards and end several years later (but prior to petroleum development) with specific information on the nature, location and frequency of hazards, with a high level of geographic resolution). Studies of the location and seasonal occurrence of ice hazards, mechanical properties of sea ice, ice gouging, the movement of sea ice and the properties and spatial distribution of subsea permafrost fall within the scope of OCSEAP research.

Sea ice problems dominate the hazards program in the Arctic. No proven technology presently exists for exploration, much less production, in the ice-covered waters outside the shorefast ice zone. On the ocean bottom, ice gouging is a serious hazard to pipelines and structures. Some data exist on areas of occurrence and density and depth of gouging, although less is known about the frequency of occurrence, age of the gouges and the forces involved. In the Beaufort Sea several more years of effort are needed to fill these gaps. In the Chukchi Sea, which is no longer on the Proposed OCS Planning Schedule and where no research activity is taking place at present, it will take longer.

Maps of annually occurring ice hazards on a large scale (satellite mapping) have been completed for both the Beaufort and Chukchi Seas but the mapping of smaller-scale features (ridge occurrence and geometries, floe sizes, leads, etc.) has not gone beyond a fairly broad and cursory classification in both areas. Routine remote-sensing flights by aircraft equipped with side looking airborne radar (SLAR), laser profilometer and cameras must continue to give details of ice features with a greater degree of geographical resolution. On the other hand, a historical look at ice conditions over the last hundred years has been completed.

The major gaps in information, and the ones that are of greatest concern to the petroleum industry and regulatory agencies, are in the area of mechanical properties of sea ice, forces applied by moving ice to structures, and the dynamics of shorefast and pack ice. OCSEAP's efforts in this area are very modest in comparison with the needs for information, particularly for later, offshore leases. While OCSEAP work, in some instances funded jointly with industry, is important and should clearly be continued at the present level until exploration commences, it cannot hope to give answers to even a fraction of the problems that remain to be solved. Most will be solved by the petroleum industry, but OCSEAP's continued involvement is important to safeguard environmental concerns.

In summary, ice hazards in the nearshore area of the present lease sale are being more or less adequately researched by OCSEAP and knowledge of major ice problems, even if it is not very extensive, will exist prior to the joint Federal-State Beaufort sale. The same cannot be said for the pack ice zone outside the present lease area, nor for the area-specific problems in the Chukchi Sea. These can only be tackled in new programs preceding additional lease sales.

Detailed understanding of the horizontal and vertical distribution of permafrost becomes important prior to production, when subsea pipelines have to be installed and drill pipes have to be protected. But it is also important to know some characteristics of subsea permafrost prior to exploration. For example, permafrost poses some limitatons to directional drilling (angle drilling can only commence after the permafrost layer has been penetrated vertically). If critical sea floor habitats are to remain undisturbed, a knowledge of the thickness of permafrost is required to determine if directional drilling can reach below the center of these seafloor habitats.

The initial, expensive drilling and coring program carried out by OCSEAP in the Beaufort Sea has been discontinued. Emphasis is now on quick and cheap jetting techniques (a jet of water delivered by a high speed pump, which allows pipes to be installed tens of meters into the sediments) to measure temperature, salinity, sediment types and depth to the icebonded interface. Modeling continues using these environmental parameters in a joint program with the National Science Foundation. Shallow seismic data, obtained from industry and by OCSEAP field measurements is being analyzed to give a picture of the horizontal and vertical distribution of permafrost on a large scale. These activities will continue at the present level beyond the exploration phase in the Beaufort Sea. In the Chukchi Sea very tentative subsea permafrost investigations have been discontinued until a lease sale is announced.

Although less serious than those posed by ice and permafrost, hazards associated with seismicity and sea floor instability also exist in the Arctic. Sea floor instability is important along the shelfbreak in the Beaufort Sea, well outside the present lease area, and has not yet been addressed as a problem. Seismicity is a potential problem east of the present Beaufort Sea lease area, also not yet addressed by OCSEAP, but it has been studied in the Chukchi Sea where seismicity is considerably higher. At the end of FY 79 a general understanding of the seismicity and major fault features around Seward Peninsula and into Kotzebue Sound will have been attained.

2.1.4 Transport

In an assessment of the potential impact of OCS development on the marine environment, the transport and transformation of petroleum-related contaminants is of key significance. Petroleum or other contaminants introduced into the environment can be transported in the atmosphere, water column and sea ice acting as an intercoupled system. During the transport process, oil and other contaminants undergo continual physical and chemical changes brought about by such processes as evaporation, flocculation, emulsification, weathering, biodegradation, and chemical decomposition.

OCSEAP transport studies are specifically designed to provide data that will enable the Department of the Interior and other agencies to:

- Plan stages and siting of offshore petroleum development to minimize the potential risk to environmentally sensitive areas.
- Provide trajectories, coastal landfall, and impact predictions required for cleanup operations in the event of an oil spill or the introduction of other contaminants, trajectories, coastal landfall, and impact predictions required for cleanup operations.
- Assist in planning the location of long-term environmental monitoring stations in the study area.

Three principal transport (physical) pathways are considered in the OCSEAP effort: water, ice and sediments. Of these, coastal circulation is the dominant transporting mechanism in subarctic regions. However, in the Arctic, ice is expected to provide the most significant pathway for much of the year. Consequently, the transport programs in the Gulf of Alaska and the Beaufort/Chukchi Seas have considerably different emphasis. The relative importance of sediments is currently under investigation. To date, OCSEAP investigators have not included studies of the atmosphere as a direct contaminant pathway, but rather as the principal driving mechanism for oceanic transport.

Gulf of Alaska

Oceanographic investigations in the Gulf of Alaska have been carried out sporadically for the past half century, with an increased intensity during the last twenty years. Most studies have been conducted in the open ocean during summer months. Existing knowledge has been limited to a description of the large-scale circulation patterns, based almost exclusively upon aperiodic, widely-spaced hydrographic data. Such information does not provide adequate insight into the smaller scale circulation features active on the continental shelf and responsible for the coastal transport of contaminants.

Prior to OCSEAP, no systematic physical oceanographic and meteorological studies had been conducted on the Gulf of Alaska continental shelf. Conspicuously absent were long-term direct measurements of coastal currents and winds. OCSEAP transport investigations in the Gulf of Alaska began in FY 75. These studies were designed to proceed sequentially from a regional description of mesoscale oceanographic and meteorological features to an analytical phase of process studies. The various elements of the investigations have included literature summaries, Lagrangian and Eulerian current measurements, hydrographic station data, remote sensing data, and computer models. Meteorological investigations have concentrated on field observations and computer simulation of coastal wind patterns, which, in Alaska, can differ markedly from synoptic geostrophic winds because of the strong effects of coastal orography and land-sea temperature differences.

As the NEGOA was the first OCS area in Alaska to be selected for oil and gas development, OCSEAP study efforts began there in 1975. Between that time and FY 77, studies were concentrated primarily in

NEGOA, with much smaller efforts in the western gulf and Lower Cook Inlet. Leasing in NEGOA occurred in April 1976, with results of OCSEAP transport studies contributing significantly to tract selection. By FY 77 all the previously described transport elements were involved in NEGOA studies.

Since 1977 studies in NEGOA have progressed to a stage where a comprehensive view of the regional oceanography and meteorology is emerging. Areas of probable impingement on the western side of Kayak Island and the entrance to Prince William Sound have been identified through field studies and computer simulation. The NEGOA program in FY 79 and FY 80 will consist of a modest field effort and completion of data analysis for the Kayak Island/Hinchinbrook entrance region, in anticipation of the second NEGOA sale presently scheduled for mid-1980.

FY 77 marked the beginning of the first systematic current measurement program ever conducted around Kodiak Island. These studies were intensified in FY 78 and supplemented with a program of mesoscale surface wind investigations. The FY 78 effort is a part of a larger regional study also containing Lower Cook Inlet and the Alaskan Peninsula.

Practically the entire body of existing information on mesoscale oceanic and atmospheric circulation patterns in the Gulf of Alaska, Bering Sea, and Arctic OCS areas has resulted from OCSEAP research. Prior to OCSEAP no such information existed. Studies in the Gulf of Alaska, as elsewhere, have initially focused on offshore areas with a spatial resolution of some tens of kilometers. The rationale for this offshore rather than nearshore initial emphasis is several-fold. First, as mentioned, no previous transport information existed commensurate with the spatial scale at which many OCS development activities will occur. A possible exception is for the Beaufort Sea, where ice conditions are so formidable that practically all OCS activity will occur in the nearshore. Second, mesoscale studies are necessary to identify potential contaminant impingement areas. Third, smaller-scale, nearshore processes are often driven by mesoscale mechanisms; thus offshore studies can provide necessary boundary information for subsequent inshore projects. Fourth, there has been a general lack of nearshore development scenarios to derive criteria to guide the design and placement of appropriate studies. Fifth, considering budgetary constraints and the amount of coastline included in the present lease areas, substantial nearshore investigations must be justified on the basis of either (1) process-oriented studies in select "model systems" whose dynamics may reasonably be extrapolated to other regions; or (2) the coincidence of an important biological community with either planned nearshore development activities or likely impingement established from previous studies.

Most field activity associated with transport studies in the Gulf of Alaska is being terminated at the end of FY 78. The effort in FY 79 will be devoted almost entirely to data analysis, interpretation and synthesis, and continuation of modeling activities. The modeling effort is expected to have progressed sufficiently to be routinely applied, and for the first time it will have the benefit of oil weathering algorithms and realistic surface wind inputs obtained from other OCSEAP studies.

In FY 79 and beyond, studies of sediments as a contaminant transport mechanism will not focus on obtaining estimates of sediment fluxes, but instead will be directed toward obtaining a more quantitative picture of the processes governing sediment interaction with petroleum. Such field studies will be confined to Lower Cook Inlet and Norton Sound, which can be considered to be natural laboratories in that they have both high suspended sediment loads and existing sources of hydrocarbons.

During the second half of FY 78, a major emphasis of the Gulf of Alaska transport studies program was the beginning of synthesis of all available OCSEAP information on oceanographic and meteorological circulation patterns and processes. The FY 79 effort will be devoted almost exclusively to this task through a collaborative effort among investigators of all relevant studies to summarize what is known about the Gulf of Alaska as a transport system.

Bering Sea

For the most part, the history, present status, and projected future of transport studies in the Bering Sea parallel the situation in the Gulf of Alaska. The Bering Sea effort began in Bristol Bay and St. George Basin in FY 75 as a pioneering program to obtain mesoscale hydrographic and long-term moored current meter data. Prior to this, essentially nothing was known about the energetics and spatial and temporal variability of mesoscale circulation anywhere in the eastern Bering Sea.

A modeling effort was initiated in July-September 1976 and the field program was intensified during FY 77. At the same time studies were also extended into Norton Sound and the Chukchi Sea. This effort produced a milestone set of data, including beneath-the-ice overwintering, from a current meter array moored for nearly a year. During FY 78, the Norton Sound studies were focused more heavily within the Sound itself, a primary objective being the estimation of residence times within the eastern and western portions of the embayment. FY 78 field studies were not conducted in the Chukchi Sea by virtue of its removal from the leasing schedule. For the same reason, and the fact that studies were initiated in FY 75, the field effort was sharply curtailed in the southern Bering Sea during FY 78.

OCSEAP does not plan to continue oceanographic field work in the southern Bering Sea during FY 79. The only field work planned for Norton Sound during FY 79 is the initiation of a coastal meteorology study. The lack of a meteorological field program in the Bering Sea is the one significant difference between OCSEAP-supported studies in this area and from those in the Gulf of Alaska. Since neither Bristol Bay nor St. George Basin appear on the August 1977 Proposed OCS Planning Schedule, meteorological field studies in these regions can be postponed.

Because observations conducted by NOAA suggest that the ice edge may play a dominant role in inducing significant mesoscale departures from geostrophic winds deduced from large scale pressure maps, such investigations are needed in Norton Sound. Proposed initiation of these in FY 79 will provide sufficient lead time for the nominal 2 to 3 year study period required to adequately describe the coastal wind field. As for the Gulf of Alaska, virtually the entire transport effort in the Bering Sea during FY 79 will be synthesis of existing information.

Beaufort/Chukchi Seas

In FY 75 a modest offshore study program was begun in the Beaufort Sea for the purpose of investigating the hydrographic regime and ocean circulation under the ice of the Beaufort Sea continental shelf. Prior to OCSEAP, no such information existed. By the end of FY 78 sufficient information will be in hand to terminate these studies in the offshore areas for the present and concentrate fully on important problems nearshore. This nearshore oceanography program only began in mid-1977 and must cover large existing information gaps on nearshore circulation and transport of sediments, detritus, nutrients and biota, as well as pollutants. The fluxes of these materials characterize and maintain the biota-rich nearshore environment. Their perturbation by offshore development (causeway construction, gravel pits or mining on islands, gravel island construction, etc.) may have major effects on an important segment of the biota in the Beaufort Sea. The nearshore transport studies are a part of an integrated ecological process study involving most of the OCSEAP disciplines.

The dominance of sea ice in the Beaufort and Chukchi Seas has caused the emphasis on transport studies in these areas to differ in two significant aspects from those in any other lease area. First, there is a considerable effort toward a better understanding of ice motion and oil-retention properties, since the ice itself is likely to be a major transport pathway for much of the year. Second, an emphasis on nearshore oceanography has occurred earlier in the Beaufort Sea than in the other lease areas. One reason for this early emergence of nearshore studies is the fact that overwhelming offshore ice hazards will restrict all OCS development activities to the nearshore region for the foreseeable future. Hence a clearer picture of probable nearshore development scenarios is available for the Arctic than for any other lease area.

In the Chukchi Sea, more was known about the large scale physical oceanographic processes than in the Beaufort Sea. OCSEAP has rounded out the picture for the offshore field studies in FY 78. The FY 79 effort will be devoted to data synthesis to complete the regional circulation picture of the northern Bering Sea and Arctic Ocean. A nearshore program has not yet materialized in the Chukchi Sea and awaits announcement of a lease sale.

Transport of pollutants by ice is more important in the Arctic, but also less well known. Large-scale ice drift trajectories have been studied by OCSEAP in both the Beaufort and Chukchi Seas and have contributed to the known picture of the general ice circulation, although year-to-year variations in this drift provide large excursions from the "normal", expected behavior of the ice. These studies were replaced in mid-1978 by a more comprehensive program examining all aspects of the behavior of oil in ice, including the microscale as well as large-scale transport of spilled ice in an ice matrix. This program is expected to continue at least two years.

No specific oil-in-ice program is planned for the Chukchi Sea at present, but results from the Beaufort Sea study can probably be extrapolated to some extent into the Chukchi Sea. Exceptions are the annual ice outbreaks from the Chukchi to the Northern Bering Sea, which are occurrences that do not reflect parallel events in the Beaufort Sea. These outbreaks are important in transporting large volumes of ice, with any pollutants entrapped in the ice, very rapidly over long distances. A sea-ice surveillance radar on Bering Strait has tracked these events for a year now and will continue to do so for another year.

2.1.5 Biological Populations and Ecological Systems at Risk

A major incentive for conducting studies of biological populations is to determine which populations, communities, and ecosystems are at risk from either acute or chronic insults. Estimates of the distribution and abundance, migration, feeding sites, and behavior of populations are among the first studies undertaken to establish potential vulnerability. The further criteria of uniqueness, importance to the ecosystem, sensitivity, and aesthetic considerations must be examined in order to define fully and assess the value of a species or community and the consequences of the insult. When vulnerability is indicated, detailed site-specific studies will be undertaken to focus on processes, trophic and population dynamics, sensitivity to disturbance, habitat dependence, and physiological characteristics. The interrelationships among various components and processes of ecosystems will be increasingly emphasized in site-specific studies.

The first several years of OCSEAP biological studies have generally been concerned with establishing the distribution and abundance of key biological species through "reconnaissance" surveys. For the higher trophic levels these investigations have also had as an objective the identification of critical habitats, migratory routes and principal breeding locations. Much of the required data on abundance, distribution, and timing of important or characteristic species in most lease areas had been obtained by the end of FY 77. Those few reconnaissance studies remaining in FY 78 will not be continued in FY 79. A major shift in emphasis in biological studies away from reconnaissance-level surveys to site-specific ecological studies was initiated in FY 78.

Gulf of Alaska

The shift in emphasis toward process-oriented biological studies is reflected in the design and implementation of two major biological programs in the Gulf of Alaska in FY 78. These studies, conducted in the Kodiak and Lower Cook Inlet lease areas, emphasize environmental factors affecting biological populations and communities and the phenology and ecology of selected species. The studies have as a basic objective the description, analysis and verification of the ecological community structure of selected coastal eocsystems with regard to potential impacts of oil and gas development in the Kodiak Archipelago and Lower Cook Inlet.

A similar study is in the planning stage for the NEGOA lease area; however, it is not clear at present what level of effort the FY 79 and future budgets will allow.

Bering Sea

As in the case of the Chukchi Sea, the OCSEAP support of biological studies in the southern Bering Sea declined sharply between FY 77 and FY 78 as a result of the postponement of sale dates for both Bristol Bay and St. George Basin beyond 1981. However, the importance of the southern Bering Sea as a region of extraordinarily high productivity supporting major fishery resources dictates that a modest level of biological research be continued.

One of the major tasks addressed at the Salishan workshop on the Bering Sea Ecological Processes Study (October 3-6, 1976) was conceptualization of process-oriented studies and initial data needed to develop a modeling approach to most closely fit OCSEAP objectives. Such a scheme should be designed to provide tools for an integrated interpretation of environmental data. In keeping with this approach, an important element of the modest FY 79 program in the southern Bering sea is the investigation of the feasibility of a multi-component, dynamic, numerical ecosystem model for the region. Preliminary results from this model, developed in FY 76, suggest that most of the qualitative and quantitative dynamics of the marine ecosystem, such as interactions between species, interactions between species and the environment and the effects of man's actions on species and the ecosystem, can now be studied and quantified. Thus, during FY 79, this project will be continued to incorporate all BLM/OCSEAP generated data into an evaluation of the sensitivity of the eastern Bering Sea ecosystem to perturbations from oil development.

Studies beyond FY 79 will depend partly on the future leasing schedule and partly on how well the ecosystem model performs as an integrative tool during the FY 79 testing phase.

In Norton Sound it is planned that FY 78 reconnaissance level surveys of intertidal and subtidal benthos and for certain species of birds and marine mammals not be continued in FY 79. Emphasis will be placed on synthesis of environmental data on factors affecting biological populations and communities and on the phenology and ecology of selected species. A sound knowledge of the spatial and temporal distribution of major organisms, their migratory pathways, habitat dependence and potential susceptibility to impact is a prerequisite to a thorough understanding of the ecosystem in sufficient appropriate detail and realism to assess impacts of OCS development.

A large amount of avian data have been obtained in Norton Sound and reported by several research units. Broad-scale reconnaissance studies were completed in FY 77, and reproductive ecology and phenology of certain bird species and foraging excursions from major rookeries are being addressed during FY 78. It is planned that these data be used to identify effects of large-scale environmental changes on bird communities and to estimate population density fluxes, biomass changes and bioenergetic demands of important bird species.

Studies on the seasonal distribution and feeding habits of marine mammals in Norton Basin will emphasize the synthesis of data from previous years, especially on the association of mammals with the ice edge and on the spatial and temporal variations in food habits. Field studies will be undertaken in late FY 79 or later only if this synthesis reveals significant information gaps requiring additional work.

Studies to determine pathological conditions and major causes of morbidity and mortality in marine mammals were initiated in this area in FY 78. It is planned that these studies be continued in FY 79.

Beaufort/Chukchi Sea

The OCSEAP biological effort in the Beaufort Sea began in FY 75. As in other lease areas studies were initially reconnaissance level surveys of distribution and abundance of principal biota. The shift toward specific process studies in geographically limited regions began somewhat sooner in the Beaufort Sea than in the other lease areas. By FY 76 initial planning activities for an interdisciplinary ecological process study in the Simpson Lagoon/Barrier Island system were already underway. Survey studies of distribution and abundance of marine mammals, birds, and fish were essentially completed by the end of FY 77, and in FY 78 the biological studies showed a marked change in direction toward an emphasis of process studies to determine the interdependence of the various biological species and their dependence on habitats and abiotic parameters. Population dynamics, year-to-year variability, life cycles, and food web dependencies received major attention in FY 78. These studies are scheduled to continue through FY 79.

By the proposed lease sale date, adequate survey and process information on biota seem fairly well assured for the purpose of environmental protection during the exploration phase of the nearshore lease tracts. Followup studies demand continued efforts at synthesis of information between 1979 and 1981, prior to development.

In the Chukchi Sea the biological program has progressed more slowly than in other lease areas because of the steady decline in funding level since that region was removed from the sale schedule. The total authorized funding level for FY 79 is about 20 percent of the FY 77 value and biological studies have been de-emphasized accordingly. The FY 79 program in the Chukchi Sea will still be largely in a reconnaissance mode.

By 1980, general information required on certain aspects of the biota will be: survey and process understanding on major bird and mammal populations; littoral zone work on invertebrates, plankton and birds; and some plankton and benthos information on the northern Chukchi. Noticeably absent will be a fisheries survey and inventory, as well as process understanding and coastal habitat knowledge in the Kotzebue Sound - Selawik Lakes regions, where the complex shoreline made survey efforts too expensive to undertake in FY 76, when they could have been done.

2.1.6 Effects

The OCSEAP effects program is an ongoing effort, not coupled specifically to the schedule for any particular lease area. The results of the effects studies are used in establishing causal relationships between OCS-related perturbations and physiological or biological change, and form the basis for developing discharge regulations and operating stipulations. In addition, OCSEAP is evaluating biological responses to OCS stresses for their potential usefulness as early warning indicators or monitoring aids in detecting or quantifying environmental change.

OCSEAP initiated the program of effects research at the inception of the lease area studies program. Effects studies to date have consisted mainly of laboratory efforts. In FY 79, however, there will be a substantial shift toward field studies designed (1) to verify or validate laboratory observation under realistic field conditions and (2) to generate data on exposure concentrations and compositions likely to occur under various environmental conditions. The field observations and data are important for improved interpretation of laboratory results. In addition, there will be an extension of the program from its previous focus on the direct effects of petroleum to include studies of other OCS-related perturbations on the marine environment.

2.2 FUTURE PROGRAM EMPHASIS

The following material summarizes briefly the major program directions that are expected to influence the nature and timing of OCSEAP studies over the next few years. This summary is based on the continuing evaluation of the program content by the OCSEAP and BLM staffs, as reflected in the discussion of the previous section, and on input from the external program reviews.

2.2.1 Contaminants

- Reconnaissance hydrocarbon surveys will be discontinued after FY 78.

- Trace metal injection into the marine environment is not considered to be a serious problem and trace-metal analyses will be discontinued after FY 78.
- The FY 79 chemistry program will be process- rather than survey-oriented. Studies during FY 79 and beyond will emphasize site-specific field investigations and field weathering and dispersal studies.

2.2.2 Hazards

- Seismic hazards studies in active areas will continue to receive strong OCSEAP support for the duration of the program.
- OCSEAP must seriously explore the feasibility of funding for OBS units and strong-motion accelerometers.
- Volcanism studies in the Gulf of Alaska will continue to receive strong support as an integral part of the seismic program.
- Bottom faulting and sediment stability studies will continue to receive strong support in advance of sales for those areas still on the current Proposed OCS Planning Schedule.
- Studies of severe storm hazards will be initiated in FY 79.
- Gas-charged sediments in Norton Sound are a potentially serious hazard. These investigations should continue in FY 79 and possibly FY 80.

2.2.3 Transport

- FY 79 is a "synthesis year" for oceanographic transport studies; the field effort will be substantially reduced in FY 79.
- Studies in FY 80 and beyond will depend on the results of the FY 79 synthesis effort.
- Nearshore physical oceanography studies should be planned on the basis of the coincidence of an important biological community with either planned nearshore development activities or with likely impingement from more distant sources as established from previous, large-scale trajectory studies.

- Studies of sediments as a transport mechanism will focus on obtaining a better understanding of the processes of oil-sediment interaction.
- A new two-year study addressing the transport and retention of oil by ice was begun in FY 78 because of the importance of ice as a transport mechanism in the Beaufort Sea.

2.2.4 Biological Populations and Ecosystems at Risk

- The biology program is shifting in emphasis toward ecological process studies; reconnaissance surveys of distribution and abundance of biota will not be continued in FY 79.
- Two major site-specific ecological studies are being designed and implemented in the Gulf of Alaska (Kodiak and Lower Cook Inlet) during FY 78; these studies could possibly last for three years and have a significant influence on the nature of subsequent biological studies conducted in these areas.
- By FY 79 the number of existing bird colony studies will be reduced to a minimum; viz, those addressing the critical seabird species most likely to be impacted by OCS development. Colony studies will emphasize those observations that will permit repopulation predictions following a major loss.
- Studies of man-induced perturbations on biota under controlled conditions will be solicited and encouraged during FY 79 and beyond.
- The current mammal field studies have been largely suspended during FY 78. Primary emphasis in FY 79 will be placed on the synthesis of information from all past studies and the preparation of a detailed marine mammal species account. The results of these activities will determine which, if any, field studies might be resumed in late FY 79 or beyond.

2.2.5 Effects

- Major effort in FY 79 will be placed on design and implementation of field studies to verify and validate observations made previously under laboratory conditions.
- Other field studies will address effects of OCS perturbations other than direct petroleum effects: for example, quantitative studies will be undertaken at selected bird colonies to assess the impacts of increased aircraft traffic on bird productivity.

2.3 INFORMATION NEEDS AND TIMING

Certain key decision points during the planning schedule for any lease area require the availability of progressively higher levels of environmental information. The timing of these information requirements is the driving force behind the planning of environmental studies and the generation of useful program products. These products are outputs of the six major tasks (program objectives) described in Section 1.5 and discussed above (with the exception of Sources). The major tasks contain an interlocking hierarchy of subtasks, each of the latter having been formulated to facilitate the identification and phasing of logical collections of smaller and more manageable activities. The complete hierarchy of tasks and subtasks, discussed in detail in Section 4.6.4 of the Program Development Plan (PDP), is listed without elaboration in the following section for future reference.

2.3.1 OCSEAP Tasks (Program Objectives) and Subtasks

TASK A

WHAT ARE THE EXISTING DISTRIBUTION AND CONCENTRATION OF POTENTIAL CONTAMINANTS ASSCIATED WITH PETROLEUM DEVELOPMENT?

Subtask A-1 Determine the total petroleum and selected potentially toxic hydrocarbon components of:

- neuston and floating tar - the water column (soluble and suspended material) - selected marine organisms - sea ice and the sea ice-water interface
- sediments

Subtask A-2 Determine the seasonal horizontal and vertical distribution of methane, ethane, propane, butane, and relevant olefinic homologies in the water column. Determine the practicality of detecting and monitoring petroleum sources in Alaskan coastal waters through the use of these light hydrocarbons.

Subtask A-3 Determine the total content and chemical species of selected toxic metals, and describe the distribution and concentrations of these contaminants in:

- the water column (soluble and suspended forms)
- selected marine organisms
- bottom sediments, interstitial water, and subsea permafrost
- sea ice and sea ice-water interface

TASK B

WHAT ARE THE NATURE AND MAGNITUDE OF CONTAMINANTS AND ENVIRONMENTAL DISTURBANCES THAT MAY BE ASSUMED TO ACCOMPANY PETROLEUM EXPLORATION AND DEVELOPMENT OF THE ALASKAN CONTINENTAL SHELF?

Subtask B-1 Obtain and continually update estimates of the location, nature, and timing of platform, pipeline, and facility development in each lease area.

Subtask B-2 Estimate the quantity and physical and chemical nature of contaminants from each potential source based on projected design characteristics and operating methods, as well as on experience with petroleum development operations in other locations.

Subtask B-3 Estimate the nature and amount of possible environmental disturbance likely to accompany development.

TASK C

WHAT HAZARDS DOES THE ENVIRONMENT POSE TO PETROLEUM EXPLORATION AND DEVELOPMENT?

Subtask C-1	Determine seismic and tectonic hazards in, and peripheral to, regions proposed for petroleum development.
Subtask C-2	Determine hazards to petroleum exploration and development resulting from surface and near surface faulting.
Subtask C-3	Determine the types and extent of natural seafloor instability.
Subtask C-4	Evaluate areas of seafloor erosion and deposition.
Subtask C-5	Evaluate rates of change in coastal morphology, with particular emphasis on rates and patterns of man-induced changes. Locate areas where coastal morphology is likely to be changed by man's activities and evaluate the effect of these changes.
Subtask C-6	Determine the extent and character of ice-bonded subsea permafrost along the Alaskan coast.
Subtask C-7	Characterize the frequency of occurrence, geographical distribution, and nature of ice gouging phenomena.
Subtask C-8	Determine, map, and interpret the distribution and pore pressures of shallow overpressured sediments.
Subtask C-9	Determine the stress-strain relationships in various types of sea ice encountered along the Alaskan coast to permit calculation of ice forces and loads on structures. Determine the range of forces and extremes of stresses and forces that may be placed on platforms and facilities by ice.
Subtask C-10	Synthesize existing literature to provide analysis of the frequency, intensity, and effects of extreme oceanic events.

TASK D

HOW ARE CONTAMINANT DISCHARGES MOVED THROUGH THE ENVIRONMENT AND ALTERED BY PHYSICAL, CHEMICAL, AND BIOLOGICAL PROCESSES?

Subtask D-1	Determine circulation patterns and develop the capability to predict the transport of petroleum-related pollutants in offshore regimes.
Subtask D-2	Determine circulation patterns and develop the capability to predict the transport of petroleum-related pollutants into inshore regimes.
Subtask D-3	Conduct theoretical and observational field and laboratory studies required to improve understanding of plume behavior and weathering processes to improve oil spill trajectory and toxicity forecasts.
Subtask D-4	Determine the types and characteristics of bottom sediments including benthos-sedimentary substrate interactions.
Subtask D-5	Characterize bottom sediment dynamics.
Subtask D-6	Characterize physically and chemically suspended particulates, and their influx, transport and deposition. Determine the mechanisms, pathways, and rates of suspended sediment transport including coastal morphological processes. Develop an understanding of oil/sediment interaction processes.
Subtask D-7	Map sea floor topography to support circulation studies and biologic work in spatial variations of populations.
Subtask D-8	Characterize the distribution and nature of the most important sea ice features (leads, ridges, polynyas, etc.) on a seasonal basis and the undersea morphology of sea ice on the Alaskan Continental Shelf.
Subtask D-9	Describe and analyze the dynamic behavior of sea ice (stresses motions, deformations, etc.) and the effects on transport processes of pollutants and on the safety of man-made structures.

Subtask D-10 Determine the possible interaction between ice and oil and other contaminant discharges.

Subtask D-11 Evaluate and quantify the extent and likelihood of transport of oil inland beyond the normal beach line by storm surges.

TASK E

WHAT ARE THE BIOLOGICAL POPULATIONS AND ECOLOGICAL SYSTEMS MOST SUBJECT TO IMPACT FROM PETROLEUM EXPLORATION AND DEVELOPMENT?

Subtask E-1 Determine the seasonal density distribution, critical habitats, migratory routes, and breeding locales for marine mammals. Identify critical species and sites, particularly in regard to possible effects of oil and gas development.

Subtask E-2 Describe population dynamics and trophic relationships for selected species of marine mammals.

Subtask E-3 Determine the seasonal density distribution, critical habitats, migratory routes, and breeding locales for principal marine bird species. Identify critical species particularly in regard to possible effects of oil and gas development.

Subtask E-4 Describe dynamics and trophic relationships of selected marine bird species at offshore and coastal study sites.

Subtask E-5 Determine the distribution and abundance of certain pelagic and demersal fish. Supplement current fisheries data when necessary. Determine the relative seasonal density distribution, critical habitats, growth and food habits of juvenile pelagic fish.

Subtask E-6 Determine the food dependencies of commonly occurring species of pelagic and demersal fish to establish principal ecological relationships.

Subtask E-7	Determine the distribution, abundance, diversity and productivity of the benthic community.
Subtask E-8	Provide a general description of the intertidal and shallow subtidal habitats.
Subtask E-9	Describe the ecosystem dynamics for littoral biota of the principal shore types with particular emphasis on potential, immediate and long-term impacts of contaminants and disturbances in species population dynamics, community composition, and productivity of the ecosystem.
Subtask E-10	Determine seasonal density distributions of principal species of phytoplankton, zooplankton, and meroplankton.
Subtask E-11	Determine seasonal indices of phytoplankton production, particularly the sea ice flora. Identify pathways of matter (energy) transport between synthesizers and consumers.
Subtask E-12	Determine non-population dependent physiological and population parameters of plankton communities.
Subtask E-13	Identify and characterize critical regions and habitats required by egg and larval stages of fish and shellfish species, especially those of commercial or ecosystem importance.
Subtask E-14	Development of ichthyoplankton key to aid identification of the ichthyoplankton occurring in Alaskan waters.
Subtask E-15	Characterize marine microbiological communities with regard to the normal biota of heterotrophs, chemotrophs, and pathogens.
Subtask E-16	Determine the behavior of heterotrophic microorganisms, pathogens, and chemotrophs and their response to normal environmental stresses in arctic and subarctic waters.

Subtask E-17 Determine the relationship of living resources to ice environment (including the edge of drifting ice, land fast ice, and inner pack ice), and examine the biological activities (species associations, food habits) under landfast ice on a seasonal basis in the Bering, Chukchi, and Beaufort Seas.

TASK F

WHAT ARE THE EFFECTS OF CONTAMINANTS AND ENVIRONMENTAL ALTERATIONS RELATED TO OCS OIL AND GAS ACTIVITIES ON INDIVIDUAL ORGANISMS, POPULATIONS AND ECOLOGICAL SYSTEMS

Subtask F-1 Review and evaluate the available literature and unpublished data on toxicity of crude oils and crude oil components (including toxic metals) on the basis of species, life stage, temperature at exposure, water source, oil source, geographic source of organisms, and presence of toxic metals.

Subtask F-2 Determine the acute and chronic effects of crude oil and its component fractions, toxic metal components of drilling muds, and other petroleum-associated chemicals on survival, growth, reproduction, and selected physiological and behavioral mechanisms of selected arctic and subarctic organisms.

Subtask F-3 Determine the effects of crude oil on the thermoregulatory mechanism and other functions of marine birds and mammals.

Subtask F-4 Determine by laboratory experiments the potential release of toxic metals from oil-impacted sediments, the occurrence of soluble and non-soluble toxic metals in sediments (with emphasis on organometallic complexes), and the relative importance of these toxic metals on various species in terms of uptake and effects on biota.

Subtask F-5	Determine by laboratory experiment the bioaccumulation and relative effects of petroleum hydrocarbons and other OCS-related contaminants presented through various exposure pathways, including soluble forms, food chain exposure, suspended-particulate-borne contaminants and sediment-adsorbed contaminants.
Subtask F-6	Conduct laboratory and field studies to determine recovery rates of selected organisms and ecosystems from perturbations caused by either contaminantion or other disturbances associated with petroleum development.
Subtask F-7	Determine the types and incidences of diseases presently occurring in fish, shellfish, birds, and mammals for use in (a) evaluating future impacts of petroleum-related activity, and (b) designing experiments to test the effects of contaminant exposure to disease-susceptibilty.
Subtask F-8	Determine the potential ecological effects of alternative countermeasures to oil spills.
Subtask F-9	Describe, analyze and verify the ecological community structure and productivity of selected coastal ecosystems with respect to potential impacts of OCS oil and gas development.
Subtask F-10	Describe, analyze, and verify the ecological community structure of the ice-front production system with respect to potential impacts of OCS oil and gas development.
Subtask F-11	Describe, analyze and verify the community ecology of coastal detritus systems with respect to OCS development impacts.

2.3.2 Study Resolution and Timing

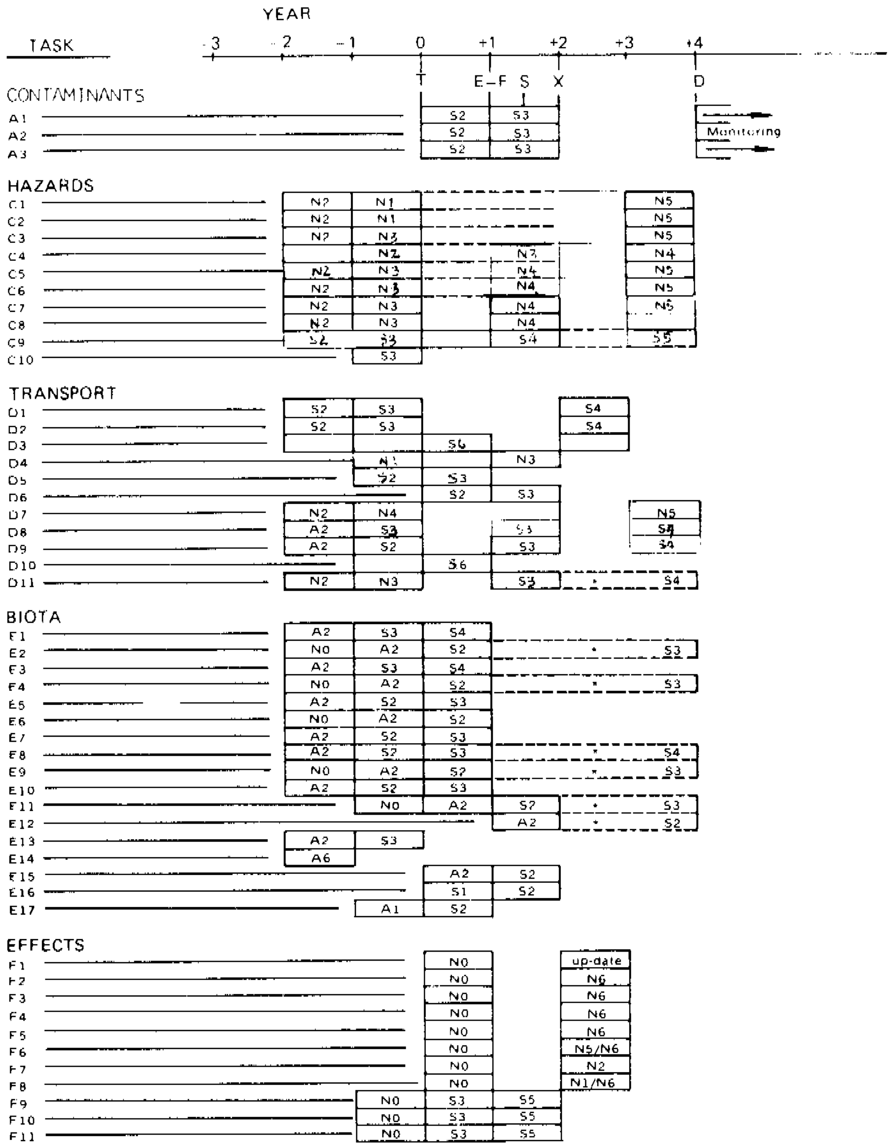
Figure 2.1 summarizes in matrix form the Department of Interior product needs and scheduling necessary in the planning of OCSEAP research. This figure is in many respects similar to Figure 5-2 in the Program Development Plan (PDP), which shows the generic time progression of the major program elements keyed to BLM needs. The two figures differ in the following important respect, however. The matrix in Figure 2.1 contains information denoting the temporal and spatial resolution judged by BLM to satisfy specific product needs at the indicated decision points.

This matrix is based on the Jamison Resolution Analysis submitted to the OSESAC by BLM on November 5, 1976 and on considerable subsequent discussion between the BLM and OCSEAP staffs. A primary objective of the particular format chosen was the quantification of the study timing and the spatial and temporal resolution required by BLM for each of the study elements identified in Section 2.3.1. The analysis that produced Figure 2.1 also added an important dimension to the needs specification not contained in the Jamison Resolution Analysis, namely, the inclusion of temporal resolution. Due to the complexity of the marine system under study, a knowledge of the required temporal resolution at various stages of the decision process is important for optimum resource allocation and design of individual investigations. Figure 2.1 contains a generic time axis which can be converted to apply to a specific lease area by the entry of a known date at any one of the decision points. Application to a specific lease area might, however, eliminate the need to address certain of the subtasks (e.g., ice hazards in NEGOA). However, the timing and resolution needs will be the same whenever a subtask is applicable.

It must be emphasized that the matrix in Figure 2.1 represents a summary of when and to what level of detail BLM needs hazards and environmental information to make leasing decisions. The matrix provides no indication of OCSEAP's progress in producing such information, nor does it attempt to address the question of the lead time required to bring certain studies up to the indicated levels of resolution. Also, it is not the intent of the matrix to imply that all levels of resolution, particularly during exploration and development, should necessarily be provided by OCSEAP alone. This is clearly not possible. During the later stages of the leasing process, much detailed information can be provided more effectively and properly by the petroleum industry.

The actual products generated by the program in response to BLM needs are discussed in detail in Section 5.0 of each TDP. A modification of Figure 2.1 is used as the format for the presentation of these products. The program products format also contains the status of the past, present, and projected resolution of each product generated by OCSEAP. In this way, past and projected program progress can be measured against BLM needs summarized in Figure 2.1. However, such a comparison requires the recognition of three important factors: (1) Because of time and funding limitations, and the possible early identification of key environmental factors in certain locations, the levels of resolution indicated in the program products list for a given lease area are not necessarily uniform throughout that area; hence, in some cases, it may only be possible to provide information for a part of the lease area at the schedule and level of resolution indicated by Figure 2.1 with additional information for the total lease area to be provided in subsequent years. (2) Abrupt shifts in leasing priorities expressed, for example, by the last three Proposed OCS Planning Schedules (June 1975, January 1977, August 1977) have resulted in less than ideal conditions for an orderly phasing of studies in some lease areas. (3) As studies progress and more is learned about particular processes, the required and projected product resolution should be continually reevaluated in the light of improved understanding of the resolution level practically achievable.

The following material provides a brief discussion of the rationale underlying the timing and resolution requirements shown in Figure 2.1.



T = TRACT SELECTION
E–F = DRAFT OR FINAL EIS
S = SALE
X = EXPLORATION BEGINS (est.)
D = DEVELOPMENT - AT LEAST 2yrs. AFTER EXPLORATION
* = HIGHER RESOLUTION NEEDED IF OIL DISCOVERED

RESOLUTION CODE

SPATIAL RESOLUTION	TEMPORAL RESOLUTION
0 = information in hand, literature reviews	N - no temporal resolution
1 = qualitative, area wide, cursory	A - annual
2 = semi-quantitative, hundreds of square miles scale or 25 miles of coastline	S - seasonal
3 = quantitative, 3–10 tracts scale or 10 miles of coastline	
4 = quantitative, tract specific (2 to 5 mile resolution)	
5 = quantitative, site specific	
6 = no spatial resolution (non-site-specific)	

FIGURE 2.1 RESOLUTION SCHEDULE FOR OCS STUDIES

2.3.3 Contaminants

The resolution schedule for OCS studies does not require information on contaminant distributions prior to tract selection. Such information is first required, on a semi-quantitative level, at the time of environmental impact statement preparation for the primary purpose of providing a broad characterization of potential contaminant levels in the lease areas of concern. As the OCS exploration phase is reached, somewhat improved spatial resolution is required to update existing information and to obtain a more detailed picture of existing contaminant concentrations in specific areas about to undergo exploration. These latter studies will form the basis for the design of long-term monitoring programs to be undertaken during the development phase. As is evident from the task descriptions of Section 2.3.1, the issue of contaminants in the environment is actually much broader than that addressed by subtasks A1-A3. A considerable number of important questions relating to contaminants are addressed under Task D, since sediment uptake, weathering, and other nonconservative transport processes will determine their final disposition.

2.3.4 Sources

As described in Section 1.3.2, the data required for this task are to be supplied to OCSEAP by BLM. Thus, while information on sources of potential contaminants and other environmental disturbances addresses an identified OCSEAP task, it is not included as such on the Resolution Schedule for OCS Studies.

2.3.5 Hazards

The resolution schedule indicates the need for semi-quantitative information on almost all hazards identified in Section 2.3.1 at least two years before tract selection. Hence, hazards information beyond the cursory or "in-hand level" can play an important role in the possible elimination of large areas from offer, even before tract selection. By the time of tract selection, hazards information must be upgraded, in general, to a level of resolution addressing individual or small groups of tracts. Considering the nature and the potential severity of the hazards in question, the studies required to produce information to the level of detail shown in Figure 2.1 are characterized by long lead times. Hence, the matrix beginning at two years before tract selection does not necessarily imply the beginning of studies. The hazards requirements are characterized by a general lack of need for temporal resolution (except for ice motion and extreme oceanic events) and a spatial resolution steadily increasing from the semi-quantitative to the site-specific some four years after tract selection. It is expected that industry will be heavily involved in providing information at the latter level of resolution.

2.3.6 Transport

The transport studies comprising tasks D-1 through D-11 can be roughly separated into three main categories: aquatic transport, ice transport, and modification of contaminant concentrations and forms due to various weathering processes. As discussed in Section 2.1.4, contaminant trajectories will be primarily determined by water motions in subarctic regions while ice will play a major role in transporting contaminants in the arctic. In either case, the ultimate fate of most contaminants will be determined by the rates of weathering and interaction with suspended particulates. The aquatic transport (Tasks D-1 and D-2) resolution requirements indicate a need for semi-quantitative, seasonal information on circulation patterns at least a year before tract selection. Such information can be used, along with other environmental data, to determine the size of the area offered at the call for nomination. At the time of tract selection, aquatic transport information should be available at a level of detail that will allow the identification of potentially adverse circulation features, on a seasonal basis, in areas comprising up to 10 tracts. This level of resolution will also be needed for the environmental impact statement. Tract selection and the preparation of the EIS will not necessarily mark the end of the need for information on coastal circulation. Several years after tract selection, seasonal, tract-specific information will be required during exploration to assess the likelihood of impingement of biological resources whose distribution has been established to a comparable level of resolution.

The required levels of detail for ice-related transport generally parallel those discussed above. In the case of ice, however, the tasks are not so clearly separable from those addressing the hazards problem and hence are expected to have a slightly longer duration than circulation studies. It should be noted that at the time of tract selection the required resolution for ice-related transport has increased temporally but not spatially, emphasizing the importance of seasonal variability in ice conditions.

2.3.7 Biota

Estimates of the distribution and abundance, migration, feeding sites and behavior of populations are among the first biological studies undertaken. The locations of the populations at each life-stage and activity are then related to likely contaminant pathways and incidence of disturbance to determine whether risk may exist. This study philosophy is reflected in the required resolution of information generated under Subtasks E-1, E-3, E-5 and E-7 (distribution and abundance of marine mammals, birds, fish and benthic communities, respectively). For example, the resolution requirement for the distribution and abundance of biota at the time of tract selection is comparable to that expected from the transport studies intended to predict impingement. This matching of required levels of detail on a multidisciplinary basis is an important planning consideration throughout the program.

After the biological populations potentially at risk have been established, the information considered in tract selection and in the preparation of the environmental impact statement, there is no need for additional studies of distribution and abundance of marine biota. Information needs shift focus to longer term studies of trophic relationships and ecosystem dynamics and the potential impacts of contaminants and other disturbances.

2.3.8 Effects

Effects studies are characteristically non-site-specific. Experimentation is required to document causal relationships between OCS development and potential changes in the biota or the ecosystem and to quantify the magnitude and reversibility of such changes. The results of effects experimentation are generally applicable to all lease areas in which the test species or habitats occur. The current program has been focused heavily on the lethal and sublethal effects of petroleum exposure in a variety of marine organisms, mainly under laboratory conditions. In FY 77, the program will be extended to include field experiments for verification of laboratory observations and experimentation on OCS perturbations other than the direct effects of petroleum contamination.

The resolution schedule for BLM needs indicates the requirement for best available information on the effects of OCS leasing and development at the time of tract selection. This information is an essential part of the assessment of potential environmental impacts of the development. An update is then required about two years after tract selection when exploration is underway and plans for development are proceeding. Since the leasing schedule now calls for lease sales of Alaskan areas at approximately 6-month intervals, a continuous program of effects research is required to ensure significant progress in the understanding of OCS impacts. The program directed at subtasks F-1 through F-8 is described in the Non-Site-Specific TDP; the ecosystem studies (subtasks F-9 - F-11) will be found in the appropriate lease area TDP's (e.g., the barrier island-lagoon study in the Beaufort TDP).

3.0 RATIONALE FOR NORTON SOUND STUDIES

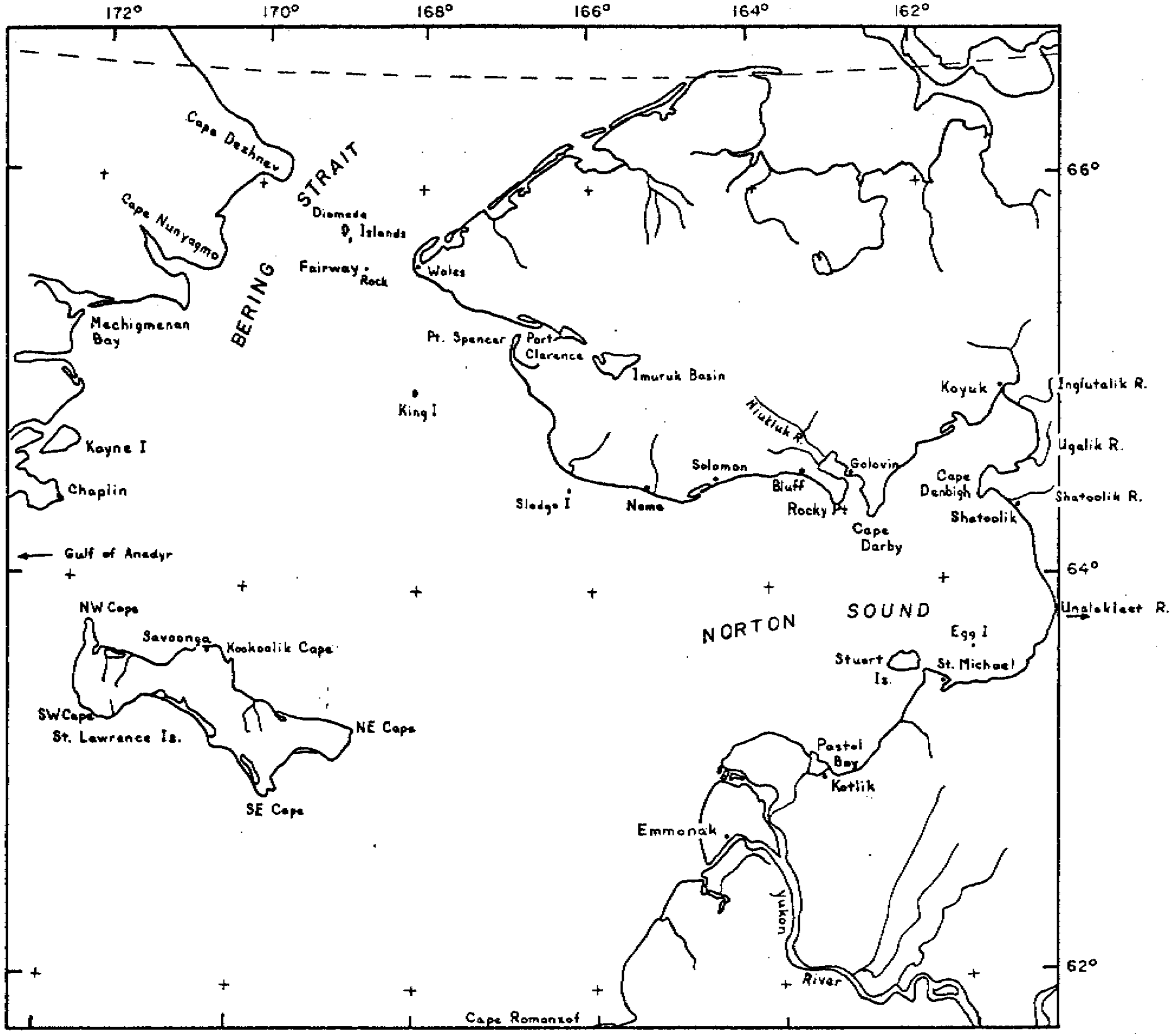
Introduction

The northern Bering Sea including Norton Sound is heavily influenced by seasonal ice from late autumn through early spring. The Sound is a subarctic embayment, averaging 20 m deep, whose shelf slopes gently downward to the west. Shorelines along Norton Sound and the Seward Peninsula are generally abrupt with steep bluffs and a few cliffs interspersed with small stretches of low-lying, sandy or silty beaches. The entire coastal region is underlain by discontinuous permafrost.

Currents in Norton Sound are affected primarily by winds and freshwater input from the Yukon River (Yukon-Kuskokwim delta on the south coast of Norton Sound is the largest delta complex in Alaska). Wind mixing may extend to the bottom of the Sound, and may drive significant currents. Surface waters flow northward past the west end of Norton Sound and a deep influx of Bering Sea water flows inward along the bottom of the Sound.

The variety and distribution of marine animals along the coast of Norton Sound reflect the combined effects of water and ice movements. Plankton, invertebrates, and fish that thrive at the ice edge in great abundance provide food for the concentrations of marine birds and mammals. Polychaete annelids comprise approximately 50% of the total biomass of benthic organisms in Norton Sound. Small Tanner and king crabs inhabit the area and several species of shrimp are common. Fish are generally small and sparsely distributed.

Coastal marshlands along the south coast of the Seward Peninsula are important stopovers for migrating swans, geese, cranes, and shorebirds. In offshore areas, murres, guillemots, puffins, auklets, jaegers, fulmars, and others feed in and beneath the ice edge and rest upon it. King Island, Sledge Island, Egg and Besboro Islands in Norton Sound, and Cape Denbigh, Bluff, Rocky Point, and Cape Darby on the southern coast of the Seward Peninsula support seabird colonies. The general movement pattern of marine mammals is northward in spring as the ice edge retreats



NORTON SOUND

and southward in fall with the advance of the ice.

The recent discovery of an apparent major offshore petrogenic seep south of Nome may significantly increase interest in Norton Basin as development potential. Norton Basin lease sales were previously scheduled for late 1979. The OCS lease sales schedule is presently under review and the most recent listing (August 1977) extends the time of sale to December 1981.

3.1 SCOPE AND DIRECTION

3.1.1 Premise

The assessment of marine resources in the Norton Basin is viewed as an interdisciplinary task involving studies in biology, chemistry, geology, meteorology and oceanography pertaining to OCS development and synthesizing the resulting information into a cohesive whole. OCSEAP studies in this oil and gas lease area, initiated in FY 76, follow the Program Development Plan (PDP) in developing and managing scientific studies and providing specific products and deliverables. Research activities have evolved around the OCS Planning Schedule, information needs and objectives of BLM, and specific regional environmental characteristics. These studies are being supplemented by extensive literature searches and compilation and review of available scientific data and results as they relate to the description of the environment and possible effects of OCS development.

The evaluation of potential adverse impacts and risks to biota habitats, ecosystem disturbances, characterization of environmental hazards, identification of most probable landfalls and potential pathways of contaminants released in the lease area or in areas related to OCS development are some of the most important features that must be adequately addressed and understood to insure environmental safety and resource conservation. The relevance and needs for such studies and the information products needed for decision-making are outlined in a later section.

In the Norton Basin lease area, OCSEAP studies have addressed the following objectives:

- Establish background levels of petroleum related contaminants in water, sediment, and selected biota; these studies address PDP Task A (Contaminants)
- Characterize vulnerability of the region to environmental hazards, including geologic (seismicity, volcanism, faulting, sediment instability, and coastal configuration and processes), meteorologic (storm winds), and oceanographic (storm waves, tsunamis); these studies address PDP Task C (Hazards).
- Determine water property distributions, mean flow characteristics and circulation regime in the water column and over the seabed, and probable contaminant trajectories; shelf and nearshore studies are conducted to address PDP Task D (Transport).
- Evaluate extensive fish resources, both shellfish and finfish, which constitute a major source of local employment and regional economy; a part of this study relates to PDP Task E (Biota).
- Study the distribution and abundance of the extensive and varied regional biota, evaluate factors responsible for the observed high but non-uniform productivity over the shelf, identify major bird and marine mammal colonies and delineate important foraging and hauling areas, including the identification and assessment of coastal areas and embayments which are critical to feeding, spawning, rearing, and migration of fish, bird, or mammals; these studies address PDP Task E (Biota).
- Conduct site-specific studies on trophic dynamics and evaluate potential contaminant transport through food webs, in addition to describing selected areas with regard to population density distribution, feeding and reproductive niches, and phenology of biological events; these studies address PDP Tasks E (Biota) and F (Effects).

Studies relevant to this area include sea ice as a potential hazard to structures and facilities offshore, as a platform for biotic dispersion or as an agent of contaminant transport or overall biological productivity. Equally appropriate are studies of effects of landfast ice on coastal geomorphology and intertidal benthic distribution. Such studies address PDP Task F (Effects).

Information related to the nature and magnitude of potential contaminant input as a result of OCS activities, necessary for OCSEAP planning and establishing of priorities and timing for other research tasks, will be provided by BLM as it becomes available. This information relates to PDP Task B (Sources).

Data and information generated by these studies are used in the development of Draft Environmental Impact Statements (DEIS) and Final Environmental Impact Statements (EIS) for the proposed action, alternatives to the proposed action, lease tract selection, recommendations for platform design, pipeline permitting and routing, onshore facility design and location, and formulation of stipulations and operating procedures.

The timing and sequence of Norton Sound research studies in FY 79 are geared toward the OCS Planning Schedule for a Norton sale. This schedule calls for DEIS in December 1980, EIS in June 1981, proposed notice of sale in September 1981 and sale in December 1981.

3.1.2 Long-Term Needs

Concentrated OCSEAP investigations in the Norton Basin lease area were initiated during FY 76 after a major expansion of the OCS environmental assessment program was requested by BLM.

The level of research during FY's 77 and 78 remains relatively uniform: 31 Research Units were engaged in FY 77, and 33 in FY 78. As expected, major emphasis to date has been placed on identifying significant biological populations, assessing geological hazards, and describing the circulation regime. So far OCSEAP studies have provided reconnaissance data on biological populations and communities at nominal and, in some cases, ordinal level of resolution, a very generalized distribution pattern of petroleum-related contaminants, an adequate knowledge of mesoscale circulation and distribution properties, and preliminary assessment of some geological hazards at tract-scale spatial resolution. Studies on assessment of environmental hazards, process-oriented biological studies, interaction between biotic and abiotic factors, probable contaminant trajectories under different conditions, nearshore circulation and meteorological conditions are now underway.

3.2 RATIONALE AND PROGRAM DIRECTION - FY 79

3.2.1 Contaminants

Light Hydrocarbons - A major gas seep was detected by Cline (RU 153) in FY 76, located about 12 km south of Nome. The water column in this area had elevated concentrations of C_2 to C_4 hydrocarbons with high ratios of saturates to unsaturates, characteristic of thermogenically derived gas. The relative distribution of higher homologs suggested that the gas might be associated with liquid hydrocarbons. The discovery of gasoline range hydrocarbons in a sediment core taken from the seep area further corroborated this hypothesis.

Heavy Hydrocarbons - A collection of 20 surface sediment samples was collected by Kaplan (RU 480) during FY 77. Analysis of these samples is not complete, but the results will be available prior to final planning for the FY 79 field program. Shaw (RU 275) collected 6 surface water samples in Norton Sound in FY 76 and they were found to contain from 0.3 to 1.3 μg/kg of total hydrocarbons and there was no evidence for petroleum derived hydrocarbons. However, these samples were collected south or west of the seep area. No floating tar was detected by Shaw in 13 seston tows from Norton Sound. No biota from Norton have been analyzed.

Metals - Burrell (RU 162) collected sediment samples for metal analysis during September of 1976. Extracts of the sediment were analyzed for heavy metals and the contents of Fe, Ni, Zn, and Cu were closely correlated with sediment grain size. The content of Mn was not so closely correlated. The concentration of Cd was always less than 0.1 μg/g. No water or biota samples have been collected from Norton Sound for metal analysis.

Interpretation of these data indicates that the plume from the gas seep is controlled by the prevailing currents and is moved north and west from its source. There is some evidence that liquid hydrocarbons may be associated with the seep, but they have not been directly detected. Water samples for heavy hydrocarbons were not collected from the seep area and sediment samples have not yet been analyzed. There is no evidence for pre-existing petroleum contamination in those samples that have been analyzed from Norton Sound. Heavy metals are found in sediments in concentrations similar to other Alaskan OCS areas.

For the past ten years Hans Nelson (RU 429) has conducted research on heavy metal and trace element distribution in river, shoreline, and offshore bottom sediment of the northern Bering Sea area. This work began with the USGS heavy metals program.

In the past two years Nelson has collected sediment samples for trace metals analysis for OCSEAP. Sediment samples have been analyzed for heavy metals and the content of Fe, Mg, Ca, Ti, Mn, B, Ba, and Cr in Norton Basin and the Northern Bering Sea. All analyses have been completed, statistical analysis is being conducted, and finally three-dimensional graphics techniques will be utilized.

In FY 79, a coordinated effort will be placed on the natural seep area in the Norton Sound to study the processes controlling the distribution and abundance of petroleum contaminants in this system (P 902, RU's 152, 153, 480).

3.2.2 Hazards

Geologic hazards in the form of seismicity pose potential threats to structures, platforms, and other facilities. Because of high seismic risks involved and the long-term usefulness of the information obtained, this research will continue at current level of effort and funding in FY 79. The results will include continually updated data with better location accuracy.

Studies to identify and describe areas of faulting and sediment slides and slumps are being continued by Nelson (RU 429). This research unit is planned to continue studies in FY 79 as additional data are required on the location of surface and nearsurface faults and actual or potential sediment slump and slide areas.

3.2.3 Physical Oceanography and Transport

It is planned that in FY 79 OCSEAP physical transport studies will continue to emphasize nearshore and shelf circulation. Additional data from moored current meter arrays and pressure gauges will be obtained to determine the variability in the mean flow and to elucidate temporal changes in the flow regime. Particular attention will be given to areas which are highly productive or where active sediment transport occurs. This research unit will also continue to examine long-term current meter records obtained in offshore waters. STD surveys will not be emphasized in FY 79 as sufficient salinity and density distribution data are currently available and will be supplemented by observations made in FY 78. These data will be compiled, interpreted and reported by Coachman (RU 541) in FY 79. Royer (RU 289) will also continue to maintain a file and catalog of satellite imagery data and distribute these data to other investigators upon request.

Presently only modest data are available on local wind fields and meteorological conditions in nearshore areas of Norton Sound. Nearshore winds can differ significantly from synoptic weather charts because of strong coastal orographic effects. These differences can lead to errors in contaminant transport calculations that are usually based on synoptic geostrophic winds. It is planned that in FY 79, coastal and nearshore meterological studies will be initiated on those coasts with significant relief (P 323).

Modeling studies by Leendertse (RU 435) are planned to continue in FY 79. The modeling task will produce simulated trajectories and approximate landfalls under different initial conditions. Several changes in earlier versions are being implemented and formulations of these models will be improved to obtain better outputs and documentation and to minimize boundary condition problems.

3.2.4 Biological Productivity, Communities, Populations

It is planned that FY 78 reconnaissance level surveys of intertidal and subtidal benthos and certain species of birds and marine mammals will be discontinued in FY 79. Emphasis will be placed on environmental factors affecting biological populations and communities and on the phenology and ecology of selected species.

A large number of avian data have been obtained and reported by several research units. Broad-scale reconnaissance studies were completed in FY 77, while foraging excursions from major rookeries (RU 337) and reproductive ecology and phenology of certain bird species (RU 196 and 237) are being addressed during FY 78. It is planned that these data be used to identify effects of large-scale environmental changes on bird communities and to estimate population density fluxes, biomass changes and bioenergetic demands of important bird species. This task will be addressed by Wien (RU 108).

Studies on the trophic relationships and population dynamics of marine mammals in Norton Basin will continue in FY 79 (RU 230 and 232). Major emphasis will be placed on the synthesis of data from previous years, especially on the association of mammals with the ice edge and on spatial and temporal variations in food habits.

3.3 PROJECT SELECTIONS - NORTON SOUND

3.3.1 Task A - Contaminants

The distribution of potential contaminants in Norton Sound will be described prior to the development of petroleum resources in this area. This will enable detection and monitoring of changes in a contaminant's concentration or occurrence during exploratory and production phases of OCS development, and will provide contaminant background levels which might be correlated with concurrent ecological changes in Norton Sound. General approaches to contaminant studies are the same as those employed in other Alaska OCS lease areas and include:

1. Broad geographic surveys of contaminant distributions in several types of sample matrices, e.g., water, sediments, and selected biota.
2. Site-specific studies in areas expected to undergo OCS development (potential sources of contaminants) and in areas identified as vulnerable or critical ecological habitats (potential targets).
3. Periodic resampling of areas and matrices sampled during broad geographic surveys to determine whether changes have occurred over the broad geographic scale.

All three subtasks (A-1, A-2, A-3) discussed in the TDP will be addressed in Norton Sound during FY 79. Subtask A-1 is to be accomplished under P 902, RU 153 and RU 480; subtask A-2 will be addressed by RU 153; and subtask A-3 will be addressed by RU 152. The efforts will be specifically directed towards the hydrocarbon seep area discovered in northern Norton Sound (see Background section, this TDP). In addition, analysis of contaminant levels in selected species will continue in FY 79.

3.3.2 Task C - Hazards

One of the primary objectives of the Alaska Environmental Assessment Program is to identify hazards so that environmental risks can be minimized or avoided through appropriate plans, designs, site selection, stipulations and regulations. The Norton Sound area is subject to special hazards not unlike those associated with the Chukchi and Beaufort lease areas, involving ice and permafrost. Some of the results of studies undertaken in these two lease areas can be extrapolated to Norton Sound. Other studies must be specific to Norton Sound. In FY 79 only subtasks C-1, C-2, and C-3 will be funded in Norton Sound. C-10 has been accomplished. Related work for FY 79 is treated under subtask D-11. Work on ice-gouging (C-7) is a secondary objective of RU 429 (see subtasks C-2 and C-3).

Subtask C-1 will be addressed by RU 483 which will be responsible for continued operation through FY 79 of the small array of seismic stations now established on the Seward Peninsula.

Subtask C-2 will address the study of potentially hazardous areas that have been identified in FY 77 and 78. Detailed characterization of these selected sites will be accomplished under RU 429.

RU 429 will also address subtask C-3 in FY 79.

3.3.3 Task D - Transport

The mechanisms of transport and transformation of petroleum and other pollutants and the potential transport pathways are of key significance in the study program, linking pollution sources to biological receptors. Data on transport mechanisms and pathways will aid in planning offshore petroleum development in Norton Sound in such a way as to minimize risk to environmentally sensitive areas. This information will also allow impact predictions to be made both for routine exploratory and production operation and in the event of oil spills, thus providing guidance for the design and implementation of environmental monitoring and cleanup programs. Information required to address specific aspects of these problems is discussed in the TDP under subtasks D-1 and D-11.

The following subtasks will be considered in FY 79 for Norton Sound. Under Subtask D-1 an assessment of the environmental impacts associated with water-borne contaminants requires estimates of the likely spatial and temporal distributions of these contaminants away from their sources. These distributions will depend on meteorological driving forces, prevailing shelf circulation patterns and hydrographic regimes both beneath the ice and in ice-free regions. During FY 76 and FY 77 the broad features of the current and hydrographic regimes in the Norton Sound lease area were established for the first time on a year-round basis. These efforts need to be pursued further in FY 79 in coordination with nearshore studies (subtask D-2) under RU 541 (formerly 141-E) and RU 435. In FY 79, these RU's wll generate trial trajectories for a number of selected potential source terms in the Norton Basin lease area.

Subtask D-2 is identified separately from that described in D-1 only to emphasize that, in general, inshore circulation patterns are more complex, temporally and spatially, than those occurring further offshore. Observed inshore circulation patterns are often driven both by local forcing mechanisms, primarily wind stress, and the larger scale driving forces in the offshore regime. In Norton Sound this is particularly evident, for example, in the role of storm surges in modifying coastal circulation patterns. Inshore circulation studies will receive more attention in FY 79 under RU's 435, 541, and P-323.

Because of the particularly heavy sediment inputs into Norton Sound from the Yukon River and the many smaller rivers feeding into the Sound, this subtask is of great importance. Subtask D-6 work will focus on transport of seep-introduced petroleum and will be accomplished under RU 152.

The dominant environmental feature in Norton Sound over much of the year is ice. Not only does sea ice present a safety hazard to man-made structures as described under Task C, it also constitutes a major vehicle for the containment and transport of spilled contaminants. As a first step toward assessing the role of sea ice as a significant transport medium, its distribution and important physical features must be characterized. The primary activities directed toward subtask D-8 will include establishment of a statistical data base on the spatial and temporal distribution of arctic sea ice through aircraft and satellite remote-sensing (also providing data for assessing hazards and ice habitats). This will be addressed by Research Units 87 and 267.

The activities described in subtask D-8 are primarily concerned with the static nature and the statistical distribution of sea ice features. Subtask D-9 addresses the problem of mesoscale and large-scale ice motions and their potential roles as contaminant transport mechanisms, emphasizing movements through Bering Strait and the area immediately to the south. Activities directed toward this task include studies of large-scale ice trajectories using satellite-tracked buoys; meso- and small-scale ice motion and deformation studies using shore-based radar units. This will be addressed in FY 79 through Research Unit 88.

In order to predict how sea ice might contain and interact with oil spills, laboratory and field studies wll be undertaken to investigate the relationship of small scale sea ice properties to the entrainment and diffusion of oil within the ice under subtask D-10.

Studies were begun in the Beaufort lease area in FY 76, and have provided new data on the behavior of oil in a growing sheet of slush and pancake ice. A major gap to date is the lack of information on the fate of oil originally entrained in flat young sea ice where the ice is subsequently crushed into rubble field or pressure ridges. Aspects of this problem relevant to Norton Sound will be addressed during the FY 79 studies under Research Unit 87.

3.3.4 Task E - Biological Populations and Ecological Systems at Risk

Studies of the distribution and abundance, migration, feeding sites, and behavior of populations are underway for major components of the biotic systems in the Norton Sound area. The locations of the populations at each life-stage and activity will be compared to predicted paths of petroleum and incidence of disturbance to determine whether risk may exist. Criteria of uniqueness, importance to the ecosystem, sensitivity, or aesthetic considerations must also be examined to define fully and assess the value of a species or community and the consequences. When vulnerability is indicated, detailed studies will be undertaken to focus on processes, positions in food webs, population dynamics, sensitivity to disturbance, ability to recover from disturbances, mobility, habitat dependence, feeding dependence, and physiological characteristics. The last involves studies of the direct effects of hydrocarbons, trace elements, and development-related environmental alterations on the physiology and behavior of target organisms. Most of these latter studies are broadly applicable to several Alaska OCS areas and are therefore described in the "Non-Site Specific" TDP. The following subtasks are addressed by specific research units in the FY 79 Norton Sound TDP.

Marine mammals are important and highly visible components of the Norton Sound ecosystem. Some species are still of high economic value to residents of the Bering Sea and other Arctic lease areas. The array of species present in and around Norton Sound (and their distribution) changes dramatically during the short ice-free season, as compared to the longer ice-dominated period. RU's 230 and 232 address subtask E-1 although they are concerned primarily with the ice-dominated marine environment discussed under subtask E-17.

Under subtask E-2, information on population dynamics provides insight into the potential for recovery of a population from acute or chronic causes of attrition. Moreover, basic life history information helps to identify periods when marine mammal species are potentially more highly vulnerable to stresses, such as during gestation, pupping or weaning. Work under this subtask in Norton Sound is limited entirely to pinniped species. These are generally the most abundant marine mammals in the area and potentially most vulnerable, as well as being the easiest to investigate. Trophic studies are identifying prey species that may themselves be affected by OCS development. The general level of information for this subtask is relatively good for Norton Sound. Therefore, the FY 79 program calls for a generally declining level of this effort in the lease area. The principal research units addressing this subtask are RU 230 and RU 232.

Work under subtask E-4 will continue to establish the necessary data on population dynamics of sea-birds and waterfowl at selected sites in around Norton Sound. Understanding of trophic relationships is still weak because of the large sample sizes needed to clarify species and seasonal differences. RU 237 will continue efforts at selected sea bird colonies.

Because of importance of the ice environment to the living resources of the northern Bering Sea, considerable effort will continue in FY 79 to increase an understanding of ice-biota interactions. All of the research units addressing subtask E-17 have a broad geographic base extending south to the St. George Basin and north to the Chukchi or Beaufort seas. RU 196 examines the relationships between birds and sea-ice phenomena, while RU's 230 and 232 examine comparable relationships for marine mammals. RU 248 also examines relations between marine mammals and ice with heavy emphasis on remote sensing for mapping ice types and habitats.

3.3.5 Task F - Effects

Most of the organism-level effects studies relevant to Norton Sound deal with species found in other lease areas. They are therefore listed under the Non-Site-Specific TDP.

Studies planned (see Non-Site-Specific TDP) for key Beaufort Sea species will be applicable to species also important in the northern Bering Sea. Only subtask F-6 is specifically addressed in this TDP for FY 79.

Lack of funding and the absence of relevant development scenarios have precluded the initiation of subtask F-9 in Norton Sound, although it must still be considered of great importance to the overall accomplishment of OCSEAP objectives in this lease area.

The unique importance of extensive intertidal habitats in the Yukon Delta area for nesting waterfowl has already been described earlier in this section. The vulnerability of those habitats to spilled oil associated with extreme tides and storm surges has also been emphasized. Subtask F-6 involves small-scale controlled spill experiments on these sedge-dominated habitats, planned for FY 79. This effort is described under P-048.

4.0 RU AND P UNIT DESCRIPTIONS

Research and P Units are shown in the order of the tasks to which they relate. Some RU's are associated with more than one task. The following index will assist in locating particular P and RU descriptions.

4.1 DESCRIPTION FOR PROJECTS IN TASK A (CONTAMINANT BASELINES):

A-1:	RU 152	P 902
	RU 480	
A-2:	RU 153	

(RU 152) SUSPENDED SEDIMENTS IN ALASKAN OCS AREAS

This research unit addresses subtask A-1 (BLM Study Types 1-Hydrocarbon Baselines and 30-Effluent Dispersion).

Estimated Costs, FY 79:		
	$66,000	Lower Cook Inlet
	42,200	Norton Sound
	$108,200	Total

Schedule: October 1978 - September 1979

Performing Agency:

Agency: NOAA/PMEL
P.I., Degree: Richard Feely, Ph.D.
Title: Oceanographer
Percent time devoted to project and role: 40%; Supervising all laboratory and field phases of the studies.

Background:

Since FY 76, RU 152 has investigated the distribution and dynamics of suspended particulate material (SPM) in several lease areas including southeastern Bering Sea, NEGOA, Kodiak and Lower Cook Inlet. More recently laboratory investigations have demonstrated that SPM from Cook Inlet can "agglutinate" and sink emulsified oil in significant quantities. Thus, SPM may be an important transport and sinking mechanism for spilled oil. Cook Inlet and Norton Sound have high concentrations of SPM and this process may be particularly important if oil is spilled in these areas.

Objectives and Methods:

For FY 79, RU 152 will be involved in site-specific studies in Cook Inlet and in Norton Sound and will continue the investigation of SPM-emulsified oil interactions. Complementary RU's include 29, 190, 275, 480 and 153.

Specific objectives and methods in Lower Cook Inlet are:

1. Conclude laboratory analysis of samples collected in summer 1978.

2. Perform nephelometry and CTD casts at the time series stations to be reoccupied in spring 1979.

3. Deploy sediment traps, in conjunction with the physical oceanography program, to determine sedimentation rates in selected embayments and to provide settled material for

hydrocarbon analysis. This effort will be coordinated with RU 327 for sampling locations and with RU 430 for suspended sediment flux. This effort will be coordinated with RU 327 with regard to sampling locations and with RU 430 with regard to suspended sediment flux.

4. Collect large quantities of SPM for continued laboratory studies of oil/SPM interactions.

Objectives and methods for Norton Sound are:

1. Perform nephelometry and CTD casts at stations occupied in the seep area.
2. Deploy sediment traps to determine sedimentation rates and to provide material for mineralogical and hydrocarbon analysis.
3. Collect large quantities of SPM for laboratory studies of oil/SPM interaction.
4. Determine oil/SPM loadings and relate these results to the mechanisms and subsequent risks for biotic uptake of hydrocarbons from SPM.

Output:

1. Narrative Reports: These periodic reports will present, discuss and interpret the data with particular emphasis on the role of SPM as a hydrocarbon transporter and will relate the data to the mechanisms and risks of biotic uptake of oil associated with SPM. Graphical and tabular data will support the text.

2. Digital Data: Trace metal data from the analysis of FY 78 samples will be reported in format 061.

(RU 153) NATURAL DISTRIBUTION AND DYNAMICS OF LIGHT HYDROCARBONS IN WATER AND SEDIMENTS

This research unit addresses subtask A-2 (BLM Study Type 2-Low Molecular Weight Hydrocarbon Baselines).

Estimated Costs, FY 79:	$75,640	Lower Cook Inlet
	46,360	Norton
	$122,000	Total

Schedule: October 1978 - September 1979

Performing Agency:

Department: NOAA/PMEL
P.I., Degree: Joel Cline, Ph.D.
Title: Oceanographer
Percent time devoted to project and role: 50%; Supervision of all field and laboratory phases of the studies and coordination of the 1978 Norton Sound seep study expedition.

Background:

The extensive studies of background light hydrocarbons conducted by RU 153 in the Norton Sound in FY 76 discovered a major submarine seep. These studies will be intensified in FY 79 by making site-specific surveys to provide a data base to understand the nature and processes occurring near and around the submarine seeps in the Norton Sound.

The region of interest lies due south of Nome approximately 20 nautical miles and forms an arcuate plume trending NW-SE. The length of the plume is approximately 60 nautical miles, and its width nominally about 10-20 nautical miles. The occurrence of a submarine seep has been qualitatively identified on the basis of unusually high concentrations of saturated C_2 - C_5 hydrocarbons. Ethane concentrations reach a maximum of 10 nP/P in the near-bottom waters, a factor of 20 greater than normal ambient levels. Similarly, elevated concentrations of propane, and iso- and n-butanes were also detected, each of these being approximately a factor of 10 above background. No significant increases in the levels of unsaturated C_2 and C_3 hydrocarbons was observed. Recent evidence indicates the presence of gaseous and gasoline range hydrocarbons in the sediments of the seep area, Kvenvolden (USGS).

Preliminary data on the structural geology of Norton Basin support this interpretation based on the observed chemical and physical characteristics of the plume. Strata truncated by an unconformity dip basinward from the seep locus, velocity pulldowns, and numerous steeply dipping faults in the immediate vicinity of the seep provide corroborating evidence for gas or petroleum-charged sediments and strata with favorable avenues for migration of mobile hydrocarbons to the sea floor.

These factors, taken in concert with the sedimentological regime, a recent increase of basin depth estimates, and the highly localized origin of the hydrocarbons, strongly suggest a petrogenic rather than a recent biogenic origin for these gases.

In FY 78, seasonal and short-term variability of light hydrocarbons in the water column were determined at two locations in Lower Cook Inlet. Kachemak Bay, an area of high biological productivity, and Redoubt Bay, possibly impacted by oil production activities in upper Cook Inlet were selected for study. These stations will be reoccupied in spring of 1979 to obtain more information on seasonal variability and degree of parameter correlation.

Objectives:

For FY 79 RU 153 will focus on site-specific topics in two lease areas. Cline will participate in an interdisciplinary cruise to Norton Sound in the summer of 1979. The overall objectives of the cruise are as follows:

1. To determine background levels of light hydrocarbons and to assess the compositional character of the seep and delineate its range of impact on the sediments and waters of Norton Sound. A gas probe will be used to sample gases in interstitial waters. This data will be compared to data collected by USGS from samples extruded from sediment cores.

2. To evaluate plume dimensions and trajectory, through appropriate hydrographic observations.

3. To investigate the role of suspended matter in the transport and remobilization of petroleum hydrocarbons from the region of the seep, through laboratory studies of oil/SPM interaction.

4. To investigate the usefulness of the low molecular weight aromatics as indigenous tracers of natural petroleum seeps and to assess their usefulness to the documentation of such anthropogenic sources as surface and subsurface injections.

Complementary investigations will be conducted by RU's 152, 480, 29, 190 and P 902.

In Lower Cook Inlet, RU 153 will continue to evaluate light hydrocarbon variability as a function of biological productivity and petroleum production activities as well as heavy hydrocarbon contents of suspended particulate matter. This will be a continuation of FY 78 work and will include continued evaluation of the light aromatic hydrocarbons as tracers for petroleum input. Complementary investigations will be conducted by RU's 152, 275, 480, 29 and 190.

Methods:

RU 153 will deal primarily with analysis of gaseous and gasoline range hydrocarbons in the water column and interstitial water. Sorption-desorption-g.c. techniques will be used. Gasoline range aromatics as well as aliphatics will be determined. Techniques for heavy hydrocarbon analysis will be taken from RU 557. RU 153 will participate in the hydrocarbon intercalibration program.

Output:

1. Narrative Reports: Data will be presented, interpreted and discussed in light of the RU objectives and will include graphs, charts, tables and chromatograms to support the text.

   Data on oil/SPM interaction will be discussed in relation to the mechanisms and risks of biotic uptake of oil associated with SPM.

2. Digital Data: Light hydrocarbon data will be reported in format 043, and heavy hydrocarbon data in format 044.

(RU 480) DISTRIBUTION AND DYNAMICS OF PETROLEUM COMPONENTS IN SEDIMENTS OF THE ALASKA OCS AREAS

This research unit addresses subtask A-1 (BLM Study Type 1-Hydrocarbon Baselines.

Estimated Costs, FY 79:	$39,312	Lower Cook Inlet
	36,288	Norton Sound
	$75,600	Total

Schedule: October 1978 - September 1979

Performing Agency:

University; University of California at Los Angeles
P.I., Degree: I. Kaplan, Ph.D.
Title: Professor of Geology
Percent time devoted to project and role: 10%; Planning and supervision of all field and laboratory phases of the studies, as well as data and report submission.

Background:

Sediments are often hypothesized to be the major sink for spilled petroleum. This conclusion seems particularly valid for those areas with a high suspended sediment load. Recent results from Feely (RU 152) and Cline (RU 153) have demonstrated high suspended sediment loads can "sink" mechanically emulsified oil. The usually high suspended sediment loads in Lower Cook Inlet and in Norton Sound argue in favor of detailed analysis of hydrocarbons in the benthic sediments of these areas.
RU 480 began investigations of sediment heavy hydrocarbons in FY 76 and have completed analysis of sediments from Cook Inlet, Kodiak, St. George, Norton Sound and the Beaufort lease areas. Analytical difficulties in FY 77 severely limited the amount of information generated. These difficulties have been resolved and analysis of all backlogged samples will be completed in FY 78.

Objectives:

For FY 79, RU 480 will focus on site-specific topics in two lease areas, Lower Cook Inlet and Norton Sound. The Lower Cook Inlet sampling program will be designed to address the potential sedimentary impact of petroleum released during exploration and production activities. The three major objectives are: 1) determine the heavy hydrocarbon content of sediments which may have received petroleum input from production activity in upper Cook Inlet; 2) determine the heavy hydrocarbon content of sediments which may have been impacted by exploratory drillings in Lower Cook Inlet with complementary investigations conducted by RU's 29, 190, 275, 152, 153 and 557; and 3) investigate the process of hydrocarbon modification from seeps in Norton Sound.

The seep in Norton Sound is bringing both gaseous and liquid hydrocarbons to the surface as demonstrated by recent data from Cline (RU 153) and Krenvolden (USGS). In FY 79, a multi-investigator cruise to the seep area is planned. RU 480 will participate, with the following objectives: a) characterize more fully the hydrocarbon content of sediments at the seep location; b) determine the distribution of these hydrocarbons with depth in cores taken from the seep to elucidate hydrocarbon flux; c) determine the geographical extent of seep-derived hydrocarbons to gain information on transport and weathering processes. Complementary investigations will be conducted by RU's 29, 190, 152, 153, 557 and P902.

Methods:

Methodology will be identical with that currently in use by RU 480. This includes solvent extraction of heavy hydrocarbons from sediments, fractionation of the hydrocarbons by column or thin-layer chromatography and analysis by g.c. and g.c./m.s. Intra-laboratory separation and recovery efficiency will be determined using a synthetic hydrocarbon mixture and precision and interlaboratory comparability will be determined by analysis of a reference sediment.

Output:

1. Narrative Reports: These periodic reports will discuss the data in light of the stated objectives and will include graphical and tabular data to support the text.

2. Digital Data: Heavy hydrocarbon data will be reported in Format 044.

3. Visual Data: Representative chromatograms mass spectra and charts of hydrocarbon distribution will be included in the narrative reports. Copies of all chromatograms and spectra will be archived by the PI.

(P 902) CHARACTERIZATION OF LIGHT HYDROCARBONS IN SURFACE SEDIMENTS AND SEDIMENT CORES

This unit addresses subtask A-1 (BLM Study Type 1-Hydrocarbon Baseline).

Estimated Costs, FY 79: $50,000 Norton

Schedule: October 1978 - September 1979

Performing Agency:

Agency: U.S. Geological Survey
P.I., Degree: Keith Kvenvolden, Ph.D.
Title: Geochemist
Percent time devoted to project and role: 25%; Supervision of and participation in all field and laboratory phases of the study.

Background:

Investigations in FY 76 by RU 153 (Cline) and more recently by Kvenvolden have proven conclusively the presence of gaseous and gasoline range hydrocarbons in the Norton Sound seep area. Evidence is strong that these are thermogenic in origin and may be indicative of heavy hydrocarbon seepage and, possibly, producible petroleum deposits. The definable location and relatively large magnitude of the seep make it an ideal location to determine the dispersion and weathering of hydrocarbons under real conditions as well as determine the response of the bacterial community to the hydrocarbon presence. A multi-investigator, interdisciplinary cruise to Norton Sound in summer 1979 will investigate these phenomena.

Objectives:

Measurements of light hydrocarbons in sediments and sediment cores will be made to determine the geographical extent of the active seep, downcore hydrocarbon gradients and hydrocarbon flux, correlation between gas probe measurements (RU 153) and whole sediment measurements (P 902), and fractionation and modification of seep hydrocarbons and they are introduced to the sediment surface. Complementary research will be conducted by RU's 29, 190, 152, 153 and 480.

Methods:

Hydrocarbon analysis will employ sorption-desorption g.c. techniques. Cores will be taken with a vibra-core and surface sediments by Sontar-Van Veen grab.

Output:

1. Narrative Reports: These periodic reports will present, discuss and interpret analytical data in light of the stated objectives and will include charts, graphs and tables to support the text.

2. Digital Data: Light hydrocarbon data will be reported in Format 043.

3. Visual Data: Representative chromatograms will be included in the narrative reports. All chromatograms will be archived by the PI.

4.2 DESCRIPTION FOR PROJECTS IN TASK C (HAZARDS):

C-1: RU 483

C-2: RU 429

C-3: RU 429

C-4: RU 429

C-5: RU 208

C-7: RU 429

C-9: RU 88

RU 483

(RU 208) YUKON DELTA COASTAL PROCESSES STUDY

This research unit addresses subtask C-5 (BLM Study Types 11-Volcanic Hazards, 12-Surface and Near Surface Faulting, 14-Erosion and Deposition, and 15-Permafrost).

Estimated Costs, FY 79: $8,000 Norton Sound

Schedule: October 1978 - September 1979

Performing Agency:

University: University of Houston
P.I., Degree: William R. Dupre, Ph.D.
Title: Assistant Professor
Percent of time devoted to project and role: 30%; directs and participates in all phases of the project.

Background:

Complex surface processes of the Yukon-Kuskokwim delta region pose potential hazards and environmental impact problems to onshore development that may occur there in conjunction with offshore oil and gas activity in the Bering Sea. These problems include rapidly shifting coastlines and stream channels, permafrost, major flooding associated with breakup, storm-surge erosion, shorefast ice, faulting, and possible volcanism. By the end of the FY 78 field season, sufficient data will be generated from this study to define the general nature and distribution of these hazards and to evaluate their implications for siting of onshore processing and transportation facilities. Efforts in FY 79 will be devoted to final processing of the data and preparation of a final report.

Objectives:

1. To develop an understanding of morphology, processes, and potential hazards along the Yukon-Kuskokwim delta shoreline.

2. To determine processes active on the delta plain, their potential hazards, and possible effects of man-made structures.

3. To map surface geologic units and determine their physical properties, including the depth and stability of permafrost.

4. To map areas of Quaternary volcanism and faulting and determine the relative age of activity of these features.

Methods:

Various standard methods are being utilized to identify and locate features, study active processes, and to establish a chronology of recent geologic events. These include field geologic mapping, aerial reconnaissance, beach profiling, sampling for textural analysis, mineralogy, and radiocarbon dating, and review of hydrologic data, aerial photography, and published maps. Final compilation and evaluation of these data will be performed in FY 79 towards production of a final report.

Output:

1. Narrative Reports: These will provide a detailed description of the project objectives, background information, field methods, analytical procedures, results, and recommendations for further research. Implications regarding hazards to onshore facilities and potential impacts of activity will be summarized.

2. Digital Data: Beach profiles and grain size analyses of beach samples will be submitted on punch cards or magnetic tape in standard archive formats 072 and 073, respectively.

3. Visual Data:

    a. Maps of coastal morphology, showing areas of severe erosion or accretion.

    b. Maps and accompanying text describing nearshore sediment dynamics.

    c. Maps and accompanying text describing the geology, tectonics, and surface processes of the Yukon-Kuskokwim delta shoreline and delta plain.

(RU 429) FAULTING, SEDIMENT INSTABILITY, EROSION, AND DEPOSITION HAZARDS OF THE NORTON BASIN SEA FLOOR

This research unit addresses subtasks C-2, C-3, C-4, and C-7 (BLM Study Types 12 - Surface and Near Surface Faulting, 13 - Seafloor Instability, 14 - Erosion and Deposition, and 16 - Ice Gouging).

Estimated Costs, FY 79: $100,000 Norton Sound

Performing Agency:

Department: U.S. Geological Survey, Pacific-Arctic Branch of Marine Geology
P.I., Degree: C. Hans Nelson, Ph.D.
Title: Geologist
Percent of time devoted to project and role: 100%; directs and participates in all phases of project.

Background:

Reconnaissance marine geological and geophysical surveys conducted through fiscal year 1977 have identified several potential seafloor hazards in Norton Sound, including surface and nearsurface faults, ice gouging, bottom current scour, and gas-charged sediments. Detailed studies of these phenomena are planned for fiscal year 1978 and will continue into 1979. These studies will provide critical information for determining the age of recent faulting, recurrence rates and depth of ice gouging, mobility of large bedforms, and stability of gas-charged sediments.

Objectives:

The overall objective of this study is to identify and describe potential seafloor hazards which may affect oil platforms, drilling operations, and pipelines in Norton Sound. Specific objectives for FY 79 are:

1. To determine the potential intensity and depth of sediment scour in the presence of artificial structures in areas of observed scour depressions.

2. In areas of large-scale mobile bedforms, to determine the depth of active scour and periodicity of bedform movement.

3. To delineate areas of potential blowout hazards due to penetration of subsurface thermogenic gas pockets.

4. To delineate areas potentially hazardous to offshore structures because of reduced bearing capacity of gas-charged sediments.

Methods

High resolution acoustic profiling and side-scan sonar will be used to identify and characterize seafloor features. Sediment samples will be collected and analyzed for age determinations and physical properties.

Output:

1. Narrative Reports: Reports will provide a detailed description of profiling and sampling methods, spatial density of the survey, analytical and interpretive methods, background information, results of the field and laboratory work (including graphic illustrations), interpretation of the nature and severity of potential seafloor hazards in Norton Sound, and recommendations.

2. Digital Data: Grain size analysis data will be submitted on punch cards or magnetic tape in OCSEAP standard archive format type 073.

3. Visual Data:

    a. Maps showing areas of potentially severe erosion, deposition and large-scale bedform movement, including depth of active scour.

    b. Maps delineating boundaries of thermogenic gas pockets and areas potentially susceptible to uncontrolled gas escape from penetration during drilling operations.

    c. Maps and figures showing the distribution of shallow biogenic gas accumulations and associated active surface craters, including areas not covered in previous surveys.

    d. Maps delineating all areas potentially hazardous to offshore structures due to reduced bearing capacity of gas-charged sediments (both thermogenic and biogenic).

    e. Cross-sections of potentially unstable sediment masses.

4. Other Data: Sub-bottom profiles, fathograms, side-scan sonar records, and associated navigation will be submitted for inclusion in the OCSEAP data base.

(RU 483) EVALUATION OF EARTHQUAKE ACTIVITY AROUND NORTON AND KOTZEBUE SOUNDS.

This research unit addresses subtasks C-1 and C-9 (BLM Study Type 10 - Seismic Hazards).

Estimated Costs, FY 79:		
	$ 26,700	Beaufort
	58,800	Chukchi
	58,800	Norton
	$144,300	Total

Schedule: October 1978 - September 1979

Performing Agency:

University: University of Alaska
P.I., Degree: N. N. Biswas, Ph. D.
Title: Associate Professor of Geophysics
Percent of time devoted to project and role: 20%; responsible for keeping field installations operational and data reduced (the latter is done routinely and semi-automatically).

Background:

Six seismic stations were installed on the Seward Peninsula in 1976 and 1977, in order to develop an overall view of the nature and potential dangers from earthquakes in that area. Icequakes (strong motion of the sea ice sheet during shear events in Kotzebue Sound area of the Chukchi) have also been successfully recorded with the seismic network. Most of the cost of the work involves the maintenance of the sites and telemetering of the seismic signals to Fairbanks. In 1978 RCA increased the cost of telemetering the data to Fairbanks by 87% and it is now cheaper to purchase equipment and record the seismic signals in Nome. This conversion will take place during FY 79. An experiment in measuring the attenuation of seismic signals in the Prudhoe Bay area will also be undertaken in FY 79.

Objectives and Methods:

1. Operate an array of six seismic stations on the Seward Peninsula in order to develop an understanding of the nature and potential dangers of earthquakes in that area.

2. Conduct a 3-month study near Prudhoe Bay to show the attenuation of wave energy arriving at Prudhoe Bay from the seismically active area to the east, and study the associated predominant failure mechanisms.

3. During the same 3-month period, continue the ice quake studies begun near Kotzebue.

Output:

1. Narrative Reports: Catalogs of earthquake activity, including epicenters, determination of hypocentral distribution and focal mechanism solutions, establishment of b-slopes and characteristics of crustal parameters. Narrative of earthquake attenuation and icequake activity, location and strength, and correlation with wind and other forces as well as sea ice imagery from aircraft and satellites.

2. Digital Data: Readings of p, s, and amplitude of earthquakes.

3. Visual Data: Epicenter maps, amplitude spectra, graphs of attenuation coefficients, graphs and correlations with wind, satellite imagery of ice.

4.3 DESCRIPTION FOR PROJECTS IN TASK D (TRANSPORT):

D-1:	RU 435	
	RU 541	
	RU 550	
D-2:	RU 435	P 323
D-8:	RU 88	
D-9:	RU 88	

(RU 88) DYNAMICS OF NEARSHORE SEA ICE

This research unit addresses subtasks C-9, D-8 and D-9 (not designated as to BLM study types).

Estimated Costs, FY 79:		
	$33,400	Beaufort
	11,100	Chukchi
	11,100	Norton Sound
	$55,600	Total

Schedule: October 1978 - September 1979

Performing Agency:

Agency: Cold Regions Research and Engineering Laboratory, U. S. Army
P.I., Degree: Wilford F. Weeks, Ph.D.
Title: Research Glaciologist
Percent of time devoted to project and role: 20% (sabbatical during part of FY 79); principal investigator on studies of shorefast ice movement, ice ridge geometries, ice forces and ice gouging.

P.I., Degree: Austin Kovacs
Title: Research Civil Engineer
Percent of time devoted to project and role: 30%; co-principal investigator on studies of shorefast ice movement, ice ridge geometries, ice forces and ice gouging.

Background:

This project studies four problem areas:

1. The deformation and movement of shorefast ice, including ice pile-ups.

2. The large-scale movement of pack ice through Bering Strait (Chukchi Sea and Norton Sound lease areas).

3. The characterization of the pack ice along the Beaufort Sea coast, by means of aerial remote sensing.

4. The strength properties of sea ice, by examining preferred crystal orientation.

The fast ice studies have been carried out for two seasons, under ice conditions that were quite different during the two years; these studies have given an adequate understanding for present needs and will be terminated, with only a minor amount of analysis still to be carried out. The Bering Strait studies have only commenced in early 1977 and will be continued for another year at least. The adequate compilation of statistical data for the entire coastal ice conditions, which vary greatly from year to year, requires that the remote sensing program also continue. Finally, work started in FY78 on ice crystal orientation will be continued.

Objectives:

The objectives of these studies are the characterization of the nearshore sea ice as habitat, transporter of spilled oil and hazard to oil development. Specifically, the objectives are the study of:

1. Movement and deformation of shorefast ice, including ice pile-ups, jams, etc. on islands.
2. Movement and deformation of the pack ice through the Bering Strait (the major mechanism transporting any spilled oil from the Chukchi Sea to the Bering Seas).
3. Statistical characterization of nearshore ice conditions, e.g., frequency and dimensions of leads, pressure ridges, etc. on a regional and seasonal basis (these are parameters determining the effective role of sea ice as a habitat, as a transporter of spilled oil and as a hazard).
4. Preferred crystal orientation of the sea ice, which affects the strength properties of the sea ice (also indicates prevailing current directions).

(Additional objectives requested by BLM will be discussed under RU 250). Note that the P.I. has been deeply involved in the synthesis of ice hazard data. It is under this heading that he will continue to relate findings and conclusions of all OCSEAP ice projects to development scenarios.

Methods:

1. Analysis of radar transponder data from Cross and Narwhal Islands, near Prudhoe Bay.
2. Operation of a sea ice surveillance radar at Cape Prince of Wales.
3. Analysis of aircraft remote sensing data from Side Looking Airborne Radar, laser profilometer and cameras.
4. Analysis of ice cores collected across the continental shelf.

Output:

1. Narrative Reports: Shorefast ice displacement in spring and its causes, ice flux (mass and velocity) through Bering Strait throughout the period with an ice cover (all except summer), frequency distributions of number and height of pressure ridges and leads on a seasonal and regional basis, crystal orientation and its implications.

2. Digital Data: None

3. Visual Data:

   3.1 Imagery: Side Looking Airborne Radar imagery, laser profiles of sea ice, aerial photography, sea ice radar imagery (time-lapse photos of radar screen).

   3.2 Maps and figures: Displacement vectors of shorefast ice, displacement vectors and flow trajectories of sea ice in Bering Strait, frequency distributions of numbers and sizes of leads and pressure ridges on a seasonal and regional basis, crystal orientation diagrams and correlation with current vectors.

(RU 435) A DYNAMIC CIRCULATION MODEL OF THE BERING SEA

This research unit addresses subtasks D-1 and D-2 (BLM Study Types 27 - Current and Tides, 30 - Dispersion and Mixing and 32 - Trajectories of Oil Spills).

Estimated Costs, FY 79:	$ 29,600	Bristol Bay
	109,600	Norton Sound
	--20,800	St. George
	$160,000	Total

Schedule: October 1978 - September 1979

Performing Agency:

Private: Rand Corporation
P.I., Degree: J. Leendertse, Ph.D.
Title: Project Director, Water Pollution Studies
Percent of time devoted to project and role: 25%; project director and co-principal investigator.

P.I., Degree: S. Liu, Ph.D.
Title; Physical Scientist
Percent of time devoted to project and role: 50%; co-principal investigator

Background:

A comprehensive OCSEAP investigation of Bering Sea shelf water mass dynamics and its driving mechanisms, underway since September 1975, has shown that semidiurnal tidal currents contribute about three-fourths of the observed variance in Eulerian current records. Episodic current pulses, attributed to water movements on and off the shelf, are at least in part responsible for the residual circulation. The current pulses are presumed to be responses to meteorological forcing in the form of regional pressure differences and sea surface wind stresses.

The above features are considered in a numerical predictive model of the stratification and circulation in Norton Sound, St. George Basin, and Bristol Bay initiated in FY 77 by the Principal Investigator. The model presently under development includes the effects of tides, wind stress, density stratification, bottom friction and momentum transfer. This study is part of an overall modeling effort to describe tidal and wind driven circulation in the entire eastern Bering Sea.

Objectives:

The nature and effectiveness of the main physical processes which transport pollutants in the Bering Sea are to be studied by use of the model along with determinations of transport. Specifically, the model will:

1. Support and guide transport studies.

2. Determine local currents and water quality responses to wind fields and tides.

3. Provide risk planning data for OCS petroleum development.

4. Furnish contaminant trajectory, landfall and other data needed for pollution event countermeasures and for planning of FY 80 studies.

5. Provide environmental monitoring station site location planning information.

6. Provide a means of determining the intensity and location of storm tides under various conditions.

7. Develop the capability to provide trajectories under ice-cover.

Methods:

An existing three-dimensional finite difference model of the southeastern Bering Sea is being refined and extended. The initial phase of the investigation emphasized:

1. Development of time-and space-varying boundary conditions (pressure, salinity, temperature, etc.) from available field data.

2. Optimization of the finite difference approximation over the vertical.

3. Adjustment of bottom and wind stress coefficients and coefficients for mass and momentum exchanges.

Results derived from the model, when driven by data obtained earlier, will be compared to field data to verify the model. Pollutant trajectories and current fields (including tidal wave components) will be generated following verification.

Output:

1. Narrative Reports: The Principal Investigators will provide a detailed report for Norton Sound and Southeastern Bering Sea, including:

    a. progress and strategy used in adjustment and verification of the model.

    b. graphic presentations of derived current data which can be compared to empirical data for verification of the model.

    c. pollutant trajectories from hypothetical spill locations under typical conditions.

    d. a discussion of results of verifications and implications of those results on accuracy of trajectory predictions.

2. Digital Data: Not required.

3. Visual Data: Numerous graphs and charts of simulation results showing:

    a. inputs
    b. pollutant trajectories
    c. horizontal and vertical velocity fields
    d. comparisons of field and other simulation data

(RU 541/550) NORTON--CHUKCHI OCEANOGRAPHIC PROCESSES

This research unit addresses subtasks D-1 (BLM Study Type 27 - Currents and Tides and 29 - Residence Time and Flushing).

Estimated Costs, FY 79:	$ 35,000	Chukchi Sea
	105,000	Norton Sound
	$140,000	Total

Schedule: October 1978 - September 1979

Performing Agencies:

University: University of Washington (RU 541)
P.I., Degree: L. K. Coachman, Ph.D.
Title: Professor of Oceanography
Percent of time devoted to project and role: 10%; project co-ordinator, CTD analysis, and interpretation.

Agency: NOAA/ERL/PMEL (RU 550)
P.I., Degree: R. L. Charnell, M.S.
Title: Supervisory Oceanographer
Percent of time devoted to project and role: 15%; analysis and interpretation of current meter data.

P.I., Degree: J.D. Schumacher, Ph.D.
Title: Oceanographer
Percent of time devoted to project and role: 25%; analysis and interpretation of current meter data.

Background:

Field investigations were initiated in the Norton Sound and Chukchi Sea lease areas during FY 77 under this Research Unit. These studies constitute the first detailed oceanographic measurements ever conducted in either region. Studies included the deployment of moored current meter arrays on the other edges of the two lease areas and near the mouth of Norton and Kotzebue Sounds. These instruments, deployed in the fall of 1976, were recovered in the fall of 1977 and yielded the first known verification of the continuity of northward flow under the ice through Bering Strait during the winter.

CTD data are available from nearshore in Kotzebue and Norton Sounds following the FY 77 and 78 field work. These include CTD data taken through the ice in FY 78. (February-March). These data, along with results from current meters deployed in FY 78, are believed to be sufficient to meet program objectives first set forth in FY 77.

Objectives:

The primary FY 1979 objective is to complete the analyses of data acquired to date in order to define the dominant circulation features, including spatial and temporal variability, within the offshore and nearshore regions of the Norton Sound/Chukchi Sea lease areas. Specifically, the objectives are:

1. To quantify the velocity fluctuations at mooring sites.
2. To correlate fluctuations in transport with synoptic scale variations in meteorological parameters.
3. To describe regional mean flow patterns.
4. To analyze the impact of ice-cover on rate of wind energy transfer to the water column.
5. To define the nearshore hydrography and circulation patterns within Norton and Kotzebue Sounds and to interpret the circulation features in terms of residence time and flushing of these sounds.
6. To provide verification data for modeling to tidal and wind driven circulation within the Norton Sound lease area (RU 435).

Output:

1. Narrative Reports: As required of all OCSEAP projects. Reports provided will include:
    a. A description of circulation in the region.
    b. An analysis of the effect of climatic systems and meteorological events on circulation.
    c. An objective estimate of variability of currents described in a.
    d. An estimate of the effectiveness of mixing processes and flushing time of enclosed sounds.
2. The narrative report will contain a description of measurement locations, measurement and analysis techniques, sampling frequency and duration.
3. Digital Data: All current meter, pressure gauge, and CTD data will be in digital form and will be submitted to OCSEAP in approved format processed data tapes.

(P 323) NEARSHORE METEOROLOGY IN THE BERING SEA

This research unit addresses subtask D-2 (BLM Study Type 28 - Windfields).

Estimated Costs, FY 79: $50,000 Norton Sound

Schedule: October 1978 - September 1979

Performing Agency: To be determined

Background:

This research unit addresses subtask D-2, section h, Local Meteorological Studies, in part.

Orographic effects and the presence of the land-sea boundary cause local winds to differ significantly from winds calculated from pressure gradients on synoptic weather charts. The effects occur on a scale that precludes calculations of trajectories of hypothetical or real oil spills unless a procedure is available for determining more realistic wind fields in the area of the spill.

The need for determination of local wind fields for running trajectory and circulation models will be met in Norton Sound in part by use of the model developed for the Beaufort Sea by RU 519. However, the combination of orographic effects and the sea breeze are not well understood, and it is unlikely that the model developed for the Beaufort Sea can be used in Norton Sound without data from there.

Objectives:

The objective of this research is to compare local winds with large scale pressure distributions and to derive from that comparison an algorithm that may use the pressure distribution to calculate a local wind field which accounts for local topography and the landsea boundary. The results will be digitized or made otherwise directly available for use in the circulation model (RU 435).

Strategy and Methods:

Winds will be measured and recorded along the coast at several locations. (Recordings will coincide partly with shipboard observations if sea-time is available) The pressure field will be determined from an array of widely spaced pressure transducers.

The pressure field will be analyzed for the geostrophic and surface wind fields. The wind field will be fitted to the pressure field, using existing models as used in the Beaufort Sea study (Schwertfeger 1974, 1975; Dickey 1960, and Walsh 1974). Analysis will also be performed for specific weather map types as well as for the general case.

Outputs:

A narrative report will be provided which includes an algorithm with coefficients for deriving local winds from synoptic weather charts by weather type with a discussion of probable errors and recommendations for their reduction. The report will also fully document methods of data acquisition and analysis and discuss the modification, if any were required, to existing models relating winds to pressure fields.

Data acquired will be archived in the OCSEAP data base in format FT 101 as specified by the project office. Data will be provided to RU 435 in the form of digitized wind fields applicable to the circulation model.

4.4 DESCRIPTION FOR PROJECTS IN TASK E (BIOTA):

E-1: RU 230
E-2: RU 194
RU 230
RU 232
E-3: RU 196
RU 237
E-4: RU 196
RU 237
E-6: RU 232
E-7: RU 232
E-15: RU 29
RU 190
E-17: RU 196
RU 230
RU 237

(RU 29) ASSESSMENT OF POTENTIAL INTERACTIONS OF MICROORGANISMS AND POLLUTANTS FROM PETROLEUM DEVELOPMENT IN LOWER COOK INLET AND THE BEAUFORT SEA

This research unit addresses subtasks E-15 (BLM study type 57 - Effects of Contaminants on Normal Microbial Activity).

Estimated Costs, FY 79:		
	$ 70,500	Beaufort Sea
	$ 32,500	Lower Cook Inlet
	$ 32,500	Norton Sound
	$135,500	Total

Schedule: October 1978 - September 1979

Performing Agency:

University: University of Louisville
Department: Department of Biology
P. I., Degree: R. Atlas, Ph.D.
Title: Assistant Professor of Biology

Background

The goals of the OCSEAP microbiology program are to determine the effects of oil on the numbers and types of bacteria present in each lease area and their contribution to the productivity of the area, through carbon and nitrogen fixation and denitrification. Spatial and seasonal variation can be enormous; hence sampling should be done on a seasonal and spatial basis. In addition, the capabilities of the microbial population to degrade oil should be investigated.

These objectives have been addressed by RU 29 and 190. To date we have a good understanding of the types and numbers of bacteria and their productivity in Cook Inlet on a seasonal and geographical basis. Geographical data only on types and numbers of bacteria, biomass, and nitrogen fixation will be available in FY 78 for the Beaufort Sea.

Objectives:

RU 29 is concerned with the determination of the effects of oil on the numbers and types of bacteria present in water and sediment samples, the rates at which they carry out denitrification. In FY 79, objectives for each lease area will be as follows:

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

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

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

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

Methods:

Sediment and water samples will be collected during one cruise in Norton Sound and one cruise in Cook Inlet. The plexiglass trays on the floor of the Beaufort Sea will be sampled by divers 3 times per year.

Total bacteria will be quantified by epifluorescence counting, and viable bacteria will be quantified by growth on glucose or glutamic acid-containing agar at 5 and/or 20? C. Hydrocarbon biodegradation potential (a measurement of the capability of the bacterial population to degrade hydrocarbons) will be determined by measuring the rate of CO_1 release from ^{14}C labeled hydrocarbons added to samples. Taxonomy of the bacterial population will be determined by measuring the numbers of microbes capable of growing on a large variety of substrates, including sugars, alcohols, and amino acids.

Compositional analyses of petroleum and its biodegradation products will be performed using gas chromatography and mass spectrometry. The investigator will participate in intercalibration analyses in cooperation with other OCSEAP-sponsored laboratories.

Output:

1. Reports containing:
    - a. detailed descriptions of experimental methodology, including protocols for sample collection, measurements of total and viable bacteria, hydrocarbon biodegradation potential, numerical taxonomy, and chemical analyses;
    - b. results, including figures and tables showing numbers of total and viable bacteria, hydrocarbons biodegradation potential, and numerical taxonomy as a function of sample type and site and of environmental parameters such as temperature and salinity. Chromatographs of petroleum components and breakdown products isolated from the plexiglass trays in the Beaufort Sea should be included;
    - c. interpretation of results, conclusions, and recommendations for future studies.
2. Digital data on microbial population counts and taxonomy, deposited at NIH, available to OCSEAP and other interested parties through NODC.

(RU 190) MICROBIAL ACTIVITY AND CRUDE OIL MICROBIAL INTERACTIONS IN WATERS AND SEDIMENTS OF COOK INLET AND THE BEAUFORT SEA

This research unit addresses subtask E-15 (BLM study type 57 - Effects of Contaminants on Normal Microbial Activity).

Estimated Costs, FY 79:

$ 15,000	Beaufort Sea
15,000	Norton Sound
100,000	Lower Cook Inlet
$130,000	Total

Schedule: October 1978 - September 1979

Performing Agency:

University: Oregon State University
P.I., Degree: R. Griffiths, Ph.D. and R. Morita, Ph.D.
Title: Research Associate; Professor of Microbiology
Percent time devoted to project and role: Griffiths: 30%; Morita, 5%; jointly plan and supervise program.

Background:

The goals of the OCSEAP microbiology program are to determine the numbers and types of bacteria present in each lease area and the potential effects of contaminants or their contribution to the productivity of the area, through carbon and nitrogen fixation and denitrification. Spatial and seasonal variation can be enormous; hence sampling should be done on a seasonal and spatial basis. The interactions of oil and microbes must be studied, including the capabilities of the microbial population to degrade oil and the effects of oil on microbial abundance, diversity, and functions.

These objectives have been addressed in the past by RU's 29 and 190. To date there is some understanding of the types and numbers of bacteria and their productivity in Cook Inlet on a seasonal and broad geographical basis. Geographical data only on types and numbers of bacteria, biomass, and nitrogen fixation will be available in FY 78 for the Beaufort Sea.

Emphasis in FY 79 will be placed on evaluating possible effects of crude oil and weathered petroleum contaminants on the nature and extent of microbial involvement in the productivity and microbial activity of selected OCS areas.

Objectives:

1. In Lower Cook Inlet, to determine the effects of petroleum on the extent and nature of microbial involvement in detrital food webs at selected nearshore study sites. More specifically this will involve:

a. Literature review and synthesis of all available information of the role microbiota in detrital food webs with emphasis on the arctic marine environments.

b. The comparison of microbial biomass, relative microbial activity, respiration ratios, microbial growth (by indirect means), and rates of nitrogen fixation and denitrification between control and petroleum impacted sediments of selected nearshore areas.

c. The determination of the rates of hydrocarbon biodegradation in control and petroleum impacted sediments of selected nearshore areas.

Measurements should also be made of the effects of oil on the following physiochemical variables, and correlations should be made with the microbial measurements listed above: pH, Eh, salinity, temperature, NO_2, NO_3, NH_4, O_2, total organic C, and total organic N.

2. In the Beaufort Sea, to determine the effects of petroleum on relative microbial activity, respiration ratios, rates of nitrogen fixation, and inorganic nutrients in bottom sediments provided by RU 29 from the plexiglass tray experiment.

3. In Norton Sound, to determine whether the presence of a natural oil seep has altered the activity of the microbial population. Relative microbial activity, respiration ratios, rates of nitrogen fixation, and inorganic nutrients will be measured in the same water and sediment samples used by RU 29 for measurements of the relative abundance of microbes.

4. To continue laboratory studies to determine the effects of crude oil on relative microbial activity, respiration ratios, and rates of nitrogen fixation.

Methods:

Samples will be collected from small boats in Cook Inlet and the Beaufort Sea and during one ship cruise in Norton Sound. Nearshore sites selected for study in Cook Inlet will include the nearshore areas that were studied in FY 78 by RU's 417 and 512. Techniques for addressing the objectives for Lower Cook Inlet will be developed at the beginning of FY 79 using information collected in FY 78 by RU's 417 and 425. Relative microbial activity will be measured by uptake of glucose and glutamic acid. Respiration ratios will be measured by the release of CO_2 from ^{14}C-labeled substrates. Nitrogen fixation will be measured by the acetylene reduction method. Procedures for determining the effects of petroleum on the microbial involvement in detrital food webs will take into consideration possible effects on nitrogen fixation and denitrification by gastro-intestinal flora as well as sediment flora. Procedures for measuring the effects of petroleum on microbial growth and biomass will also consider correction for cropping rates by protozoa.

Output:

Expected products from this research activity include:

Narrative reports: Describing the general state-of-knowledge, methodology, results and conclusions. Such narrative reports should include a seasonal documentation of the effects of oil on microbial biomass, crude oil biodegradation, respiration, growth, rates of nitrogen fixation and denitrification, and correlations of these variables with those physiochemical variables measured concomitantly. An evaluation as to the probable impacts of crude oil on the study site should be included.

Digital data: On station locations and sampling information required by the standard format; digital data on microbial biomass, microbial activity, respiration ratios, microbial growth, rates of nitrogen fixation and denitrification, and protozoan biomass and cropping rates of bacteria; digital data on physio-chemical variables measured in conjunction with the microbial studies. All data will be submitted to NIH inconjunction with RU 29 (Atlas), and RU's 371 and 391 (Krichevsky).

Visual Data: Data accompanying the narrative reports include:

a. Charts of stations locations and areas of high biodegradation, nitrogen fixation, and denitrification.

b. Graphs showing the seasonal variations of microbial variables and their relationship to those physiochemical variables measured concomitantly, rates of biodegradation of crude oil, and the effect of crude oil on these microbial processes. Supporting tables should be provided indicating the appropriate parameters and test statistics used in the analysis.

(RU 194) MORBIDITY AND MORTALITY OF MARINE MAMMALS

This research unit addresses subtasks E-2 and F-7 (BLM study types 39 - Vulnerable Populations, 40 - Life History).

Estimated Costs, FY 79:

$30,000	Kodiak
10,000	Lower Cook Inlet
10,000	NEGOA
4,000	Norton
2,000	Chukchi
4,000	Beaufort
$60,000	Total

Schedule: October 1978 - September 1979

Performing Agency:

University: University of Alaska
P.I., Degree: Francis H. Fay, Ph. D.
Title: Associate Professor
Percent of time devoted to project and role: 33% Project direction sample collection, and data analysis.

Background:

FY 76, FY 77, and FY 78 efforts consisted of aerial reconnaissance to locate stranded, dead and moribund animals and necropsy of selected individuals. A review of historical information on marine mammal morbidity and mortality was completed and an annotated bibliography prepared and cross-indexed. Research will be continued into FY 79 to provide information on annual variation in disease occurrence of stranded and beached carcasses. No further necropsy or analysis of mammal specimens obtained through selective collecting is anticipated in FY 79. A very large body of unpublished observations on many aspects of arctic fox (Alopex lagopus) biology is available to this P.I. As an alternative to commencing fieldwork on the problems of foxes, this RU will be asked to deliver a summary report dealing with fox biology as it relates to OCS activities.

Objectives:

Level of effort will be reduced in FY 79. Specifically, the objectives are:

1. To determine the number (by species, sex, and age) of stranded marine mammals along the Alaskan coast.

2. To determine the pathological conditions and agents that caused or contributed to the moribund condition or death of stranded animals.

3. To analyze and determine the major cause of natural mortality of those species of marine mammals that have been selectively collected by RU 229 (Pitcher), RU 243 (Calkins), RU 230 (Burns), and RU 232 (Burns) during the past three years.

4. To determine annual variation in the pathological agents that cause or contribute to moribund conditions or death of marine mammals.

5. To determine the occurrence of pathogenic agents in the natural populations of marine mammals.

6. To determine the source and probable drift trajectories for these areas where the highest incidence of beached mammal carcasses occur.

7. Synthesize and report on previously obtained, unpublished data (non-OCSEAP) on arctic foxes, relating their trophic dependencies to marine-derived beached carcasses, pathological conditions, and to offshore oil and gas development activities.

Methods:

The only significant change in sampling methods during FY 79 will be the concentration of sampling efforts on stranded dead mammals, rather than those collected for research purposes.

Output:

1. Narrative Reports: These will describe the distribution of stranded dead and moribund animals along the Alaskan coast, the type of pathogenic conditions that caused or contributed to the moribund condition or death of stranded animals, and of the annual variation in the incidences of selected pathogenic agents in natural populations.

2. Digital Data: These will be in OCSEAP formats File Type (FT) 011 - Histopathology, FT 025 - Mammal Specimen and FT 026 - Mammal Sighting 02.

3. Visual Data: Data supporting the narrative report will be provided in the form of maps, charts, figures, tables and, where appropriate, photographs. Specifically, the products will be:

a. Maps of stranded, moribund, and dead marine mammals.

b. Charts illustrating probable carcass drift based on stranding from known sources.

c. Figures and tables illustrating:

(1) The occurrence of pathogenic agents in selected species.

(2) The annual variation in the occurrence of pathogenic agents for selected species.

(3) The occurrence of pathogenic agents in principal life stages of selected marine mammals.

(RU 196) DISTRIBUTION, ABUNDANCE, AND FEEDING ECOLOGY OF BIRDS ASSOCIATED WITH SEA ICE

This research unit addresses subtasks E-3, E-4, E-17, F-6 (BLM Study Types 41 - Critical Habitats and Habitat Dependencies, 42 - Food Web Dependencies, and 55 - Environmental Recovery Rates of Ecosystems).

Estimated Costs, FY 79:		
	$30,000	Beaufort
	10,000	Chukchi
	10,000	Norton Sound
	$50,000	Total

Schedule: October 1978 - September 1979

Performing Agency:

Agency: Pt. Reyes Bird Observatory
P.I., Degree: George Divoky, M.S.
Title: Research Associate, Seabirds
Percent of time devoted to project and role: 75%; project leader, compilation and analysis of results.

Background:

Interpretive understanding of the broad dependencies of arctic marine birds on sea ice habitats in pre-breeding, breeding and post-breeding periods should be virtually completed in four lease areas during FY 79, with the possibility that certain specific spatial and temporal questions remain to be addressed by field checking. Otherwise, FY 79 will be a synthesizing of information in hand from earlier work in both ice habitats work and integrated trophics studies for this RU (the latter in conjunction with RU's 6, 29, 196, 230, 232 and 359).

Two additional kinds of work that have been, or will have been initiated by the end of FY 78 are the perturbations of barrier island-breeding birds and their chief predators (arctic foxes) and the pursuit of species accounts in those taxonomic groups where the PI has the best background (terns and small gulls).

Needs for any further field effort in '79 cannot be identified with certainty, until the '78 field results are evaluated.* (see items with * on page 2)

Manipulative studies, ongoing at Cooper Island since 1976, are to answer one or more of three questions:

1. What is the recovery rate for a species on a given island after destruction of all breeding adults in one year?

2. What is the return rate of adults to a given breeding island following complete reproductive failure (i.e. oiling all eggs or destruction by foxes) in a single year?

3. In the event of habitat preemption by industry on one island, can "substitute" breeding habitat be created by provision of extra driftwood or other appropriate shelter on unoccupied islands, and with or without controlling fox predation?

The 1979 work on this project will thus have four basic emphases:

- Wrap-up and exposition of pagophilic species' interactions with ice edge habitats;

- Analysis and synthesis of integrated trophics studies carried out in 1977 and 78;

- Analysis and continuing observation of manipulated nesting conditions for Arctic Terns, Pacific Eiders, and Black Guillemots on Cooper Island and other typical Beaufort barrier islands, begun in 1976;

- Species accounts formulated for small gulls and terns for all Alaskan OCS areas.

Objectives:

1. Synthesize understanding of bird occurrence in relation to all major seasonal ice events (formation, maximum extent, minimum extent) in each lease area (Norton, Chukchi, Beaufort).

2. Synthesize information on repetitive ice/polynya features on distributions of birds.

3. Synthesize predictive understanding of the importance of anomalous ice features in year-to-year variations to occurrence and abundance of pagophilic species.

4. Summarize results of work done to date to identify and follow ice and water mass dynamics seasonally to learn what influence events such as breakouts, variable shear zones, and major lead systems have on the avian community.

5. Synthesize information on trophic ecology of pagophilic species to the point that major prey items can be identified as requiring additional understanding/experimentation in view of offshore development.

6. Report on recovery potentials of reduced populations, probably at Cooper Island, with Arctic Terns, estimated in FY 78.

7. Report on effects on island "carrying capacity" of increased driftwood availability or other appropriate nest habitat modifications, in presence and absence of foxes as predators.

8. Provide species account summaries on Arctic and Aleutian Terns, Ross' and Sabine's Gulls, according to OCSEAP-specified format, statewide for Alaska.

Methods of 1977 - 78 Field Effort:

1. Limited shipboard and ice based observations, using a limited number of trained, skilled observers on cruises in and near ice/water edge habitats.

2. Observation and subsequent collection of birds to analyze stomach contents, to document trophic dependencies.

3. Shore-based studies in the Beaufort, where breeding birds come into contact with ice edge phenomena and small boat-based observations in nearshore shallow situations.

4. Aerial and satellite remote sensing interpretation in cooperation with the remote sensing projects (primarily RU 267).

5. Follow-up studies of artifically reduced breeding bird numbers on Cooper Island begun in FY 78.

6. Continue or initiate studies relating nesting structure availability to carrying capacity of specific islands.

Outputs:

1. Narrative reports: Analyses of densities, age classes, activities and stomach contents of birds encountered, including tabular and graphic trophics presentations, according to standard reporting schedule. Reports on manipulative experimental results species synthesis accounts.

2. Digital data: Marine bird ship/aircraft census data, bird colony and zooplankton data, ice and ocean conditions.

3. Visual data: Maps of the occurrence and densities of each species for each cruise, in relation to major ice features and habitat types.

4. Models: Word-schematic modeling of ice features, deformations, anomalies, as necessary to illustrate and interpret mechanisms and dynamics of the bird/ice relationships in average and extreme cases, all lease areas and seasons.

(RU 230) THE NATURAL HISTORY AND ECOLOGY OF THE BEARDED SEAL ERIGNATHUS BARBATUS AND THE RINGED SEAL PHOCA (PUSA) HISPIDA

This research unit addresses subtasks E-1, E-2, E-17, F-7 (BLM Study Types 40 - Life History Analyses, 41 - Critical Habitats and Habitat Dependencies, and 50 - Sublethal Effects of Oil).

Estimated Costs, FY 79:

$30,600	Beaufort
29,700	Chukchi
20,000	Norton Sound
10,000	St. George
$90,300	Total

Schedule: October 1978 - September 1979

Performing Agency:

Agency: Alaska Department of Fish and Game
P.I., Degree: Thomas J. Eley, M.S.
Title: Marine Mammal Biologist
Percent of time devoted to project and role: 100%; specimen collection, analysis.

P.I., Degree: John J. Burns, M.S.
Title: Marine Mammal Biologist
Percent of time devoted to project and role: 33%; overall guidance, writing, administration and scientific management, specimen collection, analysis.

P.I., Degree: Kathryn J. Frost, M.S.
Title: Marine Mammal Biologist
Percent of time devoted to project and role: 50%; specimen analysis, reporting, data management.

Background:

This multi-year study focuses on the biology and population dynamics of the two species of ice-inhabiting seals of greatest importance to coastal inhabitants of arctic Alaska. The two species differ widely in their biology as it is currently understood. The ringed seal is a small animal with greatest densities observed nearshore, in drifting and landfast ice. For food it is dependent on zooplankton and small fishes. The bearded seal is a large animal and the more completely independent of land of the two. It occurs mainly offshore and feeds on benthos obtained from drifting ice platforms.

Data required include: migration routes and timing, natality, mortality, growth (fetal and neonatal), population structure, longevity, age specific reproduction, habitat requirements and other process studies. The extent of dependency on these two species by Native Alaskans must also be monitored. These studies are required to develop an assessment of the vulnerability to, and recovery from perturbations.

Fieldwork depends in part on securing specimens from Native hunters, who make available bearded and ringed seals they harvest. Fieldwork also depends on securing specimens from key coastal sites where the investigators make use of their unique, privileged associations with Native hunters, who make available bearded and ringed seals they harvest. In important areas beyond the operating range of coastal-based hunters, project personnel obtain required samples by collection efforts from a variety of OCS-supported logistic platforms or from strategically located facilities on the coast (particularly in the Beaufort Sea where Native hunting is very limited).

Almost all specimen material will be analyzed in the Fairbanks laboratory. Data from shipboard and aerial surveys will also be acquired. Initial analysis will be accomplished at the University of Alaska Computer Center. Specimen material, as requested, will be made available to a variety of other investigators.

The project is characterized by taking the maximal amount of information from collected specimens, letting none of it go to waste, and making these analyses available to other projects (e.g., RU 232). Such a large number of determining parameters require extensive computer support for analytic work, and a multi-year systematic effort at data gathering. The 1978 effort was designed to shift emphasis to the Beaufort Sea, a region which has not been featured in previous years' work, because of relatively high costs of operation and low densities of these seals. However, the much larger harvest-based collections now undergoing analysis will provide the context of variability in which necessarily small Beaufort Sea samples can be interpreted. Successful continuation of Beaufort operations in spring and fall seasons will represent only the second year of effort in the region and will concentrate on integrated under-ice ecological studies. Emphasis will be on analysis and synthesis of data, with the field work filling only the most crucial data gaps. Final analysis and reporting on these objectives would occur in FY 80.

Objectives:

1. Synthesize knowledge of critical biological parameters as they relate to ringed and bearded seals including, but not limited to: various aspects of reproduction; age specific productivity; natal and neonatal growth; seasonal changes in condition; population structure; impact of predation and take by humans; habitat requirements; spatial and temporal distribution; migration patterns.

2. Document the patterns of occurrence of ringed and bearded seals principally investigated in FY 77 and 78 in relation to major coastal hunting sites and other locations of human activity.

3. Document the degree and extent of susceptibility of ringed and beared seals to typical elements of proposed OCS development, and the extent of current use by coastal residents.

4. To provide specimen material and information required by other projects, notably RU 232, 467, 356, 359, and 6.

5. To provide information on bearded and ringed seals in the Beaufort Sea in time for BLM's Beaufort Sea assessment process (target date: 1 April 1979). Prepare summary species accounts for bearded seals (target date: 1 July 1979) and ringed seals (targed date: 30 Sept. 1979).

Methods:

1. Shipboard, aerial observations, supplemented by satellite imagery to delineate ice features in large scale, to determine abundance and occurrence of seals by season, location and population cohort, to determine rates of polar bear predation.

2. Work with selected coastal villages to obtain any further samples required for biological studies and to determine extent of human utilization of these resources.

3. Standard measurement techniques:

    a. claw and cementum annuli for age.

    b. observation in the field and examination of parasite loads, other pathologic indications.

    c. reproductive tract examination and spermatogenic activity for reproductive history and fetal growth rates.

    d. standard weight-length measurements in addition to examination for pathologic conditions, and the taking of blubber, blood, tissue and organ samples from suitable specimens.

    e. provision of digestive tracts for R.U. 232.

    f. examination of diagnostic parts to determine discreteness of populations.

Outputs:

1. Narrative Reports: This project will report in narrative and tabular form on the parameters measured in both species of seals by field and laboratory observers, and correlative findings among major processes being examined.

2. Digital Data: Collection information, sex, specimen measurements, age, reproductive information, stomach contents, parasitology, pathology, census and ice data.

3. Visual Data: Various photographs, maps, figures and graphs as in project to date.

(RU 232) TROPHIC RELATIONSHIPS AMONG ICE-INHABITING PHOCID SEALS AND FUNCTIONALLY RELATED MARINE MAMMALS

This research unit addresses subtasks E-2, E-6, E-7, F-7, and F-10 (BLM Study Types 41 - Critical Habitats and Habitat Dependencies, 42 - Food Web Dependencies, and 50 - Sublethal Effects of Pollutants).

Estimated Costs, FY 79:

$ 61,000	Beaufort
25,600	Chukchi
13,400	Norton Sound
13,400	St. George
8,500	Bristol Bay
$121,900	Total

Schedule: October 1978 - September 1979

Performing Agency:

Agency: Alaska Department of Fish and Game
P.I., Degree: Lloyd F. Lowry, M.S.
Title: Marine Mammal Biologist
Percent of time devoted to project and role: 100%; specimen collection, sorting, analysis, write-up

P.I., Degree: John J. Burns, M.S.
Title: Marine Mammal Biologist
Percent of time devoted to project and role: 33%; scientific administration, guidance, writing

P.I., Degree: Kathryn J. Frost, M.S.
Title: Marine Mammal Biologist
Percent of time devoted to project and role: 50%; specimen collection, sorting, analysis, writing, data management

Background:

This project is part of the integrated trophics studies in the Beaufort Sea, involving RU's 6, 29, 196, 230, 232 and 359. The project also undertakes the determining and interpreting prey dependencies among four species of seals in the Bering and the Chukchi and Beaufort Seas. These observations must be broken down into age classes, season, sex, and location and comparisons made with the best estimates of occurrence and abundance of prey species, invertebrates and fish. Simultaneous samples of the same species at different localities result in widely different representations of prey items. This emphasizes the need for large samples (often requiring several years of collection) at several areas in order to obtain site specific information. Key localities for spring hunting focus have been identified based on previous results. Generally, continued emphasis can be expected in the Beaufort Sea. This project has taken a lead role in the design of interdisciplinary icebreaker cruises in the Beaufort Sea and subsequent synthesis of trophics

information. This has led to a better understanding of the overall trophic system in the Beaufort Sea. The project will undertake to include analyses of belukha and related mammal trophics material, as part of the broader marine vertebrate consumer efforts that direct the integrated trophics analysis. Food web synthesis accounts focusing on phocid seals in the Beaufort Sea will be accomplished. Emphasis will be on analysis and synthesis of data.

Objectives:

1. Complete analysis of stomach contents from seals of known sex, collection location, and date in a sample grid designed to cover 5 lease areas, 4 species, 2 sexes, all age classes, and 4 seasons. This analysis and interpretation comes yearly into a more clearly focused picture for the western and northern Alaskan shelf, and will specifically be brought up to date in synthetic form for maximum utility to the environmental statement on the Beaufort Sea sale.

2. Synthesize the trophics information collected, including life cycle and productivity information on prey species where appropriate and necessary, for the Beaufort.

3. Analyze available belukha stomach data.

4. Complete food web account summaries for marine mammal-supporting systems in the Arctic lease areas.

Methods:

1. Collection (note: same sample collection base applies in part to R.U. 230)

   a. at hunter sites in cooperation with native harvest activities, largely in spring

   b. aircraft and ship-based collections in areas, seasons not utilized by traditional hunting

2. Analysis quantitative, by volume, number and percent composition/occurrence; standard sorting procedures

3. Availability studies on prey items: otter trawls

Output:

1. Narrative Reports: as required of all NOAA-OCSEAP projects. Specifically, this project will report in narrative/tabular form the spectrum of prey species encountered in stomachs of marine mammals, percent volume, numeric frequency analysis by age, sex, species, season, and location of these results. Key links in the Beaufort Sea trophic system will be identified.

2. Digital Data: Total volume of prey items, prey species, numbers total volume for each stomach; species of mammal, sex, time of year, geographic location.

3. Visual Data: Primarily distribution maps comparing predator and prey species in density. Pie diagrams and other innovative approaches to displaying trophics information can be expected.

(RU 237) ECOLOGY OF SEABIRDS IN THE BERING STRAITS REGION

This research unit addresses subtasks E-3, E-4, and E-17 (BLM Study Types 41 - Critical Habitats and Habitat Dependencies and 42 - Food Web Dependencies).

Estimated Costs, FY 79: $33,500 Norton Sound

Schedule: October 1978 - September 1979

Performing Agency:

University: College of the Atlantic
P.I., Degree: William H. Drury, Ph. D.
Title: Professor of Biology
Percent of time devoted to project and role: 40%; summarization and final report preparation, limited field activity.

Background:

This project (originally RU 447) has, since 1976, systematically investigated colonial concentrations, migratory and trophic dynamics, productivity, and other processes from the south shore of Seward Peninsula out to Little Diomede Island. FY 78 was to have provided the final session of fieldwork, to address the feeding distribution patterns and prey selection by birds occupying key colonies previously investigated by land-based observers with this project. Success of the FY 78 effort hinges on availability of a dedicated small vessel that would take Drury's team from colony to colony, permitting them both to observe and collect birds feeding offshore from colonies, and to make landfalls for spot checking colony status. The present budget and work outline represents windup funding to pull three years of studies together to produce a synthesis of the data and a final report.

Objectives:

1. Complete analysis of processes in Bering Straits seabird colonies.
2. Analyze secular changes in colony composition at various sites.
3. Provide zoogeographic analysis of selective occurrence of key species of alcids whose restricted distributions may make them vulnerable to disturbance from marine transportation.

Method:

Standard analysis techniques applied to the following:

1. Colony surveys of the entire colony as well as counts of sample plots.

2. Comparison of numbers of pairs, nests built, eggs laid to numbers of young reaching fledging (mortality).

3. Comparison of transect aircraft data among various areas, months and years (as used on previous year's data).

4. Similar methods for seabird distribution at sea, as developed by other shipboard observers in OCSEAP.

Output:

1. Narrative Reports: As required of all OCSEAP projects. The final report for the period 1976-1979 would be expected at the end of the fiscal year.

4.5 DESCRIPTION FOR PROJECTS IN TASK F (EFFECTS):

F-6:	RU 196	P 048
F-7:	RU 194	
	RU 230	
	RU 232	
F-10:	RU 232	

(P 048) EFFECT OF OIL ON COASTAL PLANT COMMUNITIES OF THE YUKON DELTA

This unit addresses subtask F-6. (BLM study types 53 - Effects of Noise, 54 - Tainting of Commercial Species, 55 - Environmental Recovery Rates of Ecosystems and 56 - Ecosystems Vulnerability Indices).

Estimated Costs, FY 79: $110,000 Norton Sound

Performing Agency: Not determined

Background:

In the case of the Yukon Delta, oil could be carried into fresh water and up river channels as a result of strong tidal action or storm surges. Plant communities of coastal lowlands, particularly those associated with large river deltas, are important components of ecosystems of unique value to migratory birds, as well as other wildlife. Little information is available regarding the impacts which water-borne oil may have on such subarctic communities, nor on the time required for recovery of such communities and the indirect effects of contamination on nesting waterfowl. A small program on the effects of Prudhoe crude on arctic sedges and associated insects is being conducted under RU 356, and the results will be used for study design.

Objectives:

To test the effect of oil pollution on coastal lowland plant communities and to measure their recovery rate.

Methods:

1. Test plots will be selected as representative of vulnerable coastal lowland plant communities.

2. Using statistically valid experimental techniques, these small, confined vegetation plots will be exposed to varying levels of oil contamination. The subsequent effects and recovery processes will be documented for at least two years.

Output:

1. Narrative Reports: Plot selection criteria and procedures, experimental methodology, observations and interpretation.

2. Visual Data: Maps showing the locations of experimental plots, photographs representative of plots before, during, and after oil contamination, graphical presentation of sensitivity of major plant species.

3. Digital Data: Plant mortality and morbidity data will be digitized in accordance with standard OCSEAP procudures and formats.

5.0 TIMING SCHEDULE AND PRODUCTS OF OCS STUDIES IN NORTON SOUND

The following products list and timing schedule of OCS studies addresses the Norton Sound lease area. The list of deliverables is a shorthand approximation for a complex, interlocking set of studies that are often difficult to represent by codes only and in which many qualifiers are necessarily left out.

The Codes used to identify BLM-required temporal and spatial resolution are as tabulated below. The same code is used to indicate present and projected levels of resolution in columns headed 77, 78, and 79. Appearance of the code in the FY 79 column indicates that funding is planned for FY 79.

Temporal Resolution

N = no temporal resolution
A = annual
S = seasonal
St = short term, days to weeks
D = diurnal, diel

Spatial Resolution

0 = information in hand, literature review
1 = qualitative, area wide, cursory
2 = semi-quantitative, hundreds of square miles scale or 25 miles of coastline
3 = semi-quantitative, 3-10 tracts scale or 10 miles of coastline
4 = quantitative, tract specific (2 to 5 miles resolution)
5 = quantitative, site specific
6 = no spatial resolution (non-site specific)

Several codes are also used to indicate existing (Pre-1978) and Projected (1978 and on) status of the effort to attain the specific products in the Data Products List. The codes used are as follow:

1. The research is ongoing, i.e. funded for FY 79.
2. The research unit effort has been terminated, and there are no plans for its resumption. The available data are, or may be, sufficient to meet stated needs.
3. Data are available from non-OCSEAP sources.
4. The data are insufficient to meet stated needs but the project has been terminated due to budget restrictions or lease area priorities.
5. Proposed research units.

5.0 INTERIM PRODUCTS - NORTON SOUND

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
A	CONTAMINANT BASELINE																		
A-1	Distribution and concentration of hydrocarbons		Seasonal and spatial distribution patterns of hydrocarbons																
			. in sediment	Narrative/ Table/Map/ Profile/ Graph	275/ 480					S2			S4	S5		S2	S2	S3	1
			. in benthic biota		275					S2			S4	S5		S2	-	-	2
			. in pelagic biota including neuston		275					S2			S4	S5		S2	-	-	2
			. dissolved in water							S2			S4	S5		S2	-	-	2
			. in particulate matter within water column																
			Comparison of ratios of C_1/C_2+ with $^{13}C/^{12}C$	Narrative/ Table	480					S2						S2	S2	S3	1
					153					S2				S4	S5	S2	S3	S3	1
				Narrative/ Table	275/ 480					S2			S4	S5		S2			2
A-2	Distribution and concentrtion of low molecular weight (LMW) hydrocarbons in the water column		Seasonal and spatial distribution patterns of C_1-C_4 hydrocarbons	Table/Map Narrative	153					S2			S4	S5		S2	-	S3	1
			. in water column										S4	S5					
			. in sediment		153					S2						S2	-	S3	1
		Determine probable sources of existing levels of hydrocarbons	Comparison of methane and C_2-C_4 hydrocarbons		153					S2			S4	S5		S2	-	S3	1
		Use LMWH as an indigenous tracer			153					S2						S2	-	S3	1
					P902					S2			S4	S5				S3	5

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
A-3	Distribution, concentration and chemical speciation of selected toxic materials		Seasonal and spatial distribution patterns selected metals	Maps															
			. in sediment		152/					S2			S4	S5		-	-	S3	1
					162					S2			S4	S5		S2			2
					413/ 506					S2			S4	S5		S2	-	-	2
			. in benthic biota		162					S2			S4	S5		S2			4
			. in pelagic biota		162					S2			S4	S5		S2			4
			. in water column (soluble and suspended forms)		162					S2			S4	S5		S2			2
			Elemental composition and distribution of suspended particulate matter	Table/Map/ Narrative	152					S2			S4	S5		-	-	S3	1
					162					S2						S2			2
			Hydrocarbon adsorptio characterictic of suspended matter		152					S2			S4	S5		-	-	S3	1
		Monitor selected metal concentrations over broad geographical areas to determine significant changes during and following OCS development	**Will not be addressed (See Section 3)**		413					S2						S2	-	-	2
					162					S2			S4	S5		S2			4
					152											-	-	S3	1

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78.	79	
B-1					N/A														
B-2					N/A														
B-3					N/A														

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
C-1	Description of seismic and volcanic activity		Historical earthquake epicenters, focal depths and magnitudes	Map/Table	352					D3		D4				D2	-	-	2
				Map	483	NO				D3		D4				D3	D4	-	2
			Earthquake magnitude vs. frequency relationships for selected areas	Table Map	352					N3						N2	-	-	2
				Graph	483	NO				N2						N3	N4	-	2
			Seismic activity of surface and near-surface faults identified in geologic mapping	Map Report	483	NO				N3		N4				N3	N4	-	2
			Relationships between earthquake magnitude and strong ground motion	Map Report	483	NO				N2						N2	N2	-	2
			Description of volcanic activity and resulting phenomena such as flows and nuees ardentes	Maps Reports	N/A	NO													
			Seismic risk map	Map	483	NO				N3		N4				N3	N4		2
			Volcanic risk map	Map	N/A														
C-2	Description of the distribution and relative ages of surface and near-surface faults		Locations of surface and nearsurface faults classified according to apparent recency of movement (from geologic relationships)	Narrative with photo maps	267					S3						S2	S3		2
				Report Map	429					N3		N4				N3	N4	N4	1

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
C-3	Description of the types and extent of natural sea-floor instability		Delineation of existing and potential slumps and other unstable sediment masses, classified according to present relative stability	Map	429					N3		N4			N5	N3	N4	N4	1
			Thickness of unconsolidated sediment	Report Map	429					N3		N4			N5	N3	N4	N4	1
			Description of sediment physical properties	Report	290					N2						-	N2	-	2
				Report	413					S2						S2	-	-	2
				Map/Report	429					N3		N4			N5	N3	N4	N4	1
			Geologic cross-sections of potentially unstable sediment masses	Profile	429					N3		N4			N5	N3	N4	N4	1
			Description of the geologic history of unconsolidated sediment units.	Report/ Map	429				N3			N4			N5	N3	N4	N4	1
			Interpretation and description of the nature and severity of sediment instability	Report	429					N3		N4				N3	N4	N4	1

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
C-4	Identification and description of areas of potentially hazardous seafloor erosion, deposition and bedform movement		Locations of areas of severe erosion and deposition (indicating rates where possible).	Map/Report	208					N3		N4				N2	N3	N3	1
				Map	429					N3		N4				N3	N4	N4	1
			Distribution and description of large scale mobile bedforms showing directions and rates of movement.	Map	429					N3		N4				N3	N4	N4	1
			Interpretations regarding the nature and severity of erosion, deposition and bedform movement	Map/Report	208					N3		N4				N2	N3	N3	1
				Map	429					N3		N4				N3	N4	N4	1
			Identification of coastal areas with severe erosion or accretion, indicating rates where possible	Map/Report	208					N3		N4				N2	N3	N3	1
				Imagery	267					S2						S2	S2		2
				Profiles	431					N2		N3				N3	N3		2
			Description of nearshore sediment dynamics	Report	290					N2						-	N2	-	2
				Map	208					N3		N4				N2	N3	N3	1
				Imagery	267					S2						S2	S2		2
C-5			Description of coastal geology including active faults and surface processes	Map	99					N2			N3	N4	N5	N4			2
				Map/Report	208	N0				N3		N4				N2	N3	N3	1
				Imagery	267					S2						S2	S2		2
				Report	431					N2		N3				N3	N3	-	2
			Interpretation of the potential hazards to coastal facilities	Report	99					N2						N3			2
				Maps/Report	208	N0				N3		N4				N2	N3	N3	1
				Maps/Report	429	N0				N3		N4				N3	N4	N4	1

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
C-6	(Not applicable to GOA-BS)																		
C-7	Description of the geographic distribution of ice gouging, its severity and frequency of occurrence		Description of ice gouging activity distribution, frequency and gouge depth	Map Report	429					N2			N3	N4		N2	N3	N4	1
			Interpretations regarding the nature and severity of ice gouging and its relation to ice structures and behavior	Report	429					N2			N3	N4		N2	N3	N3	1
C-8	Description of the distribution and nature of gas-charged sediments		Description of the distribution and depth of gas-charged sediments	Report	429	NO				N3		N4				N3	N4	N4	1
			Identification of oil and gas seeps	Map Report	429	NO				N3		N4				N3	N4	N4	1
			Descriptions of the origins and characteristics of gas-charged sediments and their potential hazards	Report	429	NO				N3		N4				N3	N4	N4	1
C-9	Stress-strain relationships in ice		1. Measurements of physical properties of various types of sea ice	Report	257	NO				N3		N4				N2	N3		2
				Imagery	267	NO				N3		N4				N2	N3		2
				Maps	323	NO				N2						N2			2
				Report	429	NO				N3		N4				N2	N3	N3	1
				Report/Map	483	NO				N3		N4				N2	N3		2
			2. Estimates of ratios of stress to strain in various types of ice			NO	See Beaufort Sea TDP												

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
C-9 cont.			3. Estimates of forces of extreme ice conditions			NO		See	Beau	fort	Sea	TDP							
			4. Calculations of ice forces and loading on structures			NO		See	Beau	fort	Sea	TDP							
C-10	Characterization of frequency, intensity and effects of extreme oceanic events		1. Observational and historic information on storm surges as a function of location, season and magnitude	Tables/ Figures/ Reports	347	NO				S3						S3			2
					367	NO				S3						S2	S3	-	2
					431					S3							S3	-	2
				Report	429	NO				N3		N4				N2	N3	N3	1
			2. Observational and historical information on coastal katabatic winds as a function of location, season and magnitude	Tables/ Figures/ Graphs	367	NO				S2						S2	S3	-	2
			3. Historical information on tsunamis (See subtask C-1)	Tables	352	NO				N3						N3	-	-	2
			4. Marine and coastal climatology including: . temperature . wind . cloud cover . wave heights . storm tracks and frequencies . coastal flooding . vessel icing	Tables/ Graphs/ Reports	347	NO				S2						NO	S3	-	2
				Computer Simulations	431														

77-969

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
D-1	**Seasonal and shorter term description of water masses and circulation patterns in offshore regions**	**To predict or estimate trajectories of pollutants and time of impact**	1. Analysis of historic data in the literature and previously unreported data	**Narrative with maps**	P323			S2	S3			S4				-	-	S2	3
					347			S2	S3							S2	S2		2
			2. Analyses of historical data on climatic systems and meteorological events for their effects on circulation	**Narrative/ Reports/ Graphs/** Maps	P323			S2	S3			S4				-	-	S2	5
					289														
					347			S2	S3							S2	S2		2
				Report	435			S2	S3								S3	S3	1
			3. Seasonal temperature and salinity distribution	Maps/ Reports	87			S2									S2		2
					347			S2	S3							S2	S3	S3	1
					430			S2	S3			S4				S2	S3		2
					435			S2	S3			S4					S3	S3	1
			4. Baroclinic circulation	Maps	541			S2	S3							S2	S3	S3	1
				Reports	347			S2	S3							S2	S2		2
			5. General circulation, based on moored current meter data	**Narrative** Report	435			S2	S3								S3	S3	1
				Narrative Report	541/ 550			S2	S3			S4				S2	S3	S3	1
			6. Trajectories of drogues			NO		S2	S3										0
			7. Discussion of mixing and estimates of Lagrangian dispersion coefficients	Narrative Report	541			S2	S3			S4				S2	S3	S3	1
			8. Estimates of sea-surface slope					S2											0
			9. Measurements of local wind fields	Narrative Report	P323			S2	S3			S4				-	-	S2	5

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
D-1 cont.			10. Analyses of synoptic weather data to obtain local wind and temperature fields	Narrative Report	P323			S2	S3			S4				-	-	S2	5
			11. A procedure for determining local wind fields when synoptic data and local stations are available		*														4
			12. Currents, calculated by diagnostic model		N/A														0
			13. Currents calculated by hydrodynamical model		140			S2	S3							S3	S3	S3	1
D-2	Seasonal and shorter term description of water masses and circulation patterns in nearshore		1. Analyses of historic data in the literature and previously unreported data	Narrative	347			S2								S2	S2		2
					431			S2								S2	S2		2
			2. Analyses of historic data on climatic and meteorological events for their effects on circulation		541/550											S2	S3	S3	1
					347			S2	S3							S2	S2		2
					431				S3							S3	S3		2
			3. Seasonal temperature and salinity distribution	Narrative/Graphs/Charts	435			S2	S3			S4					S3	S2	1
					87			S2									S2		2
					541/550			S2	S3			S4				S2	S3	S3	
			4. Baroclinic circulation	Narrative	541			S2	S3							S2	S3	S3	1

*See NEGOA, Bristol Bay, St. George, and LCI TDPs. Research applies to Norton although not actually conducted there.

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
D-2 cont.			5. Nearshore circulation based on moored current meter data	Narrative	541/ 550			S2	S3							S2	S3	S3	1
			6. Trajectoried of drogues																
			7. Discussion of mixing and estimates of Lagrangian dispersion coefficients		*				S2							S2	S3	S3	1
			8. Estimates of sea surface slope	Narrative					S2										0
			9. Nearshore currents by means of a current mapping radar						S4										0
			10. Analyses of satellite photos for oceanograhpic data	Imagery/ Maps	289			S2									S2		2
			11. Surf zone dynamics; wave refraction diagrams, rip current distribution	Narrative with Maps					S2										0
			12. Storm surge probability and intensity	Narrative	435			S2	S3			S4					S3	S3	1
			13. Measurements of local wind fields nearshore	Narrative	P323			S2	S3			S4						S2	5

---

* See NEGOA, Bristol Bay, St. George and LCI TDPs. Research applies to Norton although not actually conducted there.

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
D-2 cont.			14. Analyses of synoptic weather data to obtain local wind and temperature fields	Narrative	541/ 550				S2							S2	S3	S3	1
			15. A procedure for determining local wind fields when synoptic data and local station data are available		*					S2						S2	S3	S3	1
			16. Measurements of stability of the surface (air) boundary layer and ice nuclei baseline	Narrative					S3										0
			17. Results of analysis by models	Narrative with:															
			a. General circulation	Maps	435			S2	S3			S4					S3	S3	1
			b. Tidal current (hydro-dynamical)	Maps	435			S2	S3			S4					S3	S3	1
			c. Trajectory	Maps	435			S2	S3			S4					S3	S3	1
			d. Trajectory with plume dynamics	Maps															
D-3	Description of oil spill plume behavior and oil weathering processes	Evaluation of degree of impact, and contingency requirements	1. Oil spill weathering mechanisms and estimated rates	Narrative/ Charts/ Graphs	P035 499			Resolution not applicable											5 4
			2. Laboratory determined weathering rates	Narrative/ Charts/ Graphs Tables	499			Resolution not applicable											4
			3. Field studies to determine weathering rates	Tables	P035 555 499			Resoluation not applicable											5 1 4

---

* See NEGOA, Bristol Bay, St. George and LCI TDPs. Research applies to Norton although not actually conducted there.

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
D-3 cont.			4. Description of mechanisms which cause dispersal of oil plumes																
			5. Pollutant dynamics model general	Computer code and documentation															0
			6. Pollutant dynamics model (subroutine accounting for weathering	Computer code and report															0
D-4	Description of the types and characteristics of bottom sediments and their probable interaction with oil and biota		Description of sediment grain size properties	Map	208					N3		N4				N2	N3	N3	1
					290					N2	N3					–	N3	–	2
			Description of coast morphology, beach materials and relative vulnerability of the coast to spilled oil	Map/ Report	208	N0				N3		N4				N2	N3	N3	1
			Interpretation regarding the interaction between oil and bottom sediment, oil retention capability of the substrate, and implications regarding possible effects or intertidal and benthic biota	Report	275					S2			S4	S5		S2			2
				Report	290					N2	N3						N3		2
				Report/ Map/Tables	480					S2			S4	S5		S2	S2	S3	1
D-5	Description of bottom sediment		Description of the directions and rates of bottom sediment movement	Report/ Map	430				S2	S3						–	S3		2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
D-5 cont.	.		Interpretation regarding the mechanisms of entrainment and transport of bottom sediment and their relationship to physical oceanographic processes	Report/ Map	430					S2	S3					-	S3		2
D-6	Character of suspended particulates and their effectiveness as transporters of oil		1. Sediment and suspended sediment distribution	Map	152					S2				S4	S5	-	-	S3	1
				Map	162					S2						S2	-	-	2
				Map	290					N2						-	N2	-	2
			2. Sediment movements	Report/Map	430				S2	S3							S3		2
			3. Tabular data, indicating extent of oil/sediment interaction under varying environmental conditions	Narrative/ Table/ Graph	275					S2				S4	S5	S2	S2	S3	1
					290					N2						-	N2	-	2
					454			Resolution not applicable											1
					499			Resolution not applicable											4
			4. Relation of suspended particulate matter to terrestrial and marine sources	Report/ Map	152					S2				S4	S5	-	-	S3	1
					208					N3		N4				N2	N3	N3	1
					290					N2						-	N2	-	2
D-7	Description of sea-floor topography		Description of sea-floor topographic features	Map	430				S2	S3							S3		2
D-8	Characterization of sea ice morphology including under-ice morphology		Analysis of the historical records of ice conditions	Report	261/ 262			S2								S2			2
			Description of ice conditions, seasonally and areally from contemporary data; position of ice front, ex.	Report	257/ 267			S1	S2	S3		S4				S2	S3		2
				Seasonal Maps				S1	S2	S3		S4				S2	S3		2
				Narrative Reports/ Maps	88			S1	S2	S3		S4				S2	S3	S3	1

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
D-8 cont.			Under ice morphology and its potential as a trap for oil					See Beaufort Sea FY 79 TDP											
D-9	Description of ice dynamics and their effects on transport of oil and safety of structures	As input data to transport models and in evaluation of construction plans for safety	Oil trajectories in, over and under ice of various types						S2	S3		S4							0
			Model of ice motion under various environmental conditions	Narrative with Maps	88				S2	S3		S4				S2	S3	S3	1
				Narrative with Maps	257				S2	S3		S4				S2	S3		2
					267				S2	S3		S4				S2	S3		2
				Map	P321				S2	S3						S2	S3		2
D-10	Description of interaction between sea ice and oil and movement of oil in an ice field	As input to transport models	Model of behavior of oil incorporated in ice matrix	Narrative with maps	257				S2	S3		S4				S2	S3		2
			Measurements of oil movement in the presence of ice in field	Report/ Table	87														
				Narrative with maps	257				S2	S3		S4				S2	S3		2
					267				S2	S3		S4				S2	S3		2
			Comparison of model results with field results	Report/ Table	87				S2	S3		S4					S3		2
D-11	Susceptibility of marshlands near the coast to inundation by oil transported by storm tides	To assess the probability of insult to critical habitats	Calculated probability of storm surge					S2											0
			Verification of probability of storm surge by field studies	Narrative	431					S3						-	S3	-	2
			Analysis of historical storm surge records	Narrative with tables				See Task C-10											

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-1	**Description of seasonal distribution and abundance of marine mammals.**	To identify critical habitats and determine the likelihood of impingement based on **transport data and probable sources.**	1. Annotated bibliography of available marine mammal data and literature.	Narrative		NO													3
			2. Review of available literature and data on marine mammals.	Narrative	67	NO										NO			2
				Narrative	248	NO										NO			2
					232	NO										NO	NO	NO	1
			3. Seasonal distributions and relative abundance of marine mammals.	Map	69					S2	S3	S4							
				Map	230					S2	S3	S4							1
				Map	232					S2	S3	S4							1
				Map	248					S2	S3	S3				S2	S2	-	2
			4. Locations of marine mammal migration routes.	Charts	69					S2	S3	S4				S2	S2		2
					230					S2	S3	S4				S2	S2	S2	1
					232					S2	S3	S4				S2	S2	S2	1
					248					S2	S3	S4				S2	S2		2
			5. Locations of breeding and concentration areas.	Map	69					S3	S4	S4				S2	S2		2
					230					S3	S4	S4				S2	S2	S2	1
					232					S3	S4	S4				S2	S2	S2	1
E-2	Description of population dynamics **and trophic relations of marine mammals.**	To evaluate the potential effects of OCS activities on the stability of **populations within a considered critical habitat.**	1. Population dynamics of marine mammals, including: . reproductive biology . growth . population composition . habitat dependencies	Narrative	69					S2	S3	S4				-	S2	-	2
					194					S3	S3	S4				S3	S3	S3	1
					230					S2	S3	S4				S2	S2	S2	1
				Map/ Charts/ Figures/ Tables	232					S2	S3	S4				S2	S2	S2	1
					248				S1	S2									
			2. Trophics of marine mammals, including: . major prey species . foraging areas	Tables/ Charts	69				S1	S2	S3	S4				S2	S2	-	2
					230				S1	S2	S3	S4				S2	S2	S2	1
					232				S1	S2	S3	S4				S2	S2	S2	1
			3. Behavioral aspects of marine mammals relative to OCS activities.	Narrative	230	NO				N1 S0								N1	1 0

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5				
																77	78	79	
E-3	Discription of seasonal distribution and abundance of marine birds	To identify critical habitats and determine the likelihood of impingement based on transport data and probable sources	1. Annotated bibliography of marine bird data and literature	Narrative	3				S1	S2						S2	S2		2
					337				S1	S2							S2		2
			2. Literature review of marine bird data and literature	Narrative	196					S2						S2	S2	S2	1
					337				S1	S2							S2		2
					338				S1	S2						S2			2
					470					S2						S2			2
					488					S2						S2			2
			3. Seasonal distribution and abundance of marine birds	Maps	19					S2						S2	S2		2
					196					S2						S2	S2	S2	1
					337					S2							S2		2
					341					S2						S2			2
					470					S2						S2			2
			4. Locations of marine bird breeding colonies	Maps	237					S5						S_t5	S_t5	S_t5	1
					337					S5							S_t5		2
					338					S2						S2			2
					341					S5						S_t5			1
					470					S5						S_t5			2
			5. Locations of marine bird concentration areas	Map	237					S2						S2	S2	S2	1
					337					S2						S2	S2		2
					341					S2						S2			2
			6. Location of bird migration routes	Map	340					S1		S_t1		S_t1		S_t1	S_t1		2
					458					S1		S_t1		S_t1		S_t1			2
E-4	Description of population dynamics and trophic relations of marine birds	To evaluate the potential effects of OCS activities on the stability of populations within a considered critical habitat	1. Population dynamics of marine birds including: . breeding phenology . reproductive ecology . growth . habitat dependencies	Narrative	237					S2		S_t1		S_t1		S_t5	S_t5	S_t5	1
					458					S2		S_t1		S_t1		S_t5			2
					470					S2		S_t1		S_t1		S_t5			2
			2. Trophics of marine birds including: . major prey species . foraging areas	Narrative	19					S2					S3	S2	S2		2
					196					S2					S3	S2	S2	S3	1
					337					S2					S3		S2		2
					341					S2					S3				2
					470					S2					S3	S2			2
					488					S2					S3	S2			2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-4	Description of seasonal distribution and abundance of marine birds.	To identify critical habitats and determine the likelihood of impingement based on transport data and probable sources.	3. Behavioral aspects of marine birds relative to OCS activities.	Narrative	77				S1							S1	S2	S2	1
					108				S6							S6	S6		2
					237				S2							S2	S2	S2	1
					341				S2							S2			2
									S0										
E-5	Description of the seasonal distribution and abundance of marine fish.	To identify critical habitats and determine the likelihood of impingement based on transport data and probable sources.	1. Annotated bibliography of available marine fish data and literature.	Narrative															
			2. Review of available marine fish data and literature.	Narrative	19				S1							S1			2
			3. Seasonal distributions and relative abundance of marine fishes.	Map	19				S2							S2	S2		2
					232				S2							S2	S2	S2	1
			4. Locations of spawning and concentration areas, and migration routes.	Map	19				S2							S2	S2		2
			5. Locations of important commercial fishing areas.	Narrative Map	19				S2							S2	S2		2
E-6	Description of population dynamics and trophic relations of marine fish.	To evaluate the potential effects of OCS activities on the stability of populations within a considered critical habitat.	1. Trophics of marine fishes, including: . identification of major prey species . foraging areas	Table	19				S2							S2	S2		2
					232				S2							S2	S2	S2	1

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-6 cont	Description of population dynamics and trophic relations of marine fish.		2. Population dynamics of marine fishes including: . reproductive biology . growth . habitat dependencies	Narrative	175				S1	S0		S2				S1			2
E-7	Description of seasonal distribution and abundance of benthic biota.	To identify criti-habitats and determine the likelihood of impingement based on transport data and probable sources.	1. Annotated bibliography of available literature and data on benthic biota.																
			2. Review of available literature and data on benthic biota.	Narrative	5				S1	S2							NO		2
					281				S1	S2						NO			2
					502				S1	S2						NO			2
			3. Distribution and abundance of dominant benthic organisms.	Narrative/ Charts/ Maps	5					N2		S3					S1		2
					78					N2		S3					S1		2
					232					N2		S3				S1	S2	S3	1
					502					N2		S3				S1			2
	Description of population dynamics and trophic relations of benthic biota.	To evaluate the potential effects of OCS activities on the stability of populations within a considered critical habitat.	4. Population dynamics of benthic organisms, including: . Seasonal community structure . Seasonal abundance of dominant organisms . Productivity estimates	Narrative Tables Graphs Figures	5												S1		2
																S1			2
					78											S1	S2	S3	1
					232														
			5. Trophic relations of selected benthic organisms including: . food webs . identification of major prey species	Tables Figures	5					N1		S1		S3			S1		2
					232					N1		S1		S3		N1	S1	S3	1
					502					N1		S1		S3		N1			2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-8	Description of distribution and abundance of biota in littoral communities.		1. Annotated bibliography of available data and literature on littoral biota.	Narrative Charts	78					NO						NO	-	-	2
			2. Review of available data and literature on littoral biota.	Narrative	78											NO	-	-	2
			3. Regional characterization of littoral habitat, including: . Substrate . Littoral community structure . Population density distributions	Narrative	78					S2		S3		S4		S2	-	-	2
E-9	Description of the ecosystem dynamics and relative abundance of biota in littoral communities.		1. Population dynamics of intertidal biota, including: . Seasonal community structure . Productivity	Narrative	78					S2				S3		S2	-	-	2
			2. Trophic relations of littoral fauna, including: . Food webs . Identification of major predator prey relations	Narrative	-				S2				S3						0

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-10	Seasonal density distributions of principal species of plankton.		1. Time of appearance	Narrative	426				S1			S2				S2	-	-	2
					427											-	S2	-	2
			2. Quantitative distributions	Narrative	426				S2							S2	-	-	2
					427				S2							-	S2	-	2
E-11	Seasonal indices of phytoplankton standing crop and production.		1. Composition	Narrative	426					N1		S2							
					427					N1		S2							
			2. Standing crop	Narrative	426					N1		S2		S3		S2	-	-	2
					427					N1		S2		S3		-	S2	-	2
			3. Productivity	Narrative	426					N1		S2		S3		S2	-	-	
					427					N1		S2		S3		-	S2	-	
			4. Ecology of sea ice flora.	Narrative Maps/ Graphs	427					N1		S2				-	S2	-	
E-12	Non-population dependent physiological and population parameters of plankton communities.			Narrative	427											-	N6	-	2
E-13	Identification and seasonal characterization of critical habitats for egg and larval stages of fish and shellfish species.		1. Time of appearance	Narrative	380					S1		S2		S3		S1			2
			2. Quantitative distributions.	Map						S1				S6					0
E-14	Ichthyoplankton key for Alaskan waters.	OCSEA Program development.	Ichthyoplankton key.	Narrative	349				N6							N6	-	-	2
	Otolith Key	Ditto		Narrative	285				N6							N6	-	-	2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													
Task	Product	Intended Use	Specific Product	Format	R.U.	Required										Projected			Status
						-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-15	Characterize marine microbial communities with regard to quantitative levels of indigenous heterotrophs, chemotrophs and pathogens.	To identify critical habitats and determine likelihood of impingements based on transport data and probable sources.	1. Geographical density distributions of physiological groups in: . Water . Sediments	Map						N2		S2				-	-	-	0
		To define the potential for petroleum degradation in specific habitats and, therefore, likelihood of impact.	2. Hydrocarbon degradation rates.	Narrative						N1		S1		S2		-	-	-	0
			3. Evaluation of techniques used to determine oil degradation in sediments.	Narrative						N6						-	-	-	0
E-16	Response of microorganisms to normal environmental stresses.		1. Microbial activity and respiration ratios.	Narrative						S1		S2				-	-	-	0
			2. Nitrogen fixation rates in: . Sediment . Animal guts							S1		S2				-	-	-	0
E-17	Relationship of ice movements and types to distributions and abundance of various living resources.		Species abundance and distributions relative to: . Ice characteristics . Ice movements.	Narrative Maps/ Tables/ Graphs	196 248 427			S2	S2 S3 S2							S2 S2 -	S2 S3 S2	S2 - -	1 2 2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
F-1	Review of available literature and data on toxicity of crude oils as related to species, life stage and source of oil.		Summary of available information on effects of oil on Alaskan marine organisms and ecosystems.	Narrative	75		N6									N6			2
F-2	Acute and chronic effects of crude oil and other petroleum associated chemicals on selected organisms.		1. Toxicity of oil to:																
			. marine mammals	Narrative Graphs Tables Charts	389						N6					N6			4
			. marine birds		71		NO				N6					N6			1
			. fish		72		NO				N6					N6			1
			. plankton													NO			0
			. benthos		183						N6					N6			4
			. bacteria		454						N6					N6			1
			2. Sublethal effects on:																
			. marine mammals	Narrative Graphs Tables Charts	71						N6								
			. marine birds		423						N6								
			. fish		73						N6								
			. plankton		-											-	-	-	0
			. benthos		183						N6					N6			4
			. bacteria		454						N6					N6			1

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
F-3	Effects of petroleum contaminants on metabolic and reproductive functions		1. Evaluation of effects of crude oil on carbon and nitrogen fixation in: . sediments . guts of animals	Narrative	190					S1		S2					S2	S2	1
			2. Evaluation of effects of crude oil on hatching success of bird eggs.	Narrative Graphs	96 423				N6			S_t^6				S_t^6 N6	S_t^6	S_t^6	1 2
			3. Evaluation of effects of crude oil on thermoregulation of marine mammals	Narrative	71				N6							N6	N6	N6	1
F-4	Characterization of release of toxic metals from oil impacted sediments and relative importance of metals uptake and effects on biota		1. Uptake/depuration of metals in benthic organisms.		-											N6			0
			2. Metabolic an other sublethal effects in benthos.	Narrative	454							N6				N6			1
F-5	Bioaccumulation and effects of hydrocarbons, and other contaminants through various exposure pathways.		1. Evaluate accumulation of hydrocarbons through experimental food chains.	Charts Tables Graphs	73 275 389							N6 N6 N6				N6 NO N6	N6		1 1 4
			2. Evaluate accumulation through sediment-sorbed contaminants.	Narrative	454							N6				N6			1

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
F-6	Characterization of responses of selected organisms and ecosystems to perturbations induced by contaminants or disturbances associated with OCS activities		1. Characterization of perturbations due to OCS activities on selected organisms and activities.	Maps Tables Graphs	72 73 275									S5 S5 S5					1 1 1
			2. Recovery rate of selected communities in terms of: . composition and density . productivity	Narrative Maps	P48				N6									N6	1
F-7	Types and incidences of diseases present in marine organisms.		1. Incidence of pathological conditions in:	Narrative Tables Graphs															
			. marine mammals		194													N1	1
			. marine birds																
			. marine fish		332					N1						N1	N2	N2	2
			2. Identifications of pathological agents and causes in:	Narrative Tables Graphs															
			. marine mammals		194					N6					N4				1
			. marine birds																
			. marine fish		332											N1	N2	N2	2
			3: Incidence of mortality or morbidity in natural populations of:	Narrative Tables Graphs															
			. marine mammals		194					N1					N4				1
			. marine birds																

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
Task	Product	Intended Use	Specific Product	Format	R.U.	Required										Projected			
						-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
F-7			4. Effect of oil on disease susceptibility in:	Narrative Charts Tables															
			. marine mammals		71									N6		N6			1
			. marine birds		96									N6		N6			4
			. marine fish		73									N6		N6			1
F-8	Ecological effects of oil spill countermeasures.		1. Toxicity of dispersants to:																
			. marine birds		72							S6				NO		N6	0
			. marine fish									S6				NO			-
			. marine mammals									S6				NO			0
			2. Sublethal effects of dispersants in:																
			. marine fish		73							S_t6					NO	N6	1
			marine birds									S_t6					NO		0
			. marine mammals									S_t6					NO		0
F-9	Characterization of structure and function of select-coastal ecosystems with respect to potential impacts of OCS development.		Descriptions of:																
			. seasonal community structure		77			S2				S3			S5	S2	S2	S2	1
			. trophic relations of key species																
			in various habitats at selected study sites.																

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
F-10	Characterization of structure and function of ice front ecosystem with respect to potential impacts of OCS development		Descriptions of: . community structure . trophic relations of key species . primary and secondary production in the vicinity of the ice front.				See Task E-17									-	-	-	-
F-11	Descriptions of coastal detritus systems with respect to OCS development.		1. Definition of seasonal composition and origin of organic detrital materials. 2. Role of detritus in ecosystem energetics.		-											NO			0

3.0 RATIONALE FOR BRISTOL BAY

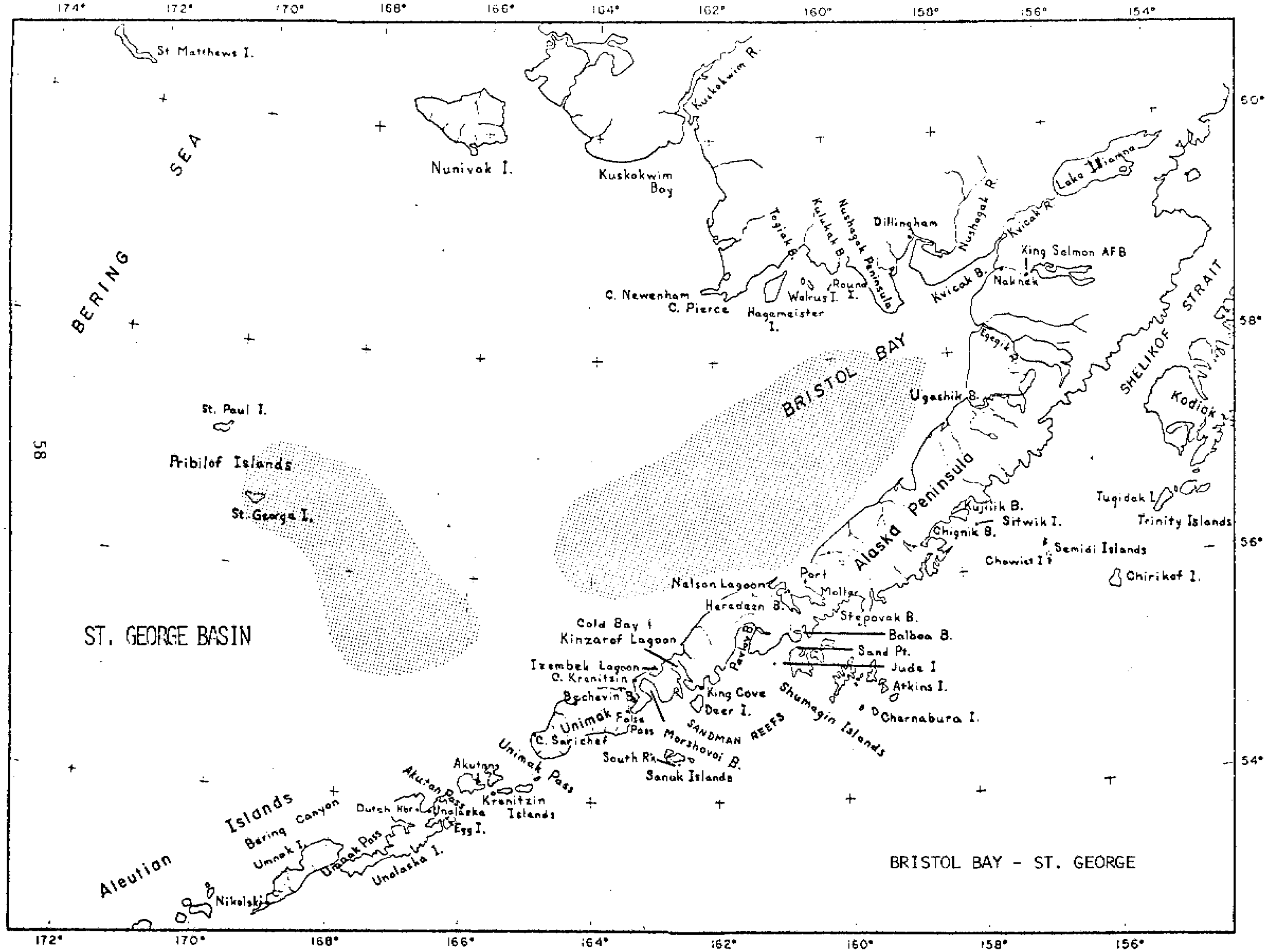
3.1 Scope and Direction

The Bristol Bay area may be considered in conjunction with the St. George Basin lease area. The two lease areas are connected oceanographically; both may be ice covered during winter, and much of the biota is common to both. As a result, many research units designed for studies in the St. George Basin also are *de facto* studies of the Bristol Bay area. For example, the results of the single ecological study of the ice edge (RU 427) are equally applicable to both areas, and the benthic surveys (RU's 281 and 282) were continuous through both regions. For the sake of both accuracy and completeness, the descriptions of studies applicable to both Bristol Bay and St. George Basin are included here.

Studies may be grouped according to the discipline involved or may, as has been chosen, be grouped according to the kinds of questions for which the BLM requires answers. Therefore, three generic types of studies are designed to yield data products directly applicable to the following kinds of questions:

- Hazards - what are the natural hazards imposed by the environment on developments?
- Biota at Risk - what are the species/communities present in areas likely to be impacted by oil exploration, development, and production?
- What are the consequences of impact by petrochemical development activities? What are the effects on key elements of the biota based on bioassay results? What are the most likely effects on the biota in field situations? Which elements are more likely to be affected than others and how might recovery take place?

Answers to the first type of question require geological and related studies to assess any hazards that might be caused by: (1) instability of the sea floor, (2) earthquakes; (3) tsunamis; (4) storm surges; (5) ice gouging; and (6) ice forces on structures.


174°
172°
170°
168°
166°
164°
162°
160°
158°
156°
154°
60°
58°
56°
54°
St Matthews I.
BERING SEA
Nunivak I.
Kuskokwim Bay
Kuskokwim R.
Togiak B.
Kulukak B.
Nushagak Peninsula
Dillingham
Nushagak R.
Kvichak R.
Lake Iliamna
King Salmon AFB
Naknek
Kvichak B.
C. Newenham
C. Pierce
Hagemeister I.
Walrus I.
Round I.
Egegik R.
SHELIKOF STRAIT
Kodiak
BRISTOL BAY
Ugashik B.
St. Paul I.
58
Pribilof Islands
St. George I.
Alaska Peninsula
Kujulik B.
Sutwik I.
Chignik B.
Semidi Islands
Chowiet I.
Tugidak I.
Trinity Islands
Chirikof I.
Port Moller
Nelson Lagoon
Herendeen B.
Stepovak B.
Balboa B.
Sand Pt.
Jude I.
Atkins I.
Chernabura I.
ST. GEORGE BASIN
Cold Bay & Kinzarof Lagoon
Izembek Lagoon
C. Krenitzin
Bechevin B.
Pavlof B.
King Cove
Deer I.
Shumagin Islands
SANDMAN REEFS
Unimak I.
False Pass
C. Sarichef
Morzhovoi B.
South Rk.
Sanak Islands
Unimak Pass
Akutan
Akutan Pass
Krenitzin Islands
Dutch Hbr.
Unalga
Egg I.
Aleutian Islands
Bering Canyon
Umnak I.
Umnak Pass
Unalaska I.
Nikolski
BRISTOL BAY - ST. GEORGE

In the second category, identification of species and communities present at possible impact points, studies are included that will enable BLM to determine if impact will or is likely to occur. These include the study of transport, which is designed to show, under specific sets of circumstances, where contaminants will appear and in what quantities. Included also are questions such as: (1) will aircraft flying over or near a rookery cause harassment that should be considered an impact? and (2) which particular habitats can be identified, as a result of an overall habitat assessment, as ones that are critical? (i.e., damage will produce a significant change in population of the species and permanent damage or removal will cause irreparable population change.)

The third type of question concerns the ability to quantify and/or validate the allegation of potential or real environmental impact. Partial answers are provided by trophic studies revealing dependence of one species on another, by studies of the physiological effect of oil on mammals and other groups of animals, and by studies that determine the relative toxicity of petrochemicals to one species or another. The ideal, of course, is an ecosystem model realistically incorporating a large volume of data into a scheme that objectively and rigorously quantifies the time-dependent effect of decimation of one or more species on the ecosystem.

In the following sections are discussions of some of the assumptions, explicit and implicit, which were made in formulating the existing program. The key issues are identified, the status of knowledge applicable to those issues is discussed, and, lastly, the general approach to be used to acquire the data products required to identify key issues and to answer the key questions is described.

3.1.1 Premises

It is desirable to set forth some of the assumptions which were also incorporated into OCSEAP planning for Bristol Bay.

- The studies will assess all impacts of OCS activities on the marine ecosystem extending shoreward to the strand line and will include possible hazards imposed by the environment on OCS activities.

- Although environmental hazards will be assessed, studies will not allow the design of structures to proceed without additional, site-specific engineering studies.
- OCSEAP studies will be confined to the acquisition of knowledge needed to predict and measure direct effects on the environment resulting from OCS development. Secondary effects (e.g., possible adverse effects on commercial fishing) will not be considered *per se*.
- The data collections are not presently intended to be so all inclusive as to meet all the needs and requirements for future monitoring programs.
- Interrelations (biological, oceanographic or OCS developmental) between lease areas must be considered; hence, there will not be complete separation of research units between lease areas.
- Comprehensive ecosystem studies are beyond the scope (time frame) of the program. However, selected critical components or processes will be studied when it appears that there exists a likelihood that OCS activities will affect such components and processes to the degree that severe, adverse environmental impact may result.
- Hazards due to ice may be addressed at least in part, by using knowledge gained in ice hazard studies conducted in the Beaufort Sea.
- OCSEAP will not determine sources of contaminants although assumptions as to sources must be made in order to describe trajectories of accidentally or operationally released materials.

3.2 KEY ISSUES AND STATUS OF KNOWLEDGE

Within the framework of the tasks described in Section 2.3.1 there are key issues which remain to be completely addressed as well as issues that have been resolved sufficiently for the current needs of the program in this area. The following material presents some judgment as to the degree to which present status of knowledge allows resolution of the issues or completion of the task. Thus, the evaluation includes a decision, based on presently existing data, as to the need to provide more answers to specific questions relating to potential impact.

3.2.1 Biota at Risk

Several subtasks require that lists of particular key species at risk, together with other features of their biology, be available for areas of possible impact by petroleum development. The status of knowledge, or the present capability to produce certain data products, are discussed in the following subsections.

Benthos

Species encountered in Bristol Bay and St. George Basin have been enumerated and their distributions mapped by Feder (RU 281), Feder and Mueller (RU 282), and Zimmerman (RU 78). Feder's data are from offshore; Zimmerman's from the intertidal area. Feder's maps include data from the literature as well as from his own studies of samples from 59 stations covering the lease area and areas downstream. Additional data were obtained by Feder from trawls conducted by Pereyra (RU 175) and analyzed by Feder. Only rare species are expected to be added to the over 600 identified as inhabiting the area.

Data products on hand include maps of distribution and some quantitative data in digital form. The data base is believed sufficient at present to address the key issue - species at risk and their seasonal location. Data from RU 281 and RU 78 may require combination into a single map showing benthic organisms on one chart or table. Selected species (of the 600 or more) need to be grouped in order to map them systematically.

Commercial Species

Because of the special interest in commercial species, they are considered here as a separate issue despite the fact that both demersal and pelagic fish are among the benthos and plankton.

Almost all of the major fishes have been commercially exploited during the past two decades. At risk are the commercial crabs, Tanner (or snow) and king, halibut, pollock, various flatfish, herring, shrimp, and salmon.

Studies prior to OCSEAP and during OCSEAP (Pereyra RU 175) have yielded a data base of sufficient detail to allow estimates to be made of biomass of all the commercial demersal fish and crabs, within the lease area and downstream of the area. These estimates are most accurate for the spring-summer season. Seasonal migrations and spawning areas of some species are known from data collected on cruises made by Pereyra. These data revealed the benthic limits of many species; deep in early spring and shallow in late summer.

The data base is considered sufficient to address the key issue that demersal fish and crabs are at risk and that they are likely to be most susceptible during their larval life in the plankton at a time when the larval forms and their food may be threatened by perturbations, and, also, when early life stages of some species are occupying shallow inland or coastal waters. Data on salmonids, including the migration routes and catch statistics of the several species of salmon, all of which are of undisputed commercial importance, were summarized by Stern, et al. (RU 483). Data on distribution of non-salmonid pelagic fish have been assembled by Wall and Macy (RU 64) and by Barton (RU 19) for herring.

The question of distribution of all pelagic fish of commercial importance is adequately addressed for present decision needs by currently available data.

Marine Birds

Prior to OCS development and the subsequent possibility of oil spills or release of other contaminants, knowledge is needed on the distribution of breeding and foraging areas of birds at risk along the possible trajectories of such releases. The areas of potential impact include nesting colonies and pelagic foraging areas scattered from Cape Newenham to Unimak Pass.

The species occurring seasonally along the Bristol Bay coast have been tabulated by Bartonek (RU 341). Included are data on preferred habitats, usage patterns, and time of occupancy. Species compositions, population estimates, and maps of shoreline habitats believed to be critical to sea birds have been prepared for the area from Cape Newenham to Unimak Pass (Arneson, RU 3). Densities of important bird species found in offshore areas have been tabulated by Bartonek (RU 337) and additional detail on distributions and densities is available in data collected by Myres and Guzman (RU 239).

Data on the species at risk and seasonal variations in their numbers along the shore are presently available and/or in process. Some gaps exist in knowledge of seasonal distribution offshore but most of the annual cycles are well known. While further integration and interpretation of data from various investigators will tend to reduce the gaps in knowledge, the data are sufficiently complete to address the issue of locations of marine bird species at risk.

Insufficient knowledge exists to predict recovery rates.

Marine Mammals

Studies conducted under the OCSEA program have included estimates of population size, seasonal abundance and distributions, identification of migration routes, foraging and breeding grounds, and other critical habitats for certain species of marine mammals. If activities related to petrochemical exploration and development occur in this lease area, adequate information is available on most species to evaluate locations of possible risk. However, insufficient knowledge exists to predict recovery rates following population losses.

Sea Otters *(Enhydra lutris)*:

Studies conducted by Schneider (RU 241) indicate that in 1975 an otter population estimated at 17,000 occupied the area between Cape Mordvinof and Cape Lieskof extending from shore to the 60m contour. This range was greatly reduced from that of previous years as a result of mortality and southwestward movement caused by extreme sea-ice conditions. The main factor limiting most sea otter populations concerns the availability of large quantities of food needed to support a high metabolic rate. Sea otters feed on sessile organisms. Thus, local changes in abundance of food could lead to marked, site-specific changes in numbers of otters. The population referred to appears to be a likely source of otters for the repopulation of the Fox and Krenitzin Islands. This population also tends to concentrate periodically, making it possible for a large spill to directly affect large numbers of otters.

Distribution and behavioral information on sea otters in this area is considered to be sufficient until further site-specific studies related for tract selections are necessary.

Ice-associated Seals:

Bearded seals *(Erignathus barbatus)* were found to be somewhat uniformly dispersed throughout Bristol Bay in April, occurring throughout the area of seasonal ice cover and migrating north in summer with the retreating ice. The total Bering Sea population is estimated at 300,000 of which approximately 8,000 - 10,000 are harvested annually by U.S. Eskimos and the U.S.S.R.

Largha seals *(Phoca largha)* are generally associated with the southern edge of the seasonal pack ice, moving north as the pack ice recedes in summer. During winter and spring, large concentrations extend from the Pribilof Islands east to Bristol Bay and north to Nunivak Island, generally 20-40 km offshore. The distance of the animals from the shore varies with the extent of the pack ice. The species is the most abundant seal found south of St. Lawrence Island during periods of ice cover. The adults eat pelagic fish, octopus, and crustaceans, but the young prefer amphipods, shrimp, and shoaling fish. The total population in the Bering Sea is an estimated 250,000 with an annual harvest of 7,000 by U.S. Eskimos and the U.S.S.R.

Ribbon seals *(Phoca fasciata)* and their distribution are related directly to ice conditions. During the winter and early spring the entire population of the Bering Sea can be found along the southern edge of the pack ice, in a band up to 150 km wide. During periods of parturition and lactation, ribbon seals usually keep to the seaward edge of floes in the center of large ice masses 50 - 250 km offshore. With the melting of the ice pack, molting seals move closer to shore, coming within 20 - 100 km. As the ice retreats northward in summer, ribbon seals leave the ice and disperse throughout the north Bering and Chukchi Seas. Their scarcity south of St. Matthew and Nunivak Islands may be related to a decrease in food. Shrimp, crabs, and mysids are the preferred foods in addition to fishes and cephalopods. The Bering Sea population, estimated at 100,000 seals, has been declining through the past decades, possibly due to heavy commercial harvests by the U.S.S.R.

Ringed seals *(Phoca hispida)* occur as far south as the Pribilof Islands during the winter and spring, but are considered rare in the Bering Sea when ice is absent.

Sea Lions and Harbor Seals:

The population of Steller sea lions *(Eumetopias jubatus)* in the eastern Aleutian Islands has declined by 40 percent over the past twenty years. Factors which may have contributed to the decline are: (1) a westwardly shift in distribution; (2) reduced food availability; (3) an increase in human and fisheries interaction; and (4) an as yet unidentified population controlling factors. On the sea ice this species is restricted to the first few miles of the ice front and is most abundant south of the Pribilof Islands. About 50 percent of the sea lion population occurs on nine islands of the Fox Islands group during the summer and fall months; the Amak Island group accounts for the remainder.

Breeding activity begins in late May and pupping occurs throughout the month of June. Ugamak Island, Bogoslof Island and Cape Morgan (Akutan Island) are the major breeding areas. The most recent estimate of the population in the eastern Aleutian Islands is 23,000. The feeding grounds and food habits of this population are relatively unknown.

Harbor seals *(Phoca vitulina richardii)* are abundant throughout the Alaska Peninsula and Aleutian Islands on the coastal waters and up to 50 miles offshore. The largest concentration of animals (80%) was observed hauled out on sandbars, inlets, and bays at Port Moller and Port Heiden, and in the mouth of the Cinder River. During winter, some harbor seals are known to use the ice edge as a hauling area and a large concentration ($>6/\text{nm}^2$) of ice-breeding harbor seals was present in western Bristol Bay west to 178° 51' W in 1976. Both tide and weather are important determinants of hauling out behavior. The foods and numbers of the Bristol Bay - Alaska Peninsula population are unknown.

An assessment should be made of harbor seal and Steller sea lion movement onto and off rookeries and ice during the winter and early spring months. The harbor seals' apparent dependency on protected tidal bays may make them vulnerable to direct impact from petrochemical contaminants. There are other aspects of the biology of the Steller sea lion and harbor seal populations on the Alaska Peninsula that are not well-defined, e.g., food habits, and these should receive further study before oil-related activities begin in this area.

Cetaceans:

Present information on most species of cetaceans reveals that their temporal and spatial ranges are highly variable. In outer Bristol Bay and St. George Basin, assuming a heavy ice year, a fair amount of sighting information exists for spring and early summer, but is lacking for autumn and winter. Seven species of cetaceans are known to utilize Bristol Bay for feeding or breeding, or for transit through the area during their northward spring migration. The Dall porpoise may breed in Bristol Bay (and by inference St. George Basin). The belukha and harbor porpoise are believed to feed in the area the year around. Most large cetaceans appear to enter the southern Bering Sea in greatest numbers in June, via Unimak Pass and the eastern Aleutian Islands. One species, the gray whale, is known to enter the Bering Sea through Unimak Pass by early April, depending on ice conditions, and then into the northern Bering Sea by late May. Counts of 9,000 animals passing through Unimak Pass were made in April-May 1977. The route taken is predominantly coastal to Nunivak Island, after which the migration occurs offshore. An undetermined number of animals are also believed to migrate to and feed around the Pribilof Islands.

Due partly to the fact that Bristol Bay and St. George Basin encompass such a large area of open water, very little is known of the behavior, migrational patterns, and critical habitats of the various species of cetaceans found in the area, particularly during the fall and winter months. Although such information is difficult to collect during those seasons, additional research then, and at other times of the year as well, is necessary to define those populations using the area and for what purposes, how they are distributed temporally and spatially, and the degree to which they might be vulnerable to environmental perturbations, particularly nearshore.

Habitats

Some areas, due to geomorphology, the proximity of needed species' requirements, and/or other factors related to particular environmental conditions, have become habitats of importance to a species or to several species. These include bird or mammal rookeries which provide suitable breeding or resting areas and access to nearby food supplies. Some habitats are also comparatively more vulnerable than others to impact from oil spills due to their physical characteristics.

The studies listed below contribute to the knowledge of particular habitats which, when compared to others in the whole of St. George Basin, are for various reasons believed especially important or critical for certain species although the same species may also be found elsewhere:

1. The ice edge

The edge of the sea ice, and an associated zone a few kilometers wide, has been found to be a unique habitat. In Bristol Bay, many species utilize the ice edge in ways that may be crucial to their survival and reproduction. Reasons for importance of the ice edge include:

- Primary productivity under and near the ice is a significant fraction of the total production and, in arctic areas, it is the site of the first bloom of the season.
- The secondary producers and fishes occur within the ice edge (zone) in such quantities that sea birds congregate there to feed in preference to open water.
- In addition, marine mammals congregate at the ice edge for parturition, feeding, and hauling out.

Data showing the unique character of the ice edge as a preferred habitat for plankton and ichthyoplankton are contained in reports by Alexander (RU 427) and Cooney (RU 426), for pinnipeds in reports by Burns et al. (RU 248 and 230) and for birds in those of Bartonek et al. (RU 337) and Divoky (RU 196). Many questions are unanswered concerning the physical and biological processes that result in the high standing crops and productivity of many species along the ice edge, at all trophic levels. However, the data are sufficient to enumerate the species at risk and to indicate critical periods in the timing of their occurrence in and around the ice edge.

If a spill should occur, there is a real possibility of entrapment of oil in the leads between ice floes and in the uneven surface beneath the ice and thus contamination of the very area critical to the biota. No data exist concerning the mechanisms by which oil might be dispersed out of the zone of the ice front. Therefore, there exist no estimates of the length of time that exposure to oil would occur in this habitat.

2. Coastal Habitats for Marine Birds and Mammals

Marine and shore birds of many species congregate for breeding in isolated colonies. These have been catalogued and mapped by Bartonek (RU 341) and Hunt (RU 83) for the Pribilof Islands, and the data are sufficient to identify habitats at risk from contaminants, at least until site-specific studies of shore facilities are required.

Sears and Zimmerman (RU 78) of Auke Bay Fisheries Laboratory have compiled a detailed atlas describing the physical features (i.e., gravel, rocky, tide flat, etc.) of the entire coastline from Unimak Pass to Cape Newenham, plus Hagemeister, Walrus, Pribilof and Nunivak Islands. They also show some of the birds and mammals observed during the survey.

The isolated rookeries and hauling out grounds that marine mammals are known to occupy have been catalogued and described by Braham et al. (RU 67, 68, and 69). Sea otters inhabit a stretch of coast including Port Moller and Unimak Island, to a depth of 60 meters (Schneider, RU 241). These studies, along with the one by Sears, provide the basis for evaluating possible future OCS-related impacts on marine mammals occupying these habitats on a seasonal basis.

Izembek Lagoon has been judged a critical area due to the high productivity of eel grass on the extensive flats. It is very important habitat for birds (Bartonek, RU 341, Arneson, RU 3) and sea otters (Schneider, RU 241). Data on the productivity of the flora are not available nor are there estimates of flushing (recovery) time should an oil spill invade the lagoon. There is ample evidence that Izembek and other lagoons are critical to the reproduction and survival of large populations of many species of birds.

3.2.2 Transport

In order to address the key question on transport, "Where would petroleum or other pollutants be transported and therefore, what environmentally sensitive areas and species would be impacted?", answers are needed to many questions on circulation. Singular among these is the question, "What are the most probable circulation patterns to be expected in the lease area at any given locality at any given time?" Key issues and the status of knowledge applicable to this question include:

1. What are the likely winds in the lease area? (RU 347, 367)

   Winds affect the overall water current patterns in ways that are still under study. They also directly affect the direction taken by an oil spill, causing the oil to move according to vectors which are slightly, but perceptibly different from the local water currents.

   Because winds affect the motion of oil on the water surface on scale lengths which cannot be resolved by synoptic weather charts, there must be found an algorithm which (1) allows an estimation of local winds over the water, and (2) accounts for the effects on the winds of local temperature gradients and mountainous terrain. Available for this are the synoptic weather data and perhaps local airport or other station data. Present knowledge is such that local wind vectors over the ice edge cannot be drawn with sufficient confidence to allow calculation of convincing trajectories.

   Reynolds (RU 367) has developed a method of predicting winds that is applicable to NEGOA, but it is not yet of sufficiently general nature to be useful elsewhere without substantiating instrumentation.

2. What are the seasonal density gradients over the Southeast Bering Sea and how do they affect local currents?

   Data on seasonal salinity and temperature as well as local currents are available (Coachman et al., RU 141), and these are augmented by historical data collected by Muench (RU 307) and Wise and Brower (RU 347). To the extent that currents can be inferred from density gradients, the data base can be used with acceptable precision to estimate the most probable current distribution for any season. The true currents obtained from current meters (baroclinic plus barotropic) are known from extensive data obtained at key points on the shelf contiguous to the lease area. This data base is believed sufficient to validate a circulation model (RU 435), but insufficient to allow verification of the model near the coast of Bristol Bay.

3. What are the rates of flow over Bristol Bay?

Empirical evidence for the flow field comes from a fairly extensive series of records from current meter moorings begun in 1975 (RU 141). These meters were deployed along two arcs over the shelf: an outer arc beginning at Unimak Pass, passing through the Pribilofs and ending at Nunivak Island; and an inner arc from Port Moller to Cape Newenham.

The assembled data reveal that the flow is toward the northwest from near the center of Bristol Bay and toward the northeast along the Alaska Peninsula, and that the rates of flow are not large. In 1977 three satellite-tracked drifting drogues remained within a 40 to 60 mile circle for approximately 70 days (Hansen, RU 217).

Because trawling has caused displacement of current meters moored in the lease area, it has not been possible to obtain adequate empirical data on currents within the lease area proper. The empirical data gathered in mid-summer from the Lagrangian drifters is inadequate to measure flow and establish trajectories between the lease area and the Pribilofs due to lack of data for other seasons.

4. What are possible trajectories of pollutants from the lease area?

This question is expected to be answered in part by a numerical model of circulation currently under development by Leendertse (RU 435). This model combines presently available data on bathymetry, winds, density structure, tides, runoff, and empirically determined currents to calculate local current fields and to derive a trajectory from these. The model does not combine biological data with oceanographic data, although much of the former is available. Thus, once the trajectory of a spill has been estimated, reference is made to other data to determine the species and habitats at risk along the route of the contaminant and the possible points of impact with the ice edge or coastline.

Data presently available and to be gathered in FY 78 will be used to drive the model and to verify its actual utility. Development of the model beyond the use of a similar one in the Netherlands is continuing, but it is not expected to be complete until further tests against actual field conditions are completed.

3.2.3 Remote Sensing

Satellite data have proven useful in showing current patterns when sediment or temperature gradients make currents visible. These data have been made available in past years by funding specific research units to examine imagery, determine the presence of oceanographic information and pass the information to others for analysis. (RU 267).

3.2.4 Contaminants

During FY 75 and FY 76, samples were collected to document the concentration and composition of petroleum-related contaminants in the Bering Sea. Research units participating in this effort were:
RU 162 -Burrell, Robertson (subcontract); RU 224 - Shaw, Kaplan (subcontract); RU 152 - Feely; RU 153 - Cline.

High molecular weight hydrocarbons: 21 sediment samples were collected by Kaplan and analyzed for hydrocarbons by gravimetry, GC and GC-MS. Total hydrocarbons ranged from 2 to 241 μg/gm sediments, with the average near 15 μg/gm. This value is similar to that found in sediments in the vicinity of the Mississippi Sound and greater than that found in offshore Gulf of Mexico sediments (Ref. Gearing et al., Geochim Cosmochim Acta. 40: 1005 (1976)). Terrigenous sources seem responsible for most of the sediment hydrocarbons in the Bering Sea. One sample, from sediments at the head of Pribilof Canyon (241 μg/gm), displayed many of the characteristics of weathered oil and demonstrated the possibility of seeps in the area. Also, a few benthic and pelagic biota have been analyzed by Shaw for heavy hydrocarbons with no petroleum contribution observed.

Low molecular weight hydrocarbons: 14 of the 21 sediment samples collected by Kaplan were also analyzed for C_1-C_6 hydrocarbons. Only methane was reported and that in concentrations from 0 to 21 μg/g of sediment. No obvious correlation exists between methane and total heavy hydrocarbons. Cline determined LMWH in the water column. A total of 72 stations were occupied and sampled at the surface, intermediate depth and near bottom. Methane concentration at the surface was highest in coastal lagoons (100 nl/l) and lower offshore. Near the bottom, values of 100 to 700 nl/l were observed offshore. Ethane concentrations were observed offshore, averaging 0.5 nl/l, as did propane. Evidence to date indicates these gases are of biogenic origin. The stations were located sufficiently far apart, however, that natural seeps, such as the one in Norton Sound, may not have been detected. This suggests the need for site-specific studies on a scale of 1-5 miles between stations when tracts are selected.

Metals

Burrell has determined the presence of selected metals in sediments, water and biota. Extractable Fe, Ni, Zn and Cu are closely correlated with the grain size fineness of sediments. The concentration of Mn is not as closely correlated. Dissolved metal concentrations in the Bering Sea differ little from oceanic mean concentrations. Selected metals in intertidal, benthic and pelagic biota have been determined. An unusual observation was the high Cd contents of the gut and reproductive organ of Neptunea (snail).

The present data base is sufficient until leasing plans are developed to the point where special sites may be investigated for seeps.

Note: Data over the St. George lease area were not collected. However, the data from Bristol Bay distinguish between Bering Sea water and coastal water. There is no reason to suspect that over the St. George Basin, levels are significantly different from adjacent areas of outer Bristol Bay. Hence, it is concluded that until site-specific data are needed, the data base is sufficient for both St. George Basin and Bristol Bay lease areas.

3.2.5 Hazards

Bristol Bay is seismically quiescent relative to the Alaska Peninsula and the Pacific side of the Aleutian chain. The frequency of seismic events in Bristol Bay has been determined by Meyers et al.[1] and Gardner and Vallier (RU 206) have plotted locations of historic epicenters. The highest frequency and areal density of seismic events occurs just north of Unalaska Island where Meyers found frequencies of recurrence of 0.1/yr. for magnitude 6.0 or greater and 1.9 per year of magnitude 4.5 -5.9. However, the number of epicenters recorded in the lease area itself is an order of magnitude less.

---

[1] Meyers, H., Brazee, R. J., Coffman, J.L., and Lessign, S.R. "An Analysis of Earthquake Intensities and Recurrence Rates in an near Alaska." NOAA Tech. Memo EDS NGSDC-3, Natl. Geophysical and Solar-Terestrial Data Center, NOAA, Boulder, Colorado (October 1976b).

The data available to judge earthquake hazards is sufficient to permit statements of risk relative to other OCS areas, but the record of epicenters is too short to allow reliable estimates of absolute risk. A presently operating seismic net, aimed primarily at the active areas south of the Aleutians (RU 16), will add data for both the St. George Basin and Bristol Bay. One of the network instruments is on St. Paul Island.

Hazards due to faulting, slumping and other sediment instabilities are determinable from data collected by Gardner and Vallier (RU 206). They have mapped locations of faults and potential slumping areas. Their track lines were not spaced closely enough to allow unequivocal determination of trends of fault lines; however, there is indication that the trends are along a NW-SE axis.

Data on faults and instability of sediments seems sufficient to determine the areas of greatest risk and for planning site-specific hazard assessment after tract selections.

Hazards to development closer to the Pribilof Islands and on the islands themselves, may be assessed, at least preliminarily, on the basis of data reported by Hopkins (RU 209). His report included locations of faults and their approximate frequency of activity, the locations and frequency of eruption of volcanoes, and the fragility of coastlines backed by sand dunes.

Data relevant to assessment of hazards due to ice appear incidentally in ice-habitat studies by Burns (RU 248), and descriptions of the nature of ice floes and the ice zone in the southeastern Bering Sea are available. These data, including satellite photos of distribution of ice (see Beaufort Sea TDP) are sufficient to establish that ice will occur in winter in the St. George Basin and Bristol Bay lease areas, and that its extent will be highly variable from year to year. Present plans are that the characteristics of the ice as a physical hazard will need to be determined by extrapolation from studies in the Beaufort and Chukchi seas.

3.2.6 Biological Process Studies

At various points in the process of making decisions on oil and gas development, it will be necessary to have knowledge sufficient to evaluate the importance of different species. It will also be essential to predict whether a seriously affected population can recover and, if so, how long recovery will take, and the degree to which other populations or species will be affected indirectly.

Laevastu, (RU 77) has developed an ecosystem model that includes components from all trophic levels. Preliminary and unverified conclusions resulting from use of the model include ones of importance in assessments of the possible effects of petroleum development:

1. Ecosystem structure and function is variable to the extent that it will be difficult, if not impossible, to distinguish between man-caused and natural influences of change in the marine environment.
2. Small scale disturbances for time and length smooth out rapidly, with seemingly no generally effective method for propagating a small scale disturbance.
3. There are exceptions to item 2, along the coast.
4. It is difficult to establish that quantitative and determinable damage can be caused to a marine ecosystem by temporary accidental damage to a part of such a system.
5. It does not seem reasonable that any mortalities resulting from oil-related activities can reach a "significant" fraction of those induced by the top predators, (marine) mammals and man.

The model is still under development; however, several provocative reports relating to trophic studies are available. Verification of the results is needed and is continuing (it is recommended that FY 79 plans include critical review of the model).

Preliminary results from some empirical trophic studies, e.g., Feder et al. (RU 281), list food preferences of several demersal fishes. These preferences include several benthic invertebrates as well as other fish. Pollock are known to be very cannibalistic, the trait being noted by Feder as well as by Laevastu (RU 77).

Additional empirical data on foods eaten are available from stomach analyses of fish (Smith, RU 284), and birds (Bartonek et al., RU 337). Sanger and Baird (RU 77) have compiled an extensive report on distributions and feeding habits of marine birds (these data were used in the ecosystem model by Laevastu). Feder, Laevastu and Sanger and Baird have all developed food web diagrams. The one by Feder is especially complex and extends through all trophic levels.

In summary, present knowledge of marine environments in the Bering Sea does not allow assessments based on data to be made of interference in ecosystem function with the effects of contaminants on single species or groups of species at a particular site. It is possible to identify or postulate perturbations in some trophic relationships, but not possible to estimate reliably the degree of dependencies involved, although there are exceptions to this in some isolated instances.

3.3 APPROACH

The approach taken to resolve the key issues discussed in the preceding section groups the several tasks described in the PDP into primary objectives to produce the kinds of information needed by BLM at various points when decisions must be made in the leasing process.

3.3.1 Program Emphasis and Direction

Hazards to Development

The information to be acquired addresses the BLM's need to assess the hazards imposed by the environment on any structures or activities related to petroleum development. These hazards are enumerated under task C and include:

- seismic and tectonic events
- surface and near surface faulting
- sediment instability

- sea floor erosion and deposition
- coastal erosion and deposition
- stratigraphic (gas-charged sediments)
- ice stress
- ice gouging
- extreme oceanic events

Biota at Risk

After tracts to be leased are identified, both the public and the BLM will have an immediate concern: What populations would be impacted and to what extent under any plausible set of circumstances accompanying any activities relating to the exploration for and development of petrochemical resources, including oil spills or other releases of contaminants? Figure 3-1 describes the organization and relationship of various tasks and information products to one another. The issue of populations at risk may be approached at two levels: (1) that all the species present in an area of plausible impact be identified and that there exist reasonably reliable estimates of their seasonal variation in occurrence and abundance; and (2) that there exists adequate knowledge of the relative importance of each species and their interrelationships, including trophic considerations, to determine the extent to which particular species might be impacted with or without serious and long-lasting (or irreversible) changes in the functioning of biological communities.

Habitat Characterization and Species Inventory

Studies to determine the distribution and abundance of principal species may be conducted as a portion of the effort to characterize habitats, or as a pseudo-random survey conducted using randomly and uniformly distributed points. Either method results in knowledge of species occurrence, distribution, and abundance. The resultant data are obviously more definitive for some species than for others, and emphasize knowledge of the dominant forms.

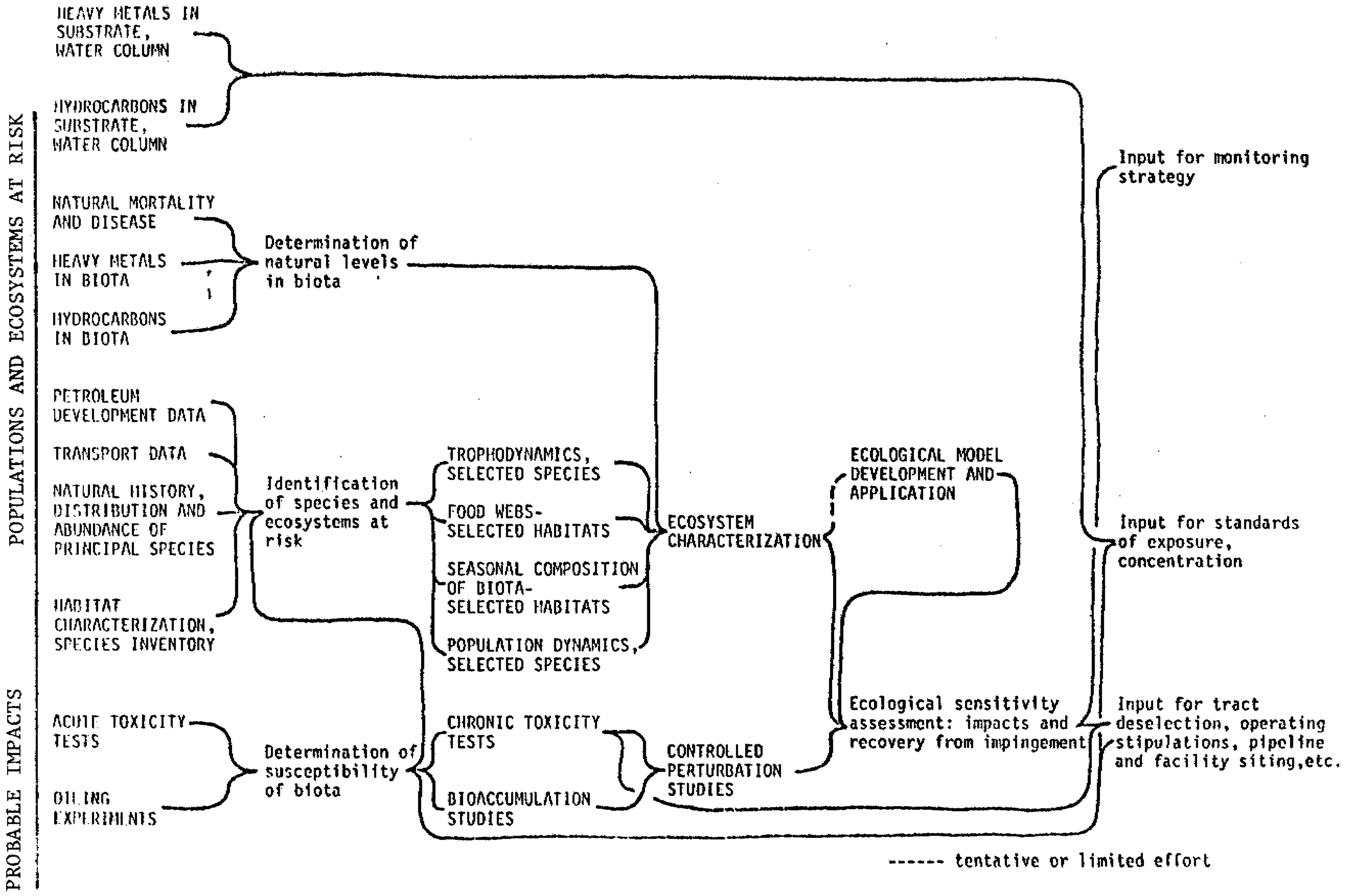


FIGURE 3-1. RELATIONSHIPS OF VARIOUS RISK AND IMPACT STUDIES

Data on the distribution and abundance of principal species are combined with transport data, as shown in Figure 3-1, to identify the species at risk. A list of the latter, coupled with knowledge of their relative susceptibility to contaminants, permits estimations of the probability of occurrence of serious perturbations.

Transport Studies

Determination of the locality where a pollutant will affect the ecosystem, and how much pollutant will be present at the point of impact, is the subject of transport studies. One of the important end results is the capability to derive trajectories of pollutant transport from any source under all conceivable meteorological conditions in all seasons. Because of the cost of the computer runs which compute trajectories, OCSEAP can provide only demonstration runs from typical sources with typical winds, to demonstrate a capability to make such identifications. In an actual field situation, a specified possible source will be identified by BLM, and that identification, considered with the time of the year and general weather conditions, will allow computer runs to be made to determine the trajectory of the contaminants. The species at risk are found by combining data on trajectories with those on species distributions for the season in question. It is also desirable, but difficult, to determine the amount of pollutants remaining after dilution by mixing and dispersion.

Because winds and currents both influence the movement of contaminants, calculation of an oil spill trajectory is possible only if knowledge of both is available for the entire area under study. Current patterns are dependent on many factors, including:

- bathymetry
- tides
- winds
- density gradients
- run off
- advection of momentum from outside
- atmospheric pressure gradients

Three types of information on transport are required: (1) knowledge of all possible trajectories from a point source; (2) determinations of species along the route of all possible trajectories; and (3) identification of all coasts and ice edges where contaminants might arrive.

Predictive Transport Model

In principle, data on the currents should be obtainable by simultaneous calculations from the equations of motion and continuity. In practice, large computers make possible approximations of the current field, accounting for each of the above factors. It is necessary, however, to verify the results using data on currents obtained empirically at strategic points. The same data may also be used later to force or drive the calculations at these known points, if desired. One of the uses of the model, therefore, is interpolation of data between known locations, with equations of motion and continuity accounted for.

The scheme adopted for calculation of current field and deviations of possible trajectories for an oil spill, using all available data, is labeled Predictive Transport Model (Figure 3-2). Inputs to this model come from various studies and are described below. The operative model predicts the trajectory of a contaminant under prescribed conditions already enumerated.

Lagrangian Currents

Empirical data used to verify the results of the operation of the predictive trajectory model are also useful under some conditions, as indicators of trajectories that oil spills would follow. A buoy, drogued to follow a particular water mass near the surface, convincingly mimics the trajectory of an oil spill, under certain assumptions, if the buoy is designed properly. If several buoys are released together, it will be found that their paths diverge. The statistics of the divergence can, with some qualification, be used to derive rates of dispersion of pollutants, or at least to indicate relative rates from one area to another.

Satellite telemetering of information on the position of buoys makes it possible to track several buoys simultaneously for many days. (≅70 days in 1977, during which time 3 such buoys remained within the Bristol Bay lease area). The results are valuable for use other than for trajectory models, and from them it is possible to draw reasonable conclusions as to the residence time of pollutants on the surface or in the water column.

Eulerian Currents

Long-term data from strategically deployed current meters have utility similar to data derived by Lagrangian methods. However, extrapolations of the former data to form plausible pollutant trajectories are less reliable. If enough current meters could be deployed, of course, no calculations of currents would be necessary for the trajectory model. However, since current meters are expensive and subject to displacement by trawlers, they are deployed only in limited numbers and at locations where calculations show that the empirical results obtained would be most useful, e.g., for boundary conditions to be imposed on any subsequent derivations. Examples of choices for current meter locations include:

- boundary of any computational model
- along density gradients if they are known or assumed
- middle of the lease area
- along bathymetric gradients
- in locations suspected to be near a tidal node where three or more meters may be useful in locating co-tidal lines.

In addition to the flow vectors derivable from current meter data, the statistics of variability of each data set and coherence among two or more time series may be used to derive dispersion data for the transport model.

Coincident with the measurement of currents are measurements of pressure on the bottom. Changes in sea level are used to determine the effect of atmospheric disturbances (wind and pressure changes) on circulation; these verify the model's capability for simulating these effects.

Nearshore Meteorological Measurements

On a short time scale oil on the water surface is sensitive to changes in the wind direction, and thus does not follow precisely the direction of the water movement. Surface currents, while responding more slowly than an oil slick to changing winds, are able to follow local winds on a scale length shorter than the scale length of synoptic weather charts. Therefore, in areas where local winds are not in conformance with the geostrophic winds due to topographic or ground temperature gradients, some means must be found to compute the true wind. The south shore of Bristol Bay is bordered by mountains, passes or wide snow fields and, during the winter, the ice edge becomes another cause of deviation of local from geostrophic winds. Muench (RU 307) has reported this effect in Bristol Bay where the temperature gradient between ice and water causes strong winds toward the open water.

It is anticipated that when an environmental impact statement is required, BLM will prescribe the location of possible oil spills. At that time, calculations of a local wind field must be made and used to predict the possible trajectories of oil on the water surface. Such a prediction might be based on the most likely of a suite of typical climatologies or a representative synoptic weather system.

Presumably, if possible oil spill sources could be named early in the leasing schedule, instrumentation could be deployed to determine the wind field empirically. However, there is little likelihood of a full set of typical or possible climatological events occurring during the instrumentation. Therefore, the OCSEA program has elected to develop a general algorithm applicable to more than one area, e.g., the Lavoie model adapted for Yakutat by Overland (PMEL). If necessary, techniques such as used by the National Weather Service to predict local winds in Lower Cook Inlet will be used.

In addition to an algorithm for computing local winds from synoptic data and local topographic conditions, it is necessary to find the most likely sequence of synoptic weather conditions. Such a sequence is necessary to set up the boundary current conditions applicable at the time of a hypothetical spill. The work of cataloguing probable atmospheric conditions is related to the task of forecasting extreme oceanographic events, drawing on the same data base present in the National Weather Service, as abstracted by RU 347.

Oil Dispersion and Weathering

These studies are described in detail elsewhere (Non-Site-Specific TDP).

Just as the predictive trajectory model calculates an oil spill trajectory, it can also be designed to account for the dispersion of the pollutant. Oil, however, does not disperse in a manner similar to a substance which dissolves in the water column. Oil on water undergoes a series of complex changes including partial evaporation, sinking of fractions that encounter suspended particles, and finally the formation of a floating mass of emulsified material of a composition quite different from that of the original spill.

Mattson's (RU 499) list of the events accounting for the weathering of oil includes:

- evaporation of fractions
- microbial degradation and photo-oxidation
- emulsification
- incorporation on suspended sediments and sinking
- dissolution of some fractions

Without algorithms to account specifically for the weathering process, the predictive model computes a trajectory and assumes that all of the oil reaches a calculated point on the shoreline or ice edge. The subjective assumption must then be made that the oil somehow spreads out and affects an area of beach of an arbitrary width.

Nearshore Mapping of Currents by Radar

If this developing technique can be verified, it will provide real-time, site-specific data in the form of maps of current vectors on a grid extending up to 70 km or more offshore. Because it is synoptic and "looks" at the surface current, unlike the data now derived from drogues or current meters, its output would be directly applicable to real-time trajectory prediction as well as for verification of models. Data from maps of currents produced by this system could be fed directly into a trajectory computation.

Biological Process Studies

The second level of detail or effort of OCSEAP studies is the determination, through various biological process studies, of the possible or likely relative damage to the ecosystem that might result from impact on or insult to different populations. There is a consensus that decimation of some populations in an area of impact may do greater damage to the ecosystem than decimation of others. There is no consensus as to how the process works or if it propagates through the system.

Various process studies have been undertaken to assess the differences in effects on the ecosystem caused by insult to or decimation of different populations. The conceptually simpler ones (certainly not simple in execution) are food web studies that determine trophic relationships sufficiently for assessments to be made of the effects on a species or population when its food is reduced or eliminated. This concern underlies studies of the feeding habits of colonial birds, for example.

The seasonal composition of biota in selected habitats details the characterization of habitats beyond mere species distributions and provides data that would allow for accuracy of impact assessment. These studies describe sequential habitat utilization; thus plausible inferences may be drawn as to how relatively important the protection of a particular habitat may be.

Many of the results of all the biologically-oriented studies described above are straight-forward statements of occurrence, behavior, numbers present, and sometimes life-stage of species and populations at risk. These data are available as maps, graphs, figures, and tabulations catalogued in the table of data products with relative by complete results.

In addition to a list of populations at risk, included in Figure 3-1 are more generalized studies, e.g., trophodynamics of selected species and ecosystem model development and application. The latter are attempts to characterize ecosystems, and thus to allow inferences to be made on the recovery rates of such systems following a possible insult.

Conceptually, the ecosystem model has the capability of describing the sequence of events occurring after a population or a community is disturbed. The model is intended to quantify the fluctuations in populations and the ultimate recovery of the ecosystem following changes in a population. All of the results of studies described earlier are, in principle, applicable to the development and operation of the model. Data on species distribution, transport, climatology, tropho-dynamics, behavior and food web relations, and commercial fishing are included as inputs to model computations. The fully developed model will test inferences drawn from data suggesting the relative importance of species, and their vulnerability and recovery rates, and will require that such inferences be consistent with known dynamic relationships and variability in populations.

To assess ecological hazards, integration of the distribution data on species at risk with those on behavior, trophodynamics and habitat is conceived of as a tract or site-specific study. This task is partly subjective but it can possibly be performed according to more rigorous procedures by use of an ecological model. The model will be designed to address the issue of relative risk and possible trade-off by providing objective responses to queries concerning short and long-term effects of various aspects of petrochemical development.

3.3.2 Rationale for Bristol Bay in FY 79

Because of budget restrictions and higher priority in other areas (Bristol Bay leasing is not presently scheduled), few studies are planned here for FY 79. The rationale for choice of projects includes:

- Those which show a high probability of yielding data that not only identify species and populations at risk but also explain processes.
- Transport studies that proceed directly to predictive capability and which are prerequisite to site-specific studies.
- Projects that require a long lead time.
- Postponement of effects work may be possible to do between the end of FY 79 and the earliest possible sale date (assumed to be late 1981) in order to profit from effects studies in higher priority lease areas.

Tasks and research units proposed for funding in FY 79 are given in Section 3.4.

Hazards to Development

Since there is evidence that seismicity in the Bering Sea is slight, as are hazards, due to the nature of the sediments, no additional field work is presently planned. An effort to compile existing data on sediments is recommended, however. Any gaps will be apparent after existing data have been analyzed; at that time (end of FY 79) there will be sufficient time for the addition of any needed field studies. In the St. George Basin TDP there is a plan for maintaining a seismometer on St. Paul Island. Its purpose is to record seismic events in the Aleutians, but data from that effort will also include seismic events from Bristol Bay, if any occur.

Biota at Risk

No biological field studies are planned for FY 79 in Bristol Bay. As shown in Section 3.2 on Issues and Status of Knowledge, much information is already available. Some of it requires analysis and integration into a form usable by the BLM; however, since the present leasing schedule shows no foreseeable need, no new analyses or reformatting will be attempted until OCSEAP has benefitted from experience by BLM with data products and syntheses designed for other lease areas. However, work on the ecosystem model (RU 77), applicable to the biota of Bristol Bay and St. George Basin, is scheduled to continue.

Reconnaissance studies are considered to be complete with the exception of synthesis of data from multiple sources. Planning of special studies, such as additional foodweb work and trophodynamics studies, will be postponed until OCSEAP review of FY 78 results, and after similar studies have been completed in Cook Inlet. Reviews will put emphasis on data available from the coastal lagoon systems of the Alaskan Peninsula to determine if they are sufficient to document the vulnerability of the lagoons to oil pollution and to determine if special studies will be advisable. If reviews by OCSEAP in FY 78 show data gaps or need for special studies beyond the reconnaissance level, they can be planned for FY 80. This is believed to be compatible with estimates that tract selection could not occur until July 1980 with a DEIS no earlier than April 1981.

Transport Studies

Additional current data will be acquired in FY 78 to supplement that obtained in FY 77. The data obtained in 1977 were provocative but until additional data are available, particularly under other weather conditions, the results will be considered inconclusive. A crucial requirement for the predictive transport model is availability of data on variability of currents. Whether used rigorously in the model or subjectively in conceptual models, data from repeated experiments are needed before conclusions as to flushing time or trajectories can be drawn from the drifter data. However, these will be delayed until firm leasing schedules are announced.

Predictive Transport Model

The schedule originally proposed for development of an operation model was three years, beginning in FY 77. Verification data from current meters deployed during 1978 will not be available for study until early FY 79. Assuming that satisfactory verification is achieved in the first half of FY 79, some operational runs may be attempted in late FY 79. These may include trial forecasts of storm surges. This work is being done under RU 435.

Integration of data from current meters, Lagrangian drifters and STD measurements is independent of development of the numerical (computer) model. High among the objectives of all research units is the description of seasonal patterns of circulation in Bristol Bay. These objectives are to be met by the publication of maps of dynamic topography from which may be inferred the direction and magnitude of currents. Currents inferred in this manner may be correlated with a time series of measurements from moored current meters. Generally, the two will not agree; only the baroclinic component shows up in density (STD) data. However, if STD measurements over a wide area on a suitably tight grid are coupled with strategically located current meter data, a useful map may be drawn which is not, however, an accurate depiction of currents. Trajectories computed from data included on such a map would be suspect, particularly if the trajectory predicts a controversial impact point.

Since the currents in Bristol Bay have a large tidal component, an added complication arises. The "true" currents are not as "smooth" as implied by the smooth contours of dynamic topography and, if anything, indicate a net flow on a time scale of days. Therefore, real trajectories, particularly nearshore, having time scales of many days, must include the tidal currents, which are difficult to calculate. Without a tidal current model it would be virtually impossible to map the tidal currents at the coast except near the points where a current meter had been moored.

In principle then, while currents could be "hand" calculated at a point for which there were no empirical data, it is difficult to find other than the baroclinic component and it is necessary to use a large computer. The alternative is to use subjective ("eyeball") methods.

In summary, given the requirement that trajectories from probable drilling sites or from tract-sized areas must be derived and that these must be reasonably accurate, there is a need for accurate calculation of currents at a large number of points. This could not be accomplished without a large, complex computer program incorporating the physics needed to calculate currents accurately, resulting in a circulation model.

3.4 SELECTED PROJECTS

3.4.1 Tasks A-F

The OCSEAP Program Development Plan has defined the objectives of the Program in terms of tasks A through F, paraphrased here:

A. What are the existing distribution and concentration of potential contaminants associated with petroleum development?

B. What are the nature and magnitude of contaminants and environmental disturbances that may be assumed to accompany petroleum exploration and development of the Alaskan continental shelf?

C. What hazards does the environment pose to petroleum exploration and development?

D. How are contaminant discharges moved through the environment and altered by physical, chemical, and biological processes?

E. What are the biological populations and ecological systems most subject to impact from petroleum exploration and development?

F. What are the effects of contaminants and environmental alterations related to OCS oil and gas on individual organisms, populations, and ecological systems?

3.4.2 Specific Subtasks (FY 79)

Research units funded for FY 79 addressing the question of species and ecosystems at risk are listed below, together with the subtasks under which they were planned:

RU 141/549 subtask D-1

BRISTOL BAY OCEANOGRAPHIC PROCESSES

Analysis of data from moored current meter and CTD surveys in FY 77 and 78 will be continued. The data are required for objective verifications of the circulation model and will result in a refinement of the data base on which subsequent trajectory analyses will depend.

RU 435, subtask D-1

PREDICTIVE TRANSPORT MODEL

This research unit will be continued.

The developmental schedule originally proposed for the model included a three-year period beginning in FY 77 before operational use of the model. Verification data from current meters deployed during 1978 will not be available for study until early FY 79. With the assumption that satisfactory verification is achieved in the first half of FY 79, some operational runs may be attempted in late FY 79. These may include trial storm surge forecasts.

RU 232, subtasks E-2, E-6, E-7, and F-7

TROPHIC RELATIONSHIPS AMONG ICE-INHABITING PHOCID SEALS.

This research unit has previously concentrated in the Norton Sound, Chukchi Sea, and Beaufort Sea lease areas. Part of the work will be done in Bristol Bay and the St. George Basin areas this year.

RU 267, subtasks C-2, C-4, C-5, C-9, D-1, D-2, D-5, D-6, D-8, D-9, and E-17.

OPERATION OF AN ALASKAN FACILITY FOR APPLICATIONS OF REMOTE-SENSING DATA AND OCS STUDIES.

This facility will be continued.

In addition to the foregoing research units which help to identify species and ecosystems at risk, there will be included one unit addressing impacts of development on biota and ecosystems.

RU 77, Subtask F-9

ECOSYSTEM DYNAMICS-EASTERN BERING SEA

This research unit will be continued.

4.0 RU AND P UNIT DESCRIPTIONS

Research and P Units are shown in the order of the tasks to which they relate. Some RU's are associated with more than one task. The following index will assist in locating particular P and RU descriptions.

4.1 DESCRIPTIONS FOR PROJECTS IN TASK D (TRANSPORT):

D-1: RU 141
RU 435
RU 549

D-2: RU 435

D-8: RU 87

D-10: RU 87

(RU 87) THE INTERACTION OF OIL WITH SEA ICE

This research unit addresses subtasks D-8 and D-10 (not designated as to BLM study types).

Estimated Costs, FY 79:		
	$16,900	St. George
	16,900	Bristol Bay
	$33,800	Total

Schedule: October 1978 - September 1979

Performing Agency:

University: University of Washington
P.I., Degree: Seelye Martin, Ph. D.
Title: Research Associate Professor
Percent of time devoted to project and role: 50%; principal investigator; involved in all phases of the field work and analysis.

Background:

Laboratory studies of the behavior of crude oil in growing ice (in test tank, agitated by wind and waves to produce grease, slush, pancake ice, etc.) have shown the oil incorporation in the ice, pumping of oil by the ice and overflow of oil on the ice. Field experiments have studied the crystal structure, void spaces, brine channels and oil containment potential of annual and multi-year sea ice in the Beaufort Sea and in FY 79 will be extended to study the processes of potential oil-ice interaction at the edge of the ice in the Bering Sea on a larger scale, including the use of SEASAT satellite imagery. These studies cannot be effectively conducted in the Beaufort Sea, since the open ice front could only be studied for a brief time. The studies have therefore, somewhat arbitrarily, been assigned to the St. George and Bristol Bay lease areas, although results obtained will be applicable to ice fronts elsewhere. Laboratory studies will not be continued.

Objectives:

The most important objectives of this research project will be to determine the following ice properties and potential oil-ice interactions:

1. The response of the Bering Sea ice edge to changes in atmospheric forcing;

2. The scale of crack systems north of the ice edge as a function of ice thickness and temperature-salinity structure, and the response of these systems to atmospheric forcing;

3. The scale of the Langmuir ice plumes in the large polynya regions;

4. The interaction of ocean swell with the ice edge and the wave propagation into the pack; and

5. The forces which go into the formation of the filament-like structures which form at the ice edge.

Each of the features which occur at or near the ice edge, from the filaments to the spacing and direction of the crack systems, will be important to understanding the spread of pollutants in the pack ice. For example, the filament formations are evidence of convergence zones, so that spilled oil may accumulate in them. Also, the dynamics and scales of the regular crack systems above the edge, and their change in orientation with changes in atmospheric circulation will determine the spread and pumping of oil within the crack systems.

Methods:

This project will employ three different observational scales: SEASAT satellite images, aircraft overflights, and ice surface measurements consisting of the taking of ice cores and the recording of ocean waves propagating through the ice. About 18-24 stations will be occupied on the ice.

Output:

1. Narrative Reports: Methods and results of studies, including:

    a. Description of ice core data.
    b. Description of ice features and their changes in time and space.
    c. The dynamics responsible for these changes.
    d. The likely behavior of oil introduced into the area of observation.

2. Digital Data: None

3. Visual Data: Photographs and satellite images of the sea ice edge. Graphs of distribution and properties of the sea ice.

(RU 141/549) BRISTOL BAY/ST. GEORGE OCEANOGRAPHIC PROCESSES

This research unit addresses subtask D-1, (BLM Study Types 27-Currents and Tides and 29-Residence Times and Flushing Characteristics).

Estimated Costs, FY 79:		
	$ 50,000	Bristol Bay
	50,000	St. George
	$100,000	Total

Schedule: October 1978 - September 1979

Performing Agency:

University: University of Washington (RU 141)
P.I., Degree: L. K. Coachman, Ph.D.
Title: Professor of Oceanography
Percent of time devoted to project and role: 15%; responsible for data analysis and interpretation.

Agency; NOAA/ERL/PMEL (RU 549)
P. I., Degree: J. D. Schumacher, Ph.D.
Title: Oceanographer
Percent of time devoted to project and role: 25%; record analysis and interpretation.

P.I., Degree: R. Charnell, M.S.
Title: Supervisory Oceanographer
Percent of time devoted to project and role: 15%; supervisory responsibility for data, record analysis, and interpretation.

Background:

Since FY 76 research has been conducted on the physical processes affecting the transport of pollutants in Bristol Bay and St. George Basin. In particular, data have been obtained and analyzed from moored current meters, pressure gauges and CTD surveys and have resulted in an understanding of some of the physical processes.

Studies under RU 141 have demonstrated that currents in Bristol Bay and the St. George Basin are controlled largely by tides, winds, and atmospheric pressure. The currents are also affected by events in the Bering Sea that initiate long waves whose effects are propagated onto the shelf and into Bristol Bay.

Analyses of data gathered during FY 78 will refine the definition of physical processes, current systems and variability. These will be integrated with model results from RU 435 following FY 78 data collection.

The major efforts in FY 79 will be the processing, analysis and interpretation of data collected during FY 77 and 78.

Objectives:

The objectives of this study are to provide information leading to an improved understanding of the hydrography, circulation patterns, and dominant driving mechanisms in the southeastern Bering Sea. Specifically, these objectives are:

1. To understand and explain long-term current and pressure fluctuations.
2. To correlate current data and meteorological data.
3. To provide verification data for modeling efforts conducted under RU 435. This consists largely of description of natural events in the data and comparisons with results of simulation of those events in the model.
4. To obtain a better understanding of the formation mechanisms and hydrographic role of large scale density inversions.

Methods:

Methodology has been thoroughly developed for processing of current meter and pressure gauge data. Data from FY 77 and FY 78 will be processed to graphic form according to present procedures; (NOAA Tech. Memo ERL/PMEL-6).

Output:

1. Narrative Report: Reports will discuss relationships between currents, sea level, and meteorological conditions inferred from acquired data. Specifically, the report will discuss figures showing:
    - Seasonal temperature and salinity distributions.
    - Baroclinic circulation
    - Circulation based on empirical data from moorings
2. Digital Data: Current meter, pressure gauge and CTD data acquired will be digitized in accordance with existing procedures in formats 022, 017, and 015.
3. Visual Data: Currents, pressures, and meteorological data will be graphically displayed, including:
    a. Appropriately filtered time plots of tidal and non-tidal currents.

b. Charts of progressive vector diagrams.

c. Stick diagrams of currents, together with winds and pressure variations.

d. Charts showing hydrographic properties and locations of water mass mixing areas.

(RU 435) A DYNAMIC CIRCULATION MODEL OF THE BERING SEA

This research unit addresses subtasks D-1 and D-2 (BLM Study Types 27 - Current and Tides, 30 - Dispersion and Mixing and 32 - Trajectories of Oil Spills).

Estimated Costs, FY 79:		
	$ 29,600	Bristol Bay
	109,600	Norton Sound
	--20,800	St. George
	$160,000	Total

Schedule: October 1978 - September 1979

Performing Agency:

Private: Rand Corporation
P.I., Degree: J. Leendertse, Ph.D.
Title: Project Director, Water Pollution Studies
Percent of time devoted to project and role: 25%; project director and co-principal investigator.

P.I., Degree: S. Liu, Ph.D.
Title; Physical Scientist
Percent of time devoted to project and role: 50%; co-principal investigator

Background:

A comprehensive OCSEAP investigation of Bering Sea shelf water mass dynamics and its driving mechanisms, underway since September 1975, has shown that semidiurnal tidal currents contribute about three-fourths of the observed variance in Eulerian current records. Episodic current pulses, attributed to water movements on and off the shelf, are at least in part responsible for the residual circulation. The current pulses are presumed to be responses to meteorological forcing in the form of regional pressure differences and sea surface wind stresses.

The above features are considered in a numerical predictive model of the stratification and circulation in Norton Sound, St. George Basin, and Bristol Bay initiated in FY 77 by the Principal Investigator. The model presently under development includes the effects of tides, wind stress, density stratification, bottom friction and momentum transfer. This study is part of an overall modeling effort to describe tidal and wind driven circulation in the entire eastern Bering Sea.

Objectives:

The nature and effectiveness of the main physical processes which transport pollutants in the Bering Sea are to be studied by use of the model along with determinations of transport. Specifically, the model will:

1. Support and guide transport studies.
2. Determine local currents and water quality responses to wind fields and tides.
3. Provide risk planning data for OCS petroleum development.
4. Furnish contaminant trajectory, landfall and other data needed for pollution event countermeasures and for planning of FY 80 studies.
5. Provide environmental monitoring station site location planning information.
6. Provide a means of determining the intensity and location of storm tides under various conditions.
7. Develop the capability to provide trajectories under ice-cover.

Methods:

An existing three-dimensional finite difference model of the southeastern Bering Sea is being refined and extended. The initial phase of the investigation emphasized:

1. Development of time-and space-varying boundary conditions (pressure, salinity, temperature, etc.) from available field data.
2. Optimization of the finite difference approximation over the vertical.
3. Adjustment of bottom and wind stress coefficients and coefficients for mass and momentum exchanges.

Results derived from the model, when driven by data obtained earlier, will be compared to field data to verify the model. Pollutant trajectories and current fields (including tidal wave components) will be generated following verification.

Output:

1. Narrative Reports: The Principal Investigators will provide a detailed report for Norton Sound and Southeastern Bering Sea, including:
    - a. progress and strategy used in adjustment and verification of the model.
    - b. graphic presentations of derived current data which can be compared to empirical data for verification of the model.
    - c. pollutant trajectories from hypothetical spill locations under typical conditions.
    - d. a discussion of results of verifications and implications of those results on accuracy of trajectory predictions.
2. Digital Data: Not required.
3. Visual Data: Numerous graphs and charts of simulation results showing:
    - a. inputs
    - b. pollutant trajectories
    - c. horizontal and vertical velocity fields
    - d. comparisons of field and other simulation data

4.2 DESCRIPTIONS FOR PROJECTS IN TASK E (BIOTA):

E-2: RU 232

E-3: RU 3

E-4: RU 3

E-6: RU 232

E-7: RU 232

(RU 3) IDENTIFICATION, DOCUMENTATION AND DELINEATION OF COASTAL MIGRATORY BIRD HABITAT IN ALASKA

This research unit addresses subtasks E-3, E-4 (BLM study types 39 - Vulnerable Populations, 40 - Life History, 41 - Critical Habitats, 42 - Food Web Dependencies, 44 - Wetland Ecosystems.)

Estimated Costs, FY 79 :	$ 5,200	NEGOA
	26,000	Lower Cook Inlet
	1,560	Kodiak
	19,240	Bristol Bay
	$52,000	Total

Schedule: October 1978 - September 1979

Performing Agency:

Agency: Alaska Department of Fish and Game
P.I., Degree: Paul Arneson, Ph.D.
Percent time devoted to project and role: 100%;
Project direction, sample collection, analysis and data processing.

Background:

Collection of information on the seasonal composition, distribution, abundance, timing of migrations and coastal habitat preference by migratory birds in the Gulf of Alaska was completed during 1976. Field work in 1977 was concentrated in Bristol Bay, Lower Cook Inlet, Kodiak, and the Alaska Peninsula. In 1978 winter surveys were conducted in Lower Cook Inlet to determine distribution and abundance of marine birds in relation to ice conditions and also to limited colony studies during the summer to determine bird usage of selected small colonies on the west of Lower Cook Inlet. Field investigations will be completed at the end of FY 78. However, the project will be continued in FY 79 to allow complete analysis of data and preparation of two comprehensive final reports.

Objectives:

The objectives of this study are to determine seasonal changes in the composition, distribution, abundance, feeding and breeding ecology of birds associated with coastal habitats. Specifically, the objectives are:

1. Determine seasonal density, distribution, and use of coastal habitat by migratory bird species.
2. Determine primary feeding and staging areas.
3. Determine breeding locales for selected species.

Methods:

Data collected from previous years will be analyzed and synthesized to provide two comprehensive final reports. Marine bird coastal habitat maps produced by this research unit have been duplicated on 35mm slides and submitted to the Program Office.

Output:

1. Final Narrative Report: Seasonal changes in distribution, density, and use (feeding, breeding, etc.) of coastal habitats by migratory birds will be described and evaluated. This report will include information available on the spring migration of birds past Cape St. Elias, a winter population estimate for Kodiak Island, and winter and spring distribution and abundance estimates of birds in Lower Cook Inlet related to ice conditions and other environmental parameters. Scientific input will be provided by RU 341 (Sanger), RU 005 (Feder), RU 424 (English), RU 512 (Blackburn) and RU 059 (Hayes) in developing this report.

   A second narrative report will be developed in which the phenology, reproductive ecology, life histories, and foraging areas for selected colonies in Lower Cook Inlet and Bristol Bay will be assessed. Literature synopses of food habits for principal life stages of selected species will be included. Input will be provided by RU 341.

2. Digital Data: By FY 79 study results will have been provided in OCSEAP format under file types FY 040 - Bird Habitat and the new bird colony format presently being developed, FT135.

3. Visual Data: Narrative reports will be supported by maps, charts, figures, and tables. Specifically, these products are:

   a. Maps which identify:

      (1) Coastal area surveyed and associated habitat.
      (2) Sampling locations.

   b. Charts which illustrate:

      (1) Seasonal changes in distribution and densities of migratory birds.
      (2) Primary breeding locales for selected species.
      (3) Primary foraging areas for selected species.
      (4) Primary migratory routes.

c. Figures and tables which illustrate:

1. (1) Changes in bird distribution and density.
2. (2) Changes in seasonal use patterns.
3. (3) Seasonal changes in feeding habits of birds associated with coastal habitat.

(RU 232) TROPHIC RELATIONSHIPS AMONG ICE-INHABITING PHOCID SEALS AND FUNCTIONALLY RELATED MARINE MAMMALS

This research unit addresses subtasks E-2, E-6, E-7, F-7, and F-10 (BLM Study Types 41 - Critical Habitats and Habitat Dependencies, 42 - Food Web Dependencies, and 50 - Sublethal Effects of Pollutants).

Estimated Costs, FY 79:

$ 61,000	Beaufort
25,600	Chukchi
13,400	Norton Sound
13,400	St. George
8,500	Bristol Bay
$121,900	Total

Schedule: October 1978 - September 1979

Performing Agency:

Agency: Alaska Department of Fish and Game
P.I., Degree: Lloyd F. Lowry, M.S.
Title: Marine Mammal Biologist
Percent of time devoted to project and role: 100%; specimen collection, sorting, analysis, write-up

P.I., Degree: John J. Burns, M.S.
Title: Marine Mammal Biologist
Percent of time devoted to project and role: 33%; scientific administration, guidance, writing

P.I., Degree: Kathryn J. Frost, M.S.
Title: Marine Mammal Biologist
Percent of time devoted to project and role: 50%; specimen collection, sorting, analysis, writing, data management

Background:

This project is part of the integrated trophics studies in the Beaufort Sea, involving RU's 6, 29, 196, 230, 232 and 359. The project also undertakes the determining and interpreting prey dependencies among four species of seals in the Bering and the Chukchi and Beaufort Seas. These observations must be broken down into age classes, season, sex, and location and comparisons made with the best estimates of occurrence and abundance of prey species, invertebrates and fish. Simultaneous samples of the same species at different localities result in widely different representations of prey items. This emphasizes the need for large samples (often requiring several years of collection) at several areas in order to obtain site specific information. Key localities for spring hunting focus have been identified based on previous results. Generally, continued emphasis can be expected in the Beaufort Sea. This project has taken a lead role in the design of interdisciplinary icebreaker cruises in the Beaufort Sea and subsequent synthesis of trophics

information. This has led to a better understanding of the overall trophic system in the Beaufort Sea. The project will undertake to include analyses of belukha and related mammal trophics material, as part of the broader marine vertebrate consumer efforts that direct the integrated trophics analysis. Food web synthesis accounts focusing on phocid seals in the Beaufort Sea will be accomplished. Emphasis will be on analysis and synthesis of data.

Objectives:

1. Complete analysis of stomach contents from seals of known sex, collection location, and date in a sample grid designed to cover 5 lease areas, 4 species, 2 sexes, all age classes, and 4 seasons. This analysis and interpretation comes yearly into a more clearly focused picture for the western and northern Alaskan shelf, and will specifically be brought up to date in synthetic form for maximum utility to the environmental statement on the Beaufort Sea sale.

2. Synthesize the trophics information collected, including life cycle and productivity information on prey species where appropriate and necessary, for the Beaufort.

3. Analyze available belukha stomach data.

4. Complete food web account summaries for marine mammal-supporting systems in the Arctic lease areas.

Methods:

1. Collection (note: same sample collection base applies in part to R.U. 230)

    a. at hunter sites in cooperation with native harvest activities, largely in spring

    b. aircraft and ship-based collections in areas, seasons not utilized by traditional hunting

2. Analysis quantitative, by volume, number and percent composition/occurrence; standard sorting procedures

3. Availability studies on prey items: otter trawls

Output:

1. Narrative Reports: as required of all NOAA-OCSEAP projects. Specifically, this project will report in narrative/tabular form the spectrum of prey species encountered in stomachs of marine mammals, percent volume, numeric frequency analysis by age, sex, species, season, and location of these results. Key links in the Beaufort Sea trophic system will be identified.

2. Digital Data: Total volume of prey items, prey species, numbers total volume for each stomach; species of mammal, sex, time of year, geographic location.

3. Visual Data: Primarily distribution maps comparing predator and prey species in density. Pie diagrams and other innovative approaches to displaying trophics information can be expected.

4.3 DESCRIPTIONS OF PROJECTS IN TASK F (EFFECTS):

F-7:	RU 232
F-9:	RU 077
F-10:	RU 232

(RU 77) ECOSYSTEM DYNAMICS, EASTERN BERING SEA

This research unit addresses subtask F-9 (BLM study types 39 - Vulnerable Populations, 42 - Food Web Dependencies, and 46 - Ecosystems).

Estimated Costs, FY 79:	$15,000	Bristol Bay
	15,000	St. George
	$30,000	Total

Schedule: October 1978 - September 1979

Performing Agency:

Agency: NMFS/Northwest and Alaska Fisheries Center
P.I., Degree: Taivo Laevastu, Ph.D.
Percent of time devoted to project and role: 50% - Project direction and model analysis.

Background:

The purpose of this research is to investigate the nature, size, complexity and feasibility of a multi-component, dynamic, numerical ecosystem model for the eastern Bering Sea and to construct a functional model permitting useful and reliable assessments of fluctuations in the eastern Bering Sea biomass. Development of the numerical ecosystem model was initiated in FY 76 and has evolved from an eight component, two-dimensional to a twenty-five component, four-dimensional model.

Preliminary results from this model show that the dynamics of the marine ecosystem such as intra- and interspecies competitions, interactions between species and the environment, and the effects of man's actions on the ecosystem, can now be simulated. Thus, during FY 79, this project will be used to integrate and synthesize the extensive data base generated through OCSEAP-sponsored research in the eastern Bering Sea.

Modeling effort will emphasize sensitivity analyses on the key species identified by BLM, those species with commercial, subsistence, or sport significance, unique, rare or endangered species, and those with pre-eminent or essential roles in the ecosystem in the eastern Bering Sea.

Objectives:

1. Identify key species, time periods or areas within the lease areas that may be especially sensitive to oil development.
2. Develop estimates of the effects of environmental perturbations, as identified by BLM, OCSEAP and the investigator, on populations of key species.

3. Identify major information gaps in the OCSEAP research program in the eastern Bering Sea.

Methods:

The existing model will be used to synthesize and evaluate the extensive data developed from OCSEAP research conducted during FY 76-77 and analyzed during FY 78.

Output:

1. Narrative Reports: Reports will provide detailed descriptions of the model with analysis and interpretation of results based on various inputs to the model. Major information gaps and sensitivity of populations to environemntal changes or oil development will be discussed.

2. Digital Data: New data will not be developed.

3. Visual Data: Visual displays or computer graphics will be developed to show:

    a. Areal and temporal changes in population densities and energy demands for major life stages of selected species or species groups.

    b. Effects of altering model constants or input variables (physical-chemical factors on estimates of population densities.

5.0 TIMING SCHEDULE AND PRODUCTS OF OCS STUDIES IN THE BRISTOL BAY

The following products list and timing schedule of OCS studies addresses the Bristol Bay lease area. The list of deliverables is a shorthand approximation for a complex, interlocking set of studies that are often difficult to represent by codes only and in which many qualifiers are necessarily left out.

The Codes used to identify BLM-required temporal and spatial resolution are as tabulated below. The same code is used to indicate present and projected levels of resolution in columns headed 77, 78, and 79. Appearance of the code in the FY 79 column indicates that funding is planned for FY 79.

Temporal Resolution

N = no temporal resolution
A = annual
S = seasonal
St = short term, days to weeks
D = diurnal, diel

Spatial Resolution

0 = information in hand, literature review
1 = qualitative, area wide, cursory
2 = semi-quantitative, hundreds of square miles scale or 25 miles of coastline
3 = semi-quantitative, 3-10 tracts scale or 10 miles of coastline
4 = quantitative, tract specific (2 to 5 miles resolution)
5 = quantitative, site specific
6 = no spatial resolution (non-site specific)

Several codes are also used to indicate existing (Pre-1978) and Projected (1978 and on) status of the effort to attain the specific products in the Data Products List. The codes used are as follow:

1. The research is ongoing, i.e. funded for FY 79.

2. The research unit effort has been terminated, and there are no plans for its resumption. The available data are, or may be, sufficient to meet stated needs.

3. Data are available from non-OCSEAP sources.

4. The data are insufficient to meet stated needs but the project has been terminated due to budget restrictions or lease area priorities.

5. Proposed research units.

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
A	CONTAMINANT BASELINE																		
A-1	Distribution and concentration of hydrocarbons	Determine existing levels of hydrocarbons, prior to initiation of petroleum-related OCS activities.	Seasonal and spatial distribution patterns of hydrocarbons:	Narrative/Table/Map															
			. in sediment	"	275					S2			S4	S5		S2	-	-	2
			. in benthic biota	"	275					S2			S4	S5		S2	-	-	2
			. in pelagic biota including neuston	"	275					S2			S4	S5		S2	-	-	2
			. dissolved in the	Narrative/	275					S2			S4	S5		S2	-	-	2
			water column	Table/Map Profile	275					S2			S4	S5		S2	-	-	2
			. in particulate matter within water column	"						S2			S4	S5		S2	-	-	2
		Determine probable sources of existing levels of hydrocarbons, i.e. biogenic or petroliferous.	Comparison of ratios of C_1/C_2+ with $^{13}C/^{12}C$	Narrative/Table	480					S2			S4	S5		S2	S3	-	2
		Monitor hydro-levels over broad geographical areas to determine significant changes in ambient concentration patterns following OCS development.																	
A-2	Distribution and concentration of low molecular weight (LMW) hydrocarbons in the water column	Determine existing levels of LMW hydrocarbons prior to initiation of petroleum-related OCS activities	Seasonal and spatial distribution patterns of C_1-C_4 hydrocarbons																
			. in water column	Table/Map Narrative	153					S2			S4	S5		S2	S3	-	2
			. in sediments	"						S2			S4	S5		S2	S3	-	2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
A-2		Determine probable sources of existing levels of hydrocarbon, i.e., biogenic or petroliferous.	Comparison of methane and C_2-C_4 hydrocarbon concentrations.		153					S2			S4	S4		S2	S3	-	2
					153					S2			S4	S5		S2	S3	-	2
		Use LMW hydrocarbon as an indigenous tracer or detection parameter to discern accumulation of hydrocarbon during or after OCS development.																	
		Examine the dispersion and diffusion of natural LMW hydrocarbons.																	
A-3	Distribution concentration and chemical speciation of selected toxic metals	Determine the concentration and distribution of nonvolatile petroleum components, especially toxic metals, prior to OCS development.	Seasonal and spatial distribution patterns selected metals:																
			. in sediment	Table/Map Narrative	162					S2			S4	S5		S2	S3	-	
			. in benthic biota		162					S2			S4	S5		S2	S3	-	2
					506					S2			S4	S5		S2	S3	-	2
			. in pelagic biota		162					S2			S4	S5		S2	S3	-	2
			. in water column (soluble and suspended forms)		162/ 506					S2			S4	S5		S2	S3	-	2
		Determine chemical speciation and transport mechanism of selected metals and characteristics of substrates to which they are adsorbed.	Elemental composition and distribution of suspended particulate matter.	Table/Map Narrative	152					S2			S4	S5		S2	S3	-	2
			Hydrocarbon adsorption characteristics of suspended matter.		152					S2			S4	S5		S2	S3	-	2

60

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
A-3		Monitor selected metal concentrations over broad geographical areas to determine significant changes during and following OCS development.	Will not be addressed (see section 3.i, premises.)																

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
B-1	Locations of drilling platforms, pipelines and	Planning of OCSEAP field and related studies.	Information required from BLM.	Charts	N/A														
B-2	Quantity and nature of contaminants from each source.	Planning of OCSEAP field and related studies.	Information required from BLM.	Charts	N/A														
B-3	Areas of altered current patterns, removed habitats, or altered migration paths.	Planning of OCSEAP field and related studies.	Information required from BLM.	Charts	N/A														

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5				
										T	E	FS				77	78	79	
C-1	Description of seismic and volcanic activity.	To determine the potential hazards to platforms, pipelines and other structures due to earthquakes and volcanic equptions, as input to tract de-selection and design stipulations.	Historical earthquake epicenters, focal depths, and magnitudes	Map				N2											0
			Earthquake magnitude vs. frequency relationships for selected areas.	Map Graph				N2								-	-	-	0
			Seismic activity of surface and near-surface faults identified in geologic mapping.	Map Report				N2											0
			Relationships between earthquake magnitudes and strong ground motion.	Map Report				N2								-	-	-	0
			Description of volcanic activity and resulting phenomena such as flows and nuees ardentes.	Maps		Not Applicable										-	-	-	0
			Seismic risk map.	Map				N2											0
			Volcanic risk map.	Map		Not Applicable										-	-	-	0

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5				
										T	E	FS				77	78	79	
C-2	Description of the distribution and relative ages of surface and near-surface faults.	To determine the potential hazards to platforms, pipelines, and other structures due to active faulting; serves primarily as input to tract deselection and to provide geographic focus for earthquake studies.	Locations of surface and near-surface faults classified according to apparent recency of movement (from geologic relationships).	Map Report				N3				N4				–	–	–	0
C-3	Description of the types and extent of natural seafloor instability.	To determine the potential hazards to platforms, pipelines, and other structures due to slumping, compaction, and liquefaction of bottom sediments; serves as input to tract deselection and siting/design stipulations.	Delineation of existing and potential slumps and other unstable sediment masses, classified according to present relative stability.	Map				N3				N4				–	–	–	0
			Thickness of unconsolidated sediment.	Map				N3				N4							0
			Description of sediment physical properties.	Map Report				N3				N4				–	–	–	0
			Geologic cross-sections of potentially unstable sediment masses.					N3				N4				–	–	–	0
			Description of the geologic history of unconsolidated sediment units.	Map Report				N3				N3				–	–	–	0

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5				
										T	E	FS				77	78	79	
C-3 cont.			Interpretation and description of the nature and severity of sediment instability.	Report				N3				N4				-	-	-	0
C-4	Identification and description of areas of potentially hazardous seafloor erosion, deposition, and bedform movement.	To determine the potential hazards to platforms, pipelines, and other structures due to seafloor erosion, deposition, and beform movement; serves as input to tract deselection and siting/design stipulations.	Locations of areas of of severe erosion and deposition (indicating rates where possible)	Map				N3				N4				-	-	-	0
			Distribution and description of large-scale mobile bedforms showing directions and rates of movement.	Map Report				N3				N3				-	-	-	0
			Interpretations regarding the nature and severity of erosion, deposition, and bedform movement.	Report				N3				N3				-	-	-	0
C-5	Identification and description of potential coastal hazards.	To determine the potential hazards to onshore development due to coastal erosion, accretion, faulting, and other onshore surface processes; serves primarily as input to siting/ design stipulations and development plan verification.	Identification of coastal areas with severe erosion or accretion, indicating rates where possible.	Map	431			N2				N3	N4			N2	-	-	4
			Description of nearshore sediment dynamics.	Map Report				N2				N3	N4			-	-	-	0

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
									T	E	FS								
C-5 cont.			Description of coastal geology, including active faults and surface processes.	Map Report				N2				N3	N4			-	-	-	0
			Interpretation of the potential hazards to coastal facilities.	Report				N2				N3	N4			-	-	-	0
C-6	(Not applicable to GOA-BS)																		
C-7	Description of the geographic distribution of ice gouging, its severity, and frequency of occurrence.	To determine the potential hazards to pipelines and other seafloor installations due to ice gouging; serves as input to siting/design stipulations.	Description of ice gouging activity, distribution, frequency, and gouge depth.	Map Report				N2				N3				-	-	-	0
			Interpretations regarding the nature and severity of ice gouging and its relation to ice structures and behavior.	Report				N2				N3				-	-	-	0
C-8	Description of the distribution and nature of gas-charged sediments.	To determine the potential hazards to platforms, piplines and other structures due to gas-charged sediments; serves primarily as input to siting/design stipulations.	Description of the distribution and depth of gas-charged sediments.	Map	206			N2	N3		N4					N3	N3	-	2
			Identification of oil and gas seeps.	Map	206			N2	N3		N4					N3	N3	-	2
			Descriptions of the origins and characteristics of gas-charged sediments and their potential hazards	Report	206			Resolution not applicable								-	-	-	2

77-969

66

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0 T	+1 E	+2 FS	+3	+4	+5	77	78	79	
C-9	Stress - strain relationships in ice.	Calculation of ice forces and loads on structures.	1. Measurements of physical properties of various types of sea ice.													-	-	-	0
			2. Estimates of ratios of stress to strain in various types of ice.						See Beaufort Sea TDP							-	-	-	0
			3. Estimates of forces of extreme ice conditions.													-	-	-	0
			4. Calculations of ic forces and loading on structures.													-	-	-	0
C-10	Characterization of frequency, intensity and effects of extreme oceanic events	To identify hazards to OCS exploration, development, and production activities.	1. Observational and historic information on storm surges as a function of location, season, and magnitude.	Tables Figures	347	NO				S3						S3			2
			2. Observational and historical informatio on coastal katabatic winds as a function of location, season, and magnitude.	Tables Figures Graphs		NO				S3						S2	S3		1
			3. Historical information on tsunamis (see Subtask C_T1)	Tables	352	NO				S3						S3			
			4. Marine and coastal climatology, including . temperature . wind . cloud cover . wave heights . storm tracks and frequencies . coastal flooding . vessel icing	Tables Graphs	347	NO				S2						NO	S3		2

67

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
										T	E	FS							
Special Studies	Description of the paleogeography of coastal onshore and submerged offshore areas over the past 50,000 years.	To provide input to an evaluation of potential cultural resources that may be impacted by OCS development.	Description of the tectonic history of the OCS area over the past 50,000 years (amounts of uplift and downwarp).	Map Report					N2							–	–	–	0
			Description of the positions of paleoshorelines over the past 50,000 years.	Map					N3							–	–	–	0

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
D-1	Seasonal and shorter term description of water masses and circulation patterns in offshore regimes.	To predict or estimate trajectories of pollutants and time of impact.	1. Analyses of historic data in the literature and previously unreported data.	Narrative with maps.	307			S2	S3							S2	02	S2	2
			2. Analyses of historical data on climatic systems and meteorological events for their effects on circulation.	Narrative with maps	347			S2	S3							S2	S2	S2	2
			3. Seasonal temperature and salinity distribution.	Narrative with maps	141 549 307			S2	S3			S4				S2	S2	S2	1
			4. Baroclinic circulation.		141 549 307			S2	S3			S4				S2	S2	S2	1
			5. General circulation, based on moored current meter data.	Narrative with figures	141 549			S2	S3			S4				S2	S2	S2	1
			6. Trajectories of drogues.	Maps and narratives.	217			S2	S3			S4				A2	S2	-	
			7. Discussion of mixing and estimates of Lagrangian dispersion coefficients.	Narrative	217			S2	S3			S4				A2	A2	-	4
			8. Estimates of sea-surface slope.	Narrative	-			S2								-	-	-	0
			9. Measurements of local wind fields.	Narrative	-			S2								-	-	-	0
			10. Analyses of synoptic weather data to obtain local wind and temperature fields.	Narrative with maps.	-			S2	S3	S3	S3	S4				-	-	-	0

69

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
D-1 cont.	Seasonal and shorter term description of water masses and circulation patterns in offshore regimes.	To predict or estimate trajectories of pollutants and time of impact.	11. A procedure for determining local wind fields when synoptic data and local station data are available.	Narrative			Resolution scale not appropriate									-	-	-	4
			12. Currents, calculated by diagnostic model	Narrative				S2	Not applicable							-	-	-	0
			13. Currents calculated by hydrodynamical model.	Map	435			S2								S4	S4	S4	1
D-2	Seasonal and shorter term description of water masses and circulation patterns in near-shore	To predict or estimate trajectories of pollutants and time of impact	1. Analyses of historic data in the literature and previously unreported data.	Narrative with maps	307			S2								S2	S2	S2	2
			2. Analyses of historical data on climatic systems and meteorological events for their effects on circulation.	Narrative with maps	-			S2								-	-	-	0
			3. Seasonal temperature and salinity distribution.	Narrative with maps	141 549			S2								S2	S2	S2	1
			4. Baroclinic circulation.	Narrative with maps	141 549			S2								S2	S2	S2	1
			5. Near-shore circulation, based on moored current meter data.	Narrative with figures	141 549			S2								S2	S2	S2	1
			6. Trajectories of drogues.	Maps and Narrative	-				S2							A2	S2	-	2

77-269

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
D-2 cont.	Seasonal and shorter term description of water masses and circulation patterns in offshore regimes.	To predict or estimate trajectories of pollutants and time if impact.	7. Discussion of mixing and estimates of Lagrangian dispersion coefficients.	Narrative					S2									-	2
			8. Estimates of sea surface slope.	Narrative	-				S2							-	-	-	0
			9. Near shore currents by means of a current mapping radar.	Map					S4							-	-	-	0
			10. Analyses of satellite photos for oceanographic data.	Narrative	289				S2							S2	S2	-	2
			11. Surf zone dynamics; wave refraction diagrams, rip-current distributions.	Narrative with maps	-				S2							-	-	-	0
			12. Storm surge probability and intensity.	Narrative	347				S2							S2	S2	-	2
			13. Measurements of local wind fields near shore.	Narrative					S3							-	-	-	0
			14. Analyses of synoptic weather data to obtain local wind and temperature fields.	Narrative with maps					S2							-	-	-	0
			15. A procedure for determining local wind fields when synoptic data and local station data are available.	Narrative	367				S2							S2	S3	-	4

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
D-2	Seasonal and shorter term description of water masses and circulation patterns in offshore regimes.	Used to assess potential for air pollution by onshore development offshore facilities.	16. Measurements of the stability of the surface (air) boundary layer and ice nuclei baseline.	Narrative	–				S3							–	–	–	0
			17. Results of analysis by models.	Narrative with:															
			a. General circulation.	Maps	435			S2	S3			S4				S3	S3	S3	1
			b. Tidal current (hydro dynamical).	Maps	435			S2	S3			S4				S3	S3	S3	1
			c. Trajectory.	Maps	435			S2	S3			S4				S3	S3	S3	1
			d. Trajectory with plume dynamics.	Maps	–			S2	S3			S4				–	–	–	0
D-3	Description of oil spill plume behavior and oil weathering processes.	Evaluation of degree of impact, areal scale of impact and contingency requirements.	1. Oil spill weathering mechanisms and estimated rates.	Narrative	499			Resolution: Not Applicable								–	–	–	4
			2. Laboratory determined weathering rates.	Tables	499			Resolution: Not Applicable								–	–	–	0
			3. Field studies to determine weathering rates.	Tables	499			Resolution: Not Applicable								–	–	–	4
			4. Description of mechanisms which cause dispersal of oil plumes.	Narrative	–			Resolution: Not Applicable								–	–	–	1
			5. Pollutant dynamics model general.	Computer code and documentation	140			Resolution: Not Applicable								–	–	–	0
			6. Pollutant dynamics model (subroutine accounting for weathering).	Computer code and report	499			Resolution: Not Applicable								–	–	–	0

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
D-4	Description of the types and characteristics of bottom sediments and their probable interaction with oil and biota.	To determine the probable fate of oil in association with bottom sediments, its longevity, cleanup difficulty, and possible effects on intertidal and benthic biota; serves as input to tract deselection.	Description of sediment grain size properties.	Map	290					N2	N3					N3	-	-	2
			Description of coastmorphology, beach materials, and relative vulnerability of the coast to spilled oil.	Map Report	-					N2	N3					-	-	-	0
			Interpretation regarding the interaction between oil and bottom sediment, oil retention capability of the substrate, and implications regarding possible effects on intertidal and benthic biota.	Report	290					N2	N3					N3	-	-	2
D-5	Description of bottom sediment dynamics.	To determine the transport trajectory of oil in association with bottom sediments. Serves as input to tract deselection and to hazards studies.	Description of the directions and rates of bottom sediment movement.	Map Report	-					N2	N3					-	-	-	0
			Intrepation regarding the mechanisms of entrainment and transport of bottom sediment and their relationship to physical oceanographic processes.	Report						N2	N3					-	-	-	0

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
D-6	Character of suspended particulates and their effectiveness as transporters of oil	Assessment of the impact potential of oil spills.	1. Sediment and suspended sediment distribution.	Narrative with maps						S2	S3					–	–	–	0
			2. Sediment movements.	Narrative with maps						S2	S3					–	–	–	0
			3. Tabular data, indicating extent of oil/sediment interaction under varying environmental condition.	Narrative with maps						S2	S3					–	–	–	0
			4. Relation of suspended particulate matter to terrestrial and marine sources.	Narrative with maps						S2	S3					–	–	–	0
D-7	Description of sea-floor topography.	To provide input to circulation studies and hazards studies	Description of sea-floor topographic features.	Map Report				N4								N2	N2	–	2
D-8	Characterization of sea ice morphology including under-ice morphology.	Assessment of role of ice cover as a habitat and in transport of spilled oil.	Analysis of the historical records of ice conditions.	Report				N2								–	–	–	0
			Description of ice conditions, seasonally and areally from contemporary data; position of ice-front, ex.	Report seasonal maps	257			S2								S2	S2	–	2
			Under-ice morphology, and its potential as a trap for oil.	Report												–	–	–	0

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
D-9	Description of ice dynamics and their effects on transport of oil and safety of structures.	As input data to transport models and in evaluation of construction plans for safety.	Oil trajectories in over and under ice of various types.	Narrative with maps	-			S2	S3			S4				-	-	-	0*
			Model of ice motion under various environmental conditions.	Narrative Documentation of model	-			S2	S3			S4				-	-	-	0*
D-10	Description of interaction between sea ice and oil and movement of oil in a ice field.	As input to transport models.	Model of behavior of oil incorporated in ice matrix.	Narrative with algorithms				Resolution scale not applicable											0*
			Measurements of oil movement in the presence of ice in field.	Narrative with maps				Resolution scale not applicable.											0*
			Comparison of model results with field results.	Narrative				Resolution scale not applicable.											0*
D-11	Susceptibility of marshlands near the coast to inundation by oil transported by storm tides.	To assess the probability of insult to critical habitats.	Calculated probability of storm surge.	Narrative				S2								-	-	-	0
			Verification of probability of storm surge by field studies	Narrative				S2								-	-	-	0
			Analysis of historical storm surge records.	Narrative with tables				S2								S2	S2	S2	2

* Applicability of completed studies in the Beaufort to conditions in Bering Sea requires study.

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-1	Description of seasonal distribution and abundance of marine mammals.	To identify critcial habitats and determine the likelihood of impingement based on transport data and probable sources.	1. Annotated bibliography of available marine mammal data and literature.	Narrative	067												NO		2
			2. Review of available literature and data on marine mammals.	Narrative	231 067 230 194												NO		2
			3. Seasonal distributions and relative abundance of marine mammals.	Map	248					S1	S2	S3				S2	S2	-	4
					034											S2	S2	-	2
					067											S2	S2	-	2
					230											S2	S2	S2	1
					231											S2	S2	-	2
			4. Locations of marine mammal migration routes.													S2	S2	-	2
				Map	067					S2	S2	S3				S2	S2	-	2
			5. Locations of breeding and concentration areas.	Map	230					S3	S4	S4				S2	S2	S2	1
E-2	Description of population dynamics and trophic relations of marine mammals.	To evaluate the potential effects of OCS activities on the stability of populations within a considered critical habitat.	1. Population dynamics of marine mammals, including: . reproductive biology . growth . population composition . habitat dependencies	Narrative	230					S2				S3		S2	S2	S2	1
			2. Trophics of marine mammals, including: . major prey species . foraging areas	Narrative	232					S2				S3		S2	S2	S2	1
			3. Behavioral aspects of marine mammals relative to OCS activities.							N6									

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-3	Description of seasonal distribution and abundance of marine birds.	To identify critical habitats and determine the likelihood of impingement based on transport data and probable sources.	1. Annotated bibliography of marine bird data and literature.	Narrative	003											S2	S2	-	2
					196											S2	S2	S2	1
			2. Review of marine bird data and literature.	Narrative	003											S2	S2	-	2
					339											NO	NO	-	2
			3. Seasonal distribution and abundance of marine birds.	Map	239					S2						S2	S2	-	2
					196											S2	S2	S2	1
					337											S2	S2	-	2
			4. Locations of marine bird breeding colonies.	Map	338					S5						S_t^5	S_t^5	-	2
			5. Locations of marine bird concentration areas.	Map	003					S2		S3				S3	S3	-	2
					341											S3	S3	-	2
			6. Locations of bird migration routes.	Map	340					S2						S2	S2	-	2
E-4	Description of population dynamics and trophic relations of marine birds.	To evaluate the potential effects of OCS activities on the stability of of populations within a considered critical habitat.	1. Population dynamics of marine birds, including:	Narrative	083					S2		S_t^1		S_t^1		S_t^5	S_t^5	S_t^5	1
					038											S_t^5	S_t^5	S_t^5	2
					341											S_t^5	S_t^5	-	2
			. breeding phenology . reproductive ecology . growth		108											S_t^6	S_t^6	-	2
			. habitat dependencies		196											S2	S2	S2	1
			2. Trophics of marine birds, including:	Narrative	083					S2				S3		S2	S2	S2	1
					341											S2	S2	-	2
			. Major prey species . foraging areas		108											S2	S2	-	2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
						-4	-3	-2	-1	0	+1	+2	+3	+4	+5				
Task	Product	Intended Use	Specific Product	Format	R.U.											77	78	79	
E-4	Description of seasonal distribution and abundance of marine birds.	To identify critical habitats and determine the likelihood of impingement based on transport data and probable sources.	3. Behavioral aspects of marine birds relative to OCS activities.	Narrative	038					S0						N6	N6	-	2
					108											S6	S6	-	2
E-5	Description of the seasonal distribution and abundance of marine fish.	To identify critical habitats and determine the likelihood of impingement based on transport data and probable sources.	1. Annotated bibliography of available marine fish data and literature.	Narrative	175					NO		NO				NO	-	-	2
					252											NO	-	-	2
					354											NO	NO	-	2
			2. Review of available marine fish data and literature.	Narrative	175					NO		NO				S2	-	-	2
			3. Seasonal distributions and relative abundance of marine fishes.	Map	019					S2						S2	S2	-	2
					175											S2	-	-	2
					437											S2	-	-	2
					483											S2	-	-	2
			4. Locations of spawning and concentration areas, and migration routes.		175					S2		S3				S2	-	-	2
			5. Locations of important commercial fishing areas.	Map	175					S2		S3				S2	-	-	2
					353											S2	-	-	2
					354											S2	S2	-	2
					437											S2	-	-	2
E-6	Description of population dynamics and trophic relations of marine fish.	To evaluate the potential effects of OCS activities on the stability of populations within a considered critical habitat.	1. Trophics of marine fishes, including: . identification of major prey species . foraging areas		077					N1		S2				S2	S2	S2	1

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-6	Description of population dynamics and trophic relations of marine fish.	To evaluate the potential effects of OCS activities on the stability of populations within a considered critical habitat.	2. Population dynamics of marine fishes including: . reproductive biology . growth . habitat dependencies	Narrative	175					N1		S2				S2	-	-	2
E-7	Description of seasonal distribution and abundance of benthic biota.	To identify critical habitats and determine the likelihood of impingement based on transport data and probable sources.	1. Annotated bibliography of available literature and data on benthic biota.	Narrative	282											NO	-	-	2
			2. Review of available literature and data on benthic biota.	Narrative	282											NO	-	-	2
			3. Distribution and abundance of dominant benthic organisms.	Map	005 281					N2		S3				S2 S2	S2 S2	- -	2 2
	Description of population dynamics and trophic relations of benthic biota.	To evaluate the potential effects of OCS activities on the stability of populations within a considered critical habitat.	4. Population dynamics of benthic organisms, including: . Seasonal community structure . Seasonal abundance of dominant organisms . Productivity estimates	Narrative	005											S2	S2	-	2
			5. Trophic relations of selected benthic organisms including: . food webs . identification of major prey species	Narrtive	005					N1		S1		S3		S2	S2	-	2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-8	Description of distribution and abundance of biota in littoral communities.	To identify critical habitats and determine the likelihood of impingement based on transport data and probable sources.	1. Annotated bibliography of available data and literature on littoral biota.	Narrative	078					NO						NO	NO	-	2
			2. Review of available data and literature on littoral biota.	Narrative	078											NO	NO	-	2
			3. Regional characterization of littoral habitat, including: . Substrate . Littoral community structure . Population density distributions	Narrative	078 003					S2		S3		S4		S2 S2	S2 S2	- -	2 2
E-9	Description of the ecosystem dynamics and relative abundance of biota in littoral communities.	To evaluate the potential effects of OCS activities on the stability of populations within a considered critical habitat	1. Population dynamics of intertidal biota, including: . Seasonal community structure . Productivity	Narrative	078					S2				S3		S2	S2	-	2
			2. Trophic relations of littoral fauna, including: . Food webs . Identification of major predator prey relations	Narrative	-					S2				S3		-	-	-	0

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-10	Seasonal density distributions of principal species of plankton.	To identify critical habitats and to determine the likelihood of impact based on transport data and probable sources.	1. Time of appearance	Narrative	426					S1		S2				S2	S2	-	2
					427											S2	S2	-	2
					380											S2	S2	-	2
			2. Quantitative distributions	Narrative	380											S2	S2	-	2
					426											S2	S2	-	2
					427											S2	S2	-	2
					156											S2	-	-	2
E-11	Seasonal indices of phytoplankton standing crop and production.	To identify critical habitats and to determine the likelihood of impact based on transport data and probable sources.	1. Composition	Narrative	427					N1		S2				S2	S2	-	2
					156											S2	-	-	2
			2. Standing crop	Narrative	427					N1		S2		S3		S2	S2	-	2
			3. Productivity	Narrative	427					N1		S2		S3		S2	S2	-	2
					156											S2	-	-	2
			4. Ecology of sea ice flora.	Narrative	427					N1		S2				S2	S2	-	2
E-12	Non-population dependent physiological and population parameters of plankton communities.				427											N6	N6	-	2
E-13	Identification and seasonal characterization of critical habitats for egg and larval stages of fish and shellfish species.	To identify critical habitats and to determine the likelihood of impact based on transport data and probable sources.	1. Time of appearance	Narrative	380					S1		S2		S3		S2	S2	-	2
			2. Quantitative distributions.	Map	380					S1				S6		S2	S2	-	2
E-14	Ichthyoplankton key for Alaskan waters.	OCSEA Program development.	Ichthyoplankton key.	Narrative	349				N6							N6	-	-	2
	Otolith Key	Ditto		Narrative	285				N6							N6	-	-	2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-15	Characterize marine microbial communities with regard to quantitative levels of indigenous heterotrophs, chemotrophs and pathogens.	To identify critical habitats and determine likelihood of impingements based on transport data and probable sources.	1. Geographical density distributions of physiological groups in: . Water . Sediments	Map	-					N2		S2				-	-	-	0
		To define the potential for petroleum degradation in specific habitats and, therefore, likelihood of impact.	2. Hydrocarbon degradation rates.	Narrative						N1		S1		S2		-	-	-	0
			3. Evaluation of techniques used to determine oil degradation in sediments.	Narrative						N6						-	-	-	0
E-16	Response of microorganisms to normal environmental stresses.	To obtain the range of variation in microbial activity in order to provide a basis for evaluating the effect of hydrocarbon contamination.	1. Microbial activity and respiration ratios.	Narrative	-					S1		S2				-	-	-	0
			2. Nitrogen fixation rates in: . Sediment . Animal guts		-					S1		S2							
E-17	Relationship of ice movements and types to distributions and abundance of various living resources.	To identify critical habitats and determine the likelihood of impingement based on transport data and probable sources.	Species abundance and distributions relative to: . Ice characteristics . Ice movements.	Narrative	248											S2	S2	-	2
					232											S2	S2	S2	1
					196											S3	S2	S2	1
					230											S2	S2	S2	1
					231											S2	-	-	2
					426											S2	S2	-	2
					427											S2	S2	-	2
					067											S2	S2	-	2
					241											S2	-	-	2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
F-1	Review of available literature and data on toxicity of crude oils as related to species, life stage and source of oil.	To provide a basis of information on which to set priorities for research exploring the effects of oil development of the Alaskan OCS.	Summary of available information on effects of oil on Alaskan marine organisms and ecosystems.	Narrative	075											N6			2
F-2	Acute and chronic effects of crude oil and other petroleum associated chemicals on selected organisms.	To provide a basis for assessment of the potential impact of oil development of the Alaskan OCS to the shelf areas and adjacent shorelines	1. Toxicity of oil to:																
			. marine mammals	Narrative	071											N6			1
			. marine birds													N0			0
			. fish	Narrative	072											N6			1
			. plankton		-											N0			0
			. benthos	Narrative	454											N6			1
			. bacteria																
			2. Sublethal effects on:																
			. marine mammals	Narrative	071											N6			1
			. marine birds	Narrative	423											N6			1
			. fish	Narrative	073											N6			1
			. plankton		-											N0			0
			. benthos	Narrative	454											N6			1
			. bacteria																

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
F-3	Effects of petroleum contaminants on metabolic and reproductive functions	To evaluate the potential for a petroleum contaminant to alter the stability of a population by affecting a key metabolic process in a way which increases the possibility of the organisms death before it reproduces.	1. Evaluation of effects of crude oil on carbon and nitrogen fixation in:																
			. sediments	Narrative	190											N6			1
			. guts of animals	Narrative	190											N0			0
			2. Evaluation of effects of crude oil on hatching success of bird eggs.	Narrative	096 243											S_t6 S_t6			2 1
			3. Evaluation of effects of crude oil on thermoregulation of marine mammals	Narrative	071											N6			1
F-4	Characterization of release of toxic metals from oil impacted sediments and relative importance of metals uptake and effects on biota	To evaluate negative effects of metals associated with OCS activities on biota, to assist in siting stipulations for development.	1. Uptake/depuration of metals in benthic organisms.		–											N6			0
			2. Metabolic an other sublethal effects in benthos.	Narrative	454											N6			1
F-5	Bioaccumulation and effects of hydrocarbons, and other contaminants through various exposure pathways.	To determine areas of greatest sensitivity in marine organisms.	1. Evaluate accumulation of hydrocarbons through experimental food chains.	Narrative	073 275 389											N6 N0 N6	 N6 		1 1 4
			2. Evaluate accumulation through sediment-sorbed contaminants.	Narrative	454											N6			1

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
F-6	Characterization of responses of selected organisms and ecosystems to perturbations induced by contaminants or disturbances associated with OCS activities.	To identify ecosystems or organisms that are potentially susceptible to adverse impact from OCS activities.	1. Characterization of perturbations due to OCS activities on selected organisms and activities.	Narrative	072 073 275														1 1 1
			2. Recovery rate of selected communities in terms of:																
			. composition and density	Narrative	029											N2			1
			. productivity																
F-7	Types and incidences of diseases present in marine organisms.	Development of a baseline of information with which to evaluate future mortality and/or morbidity relative to OCS activities. Identify species highly susceptible to impact from OCS activities.	1. Incidence of pathological conditions in:																
			. marine mammals	Narrative	194											N0			1
			. marine birds		-											N0			3
			. marine fish	Narrative	332											N0	N1		3
			2. Identifications of pathological agents and causes in:																
			. marine mammals	Narrative	194											N0	N6		1
			. marine birds		-											N0			3
			. marine fish	Narrative	332											N0	N6		3
			3. Incidence of mortality or morbidity in natural populations of:																
			. marine mammals	Narrative	194													N1	1
			. marine birds	Narrative	341													N1	1

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
			4. Effect of oil on disease susceptibility in:																
			. marine mammals	Narrative	071											N6			1
			. marine birds	Narrative	096											N6			4
			. marine fish	Narrative	073											N6			1
F-8	Ecological effects of oil spill countermeasures.	To provide data to be used in determining preferred countermeasures to oil spill.	1. Toxicity of dispersants to:																
			. marine birds	Narrative	072											N0		N6	0
			. marine fish		–											N0			–
			. marine mammals		–											N0			0
			2. Sublethal effects of dispersants in:																
			. marine fish	Narrative	073											N0	N6		1
			marine birds		–											N0			0
			. marine mammals		–											N0			0
F-9	Characterization of structure and critical function of select-coastal ecosystems with respect to potential impacts of OCS development.	Identification of critical links in the food web relative to fish, benthos, birds, and mammals.	Descriptions of:		–											N1			0
			. seasonal community structure	Narrative	077			S2				S3				S2	S2	S2	1
			. trophic relations of key species																
			in various habitats at selected study sites.																

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
F-10	Characterization of structure and function of ice front ecosystem with respect to potential impacts of OCS development	Identification of critical links in the food web relative to fish bentho birds and mammals.	Descriptions of: . community structure . trophic relations of key species . primary and secondary production in the vicinity of the ice front.					See Task E-17								-	-	-	-
F-11	Descriptions of coastal detritus systems with respect to OCS development.	Identification of critical links in the food web relative to fish, benthos, birds and mammals.	1. Definition of seasonal composition and origin of organic detrital materials. 2. Role of detritus in ecosystem energetics.		-											NO			0

3.0 RATIONALE FOR ST. GEORGE

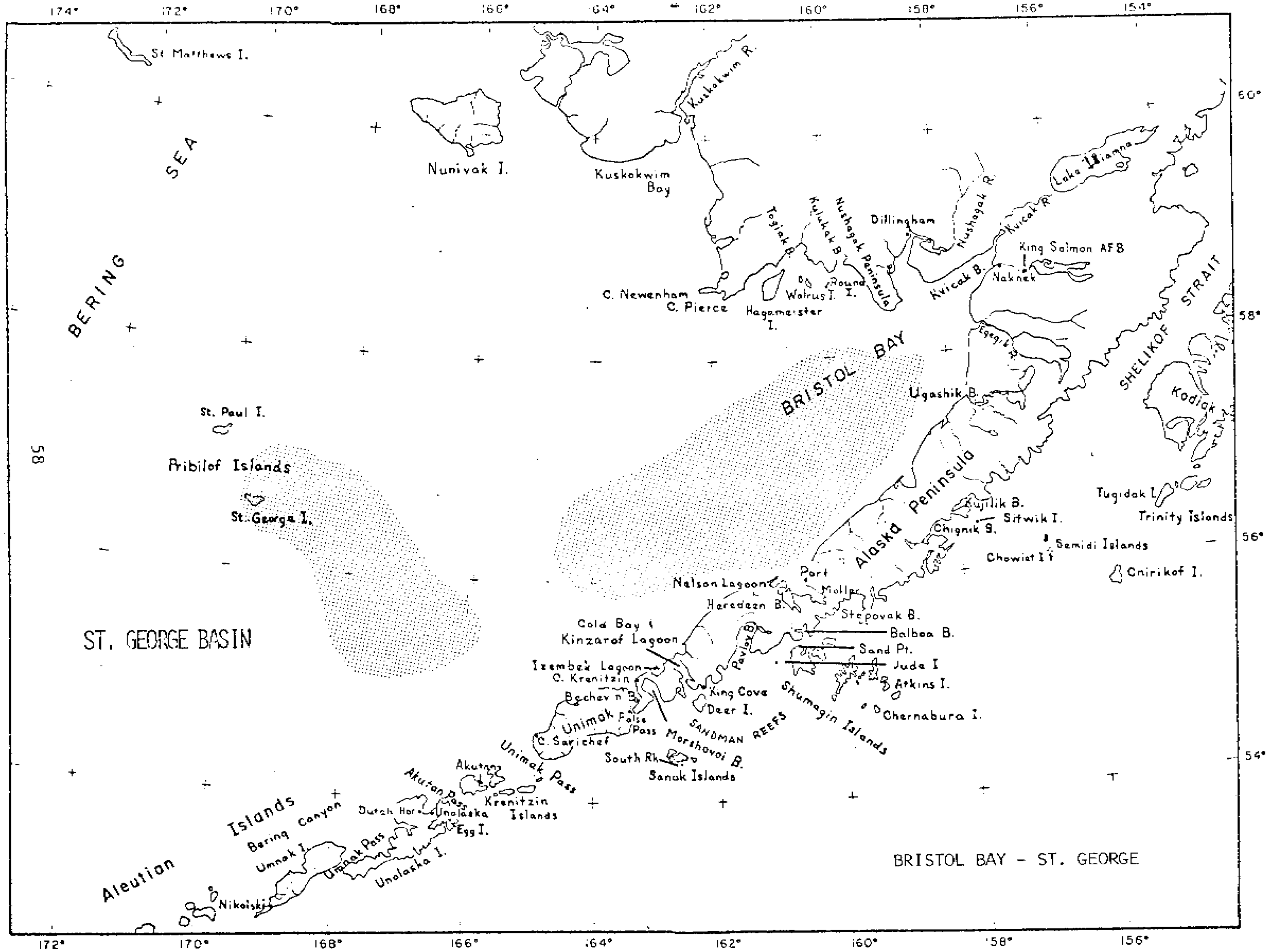
3.1 Scope and Direction

The St. George Basin may be considered together with the Bristol Bay lease area. The two lease areas are connected oceanographically; both may be ice covered during winter, and much of the biota is common to both. As a result, many research units designed for studies in the Bristol Bay also are *de facto* studies of the St. George Basin. For example, the results of the single ecological study of the ice edge (RU 427) are equally applicable to both areas, and the benthic surveys (RU's 281 and 282) were continuous through both regions. For the sake of both accuracy and completeness, the descriptions of studies applicable to both Bristol Bay and St. George Basin are included here.

Studies may be grouped according to the discipline involved or may, as has been chosen, be grouped according to the kinds of questions for which the BLM requires answers. Therefore, three generic types of studies are designed to yield data products directly applicable to the following kinds of questions:

- Hazards - what are the natural hazards imposed by the environment on developments?
- Biota at Risk - what are the species/communities present in areas likely to be impacted by oil exploration, development, and production?
- What are the consequences of impact by petrochemical development activities? What are the effects on key elements of the biota based on bioassay results? What are the most likely effects on the biota in field situations? Which elements are more likely to be affected than others and how might recovery take place?

Answers to the first type of question require geological and related studies to assess any hazards that might be caused by: (1) instability of the sea floor; (2) earthquakes; (3) tsunamis; (4) storm surges; (5) ice gouging; and (6) ice forces on structures.


174°
172°
170°
168°
166°
164°
162°
160°
158°
156°
154°
60°
58°
56°
54°
St Matthews I.
BERING SEA
Nunivak I.
Kuskokwim Bay
Kuskokwim R.
Togiak B.
Kulukak B.
Nushagak Peninsula
Dillingham
Nushagak R.
Kvichak R.
Lake Iliamna
King Salmon AFB
Naknek
Kvichak B.
C. Newenham
C. Pierce
Hagemeister I.
Walrus I.
Round I.
Egegik R.
BRISTOL BAY
Ugashik B.
SHELIKOF STRAIT
Kodiak
St. Paul I.
Pribilof Islands
St. George I.
ST. GEORGE BASIN
Alaska Peninsula
Kujulik B.
Sitwik I.
Chignik B.
Semidi Islands
Chowiet I.
Tugidak I.
Trinity Islands
Chirikof I.
Nelson Lagoon
Port Moller
Herendeen B.
Stepovak B.
Balboa B.
Sand Pt.
Jude I
Atkins I.
Chernabura I.
Cold Bay & Kinzarof Lagoon
Izembek Lagoon
C. Krenitzin
Bechevin B.
Pavlof B.
King Cove
Deer I.
Shumagin Islands
Unimak I.
False Pass
SANDMAN REEFS
Morzhovoi B.
C. Sarichef
South Rk.
Sanak Islands
Unimak Pass
Akutan
Akutan Pass
Krenitzin Islands
Dutch Harbor
Unalaska
Egg I.
Aleutian Islands
Bering Canyon
Umnak I.
Umnak Pass
Unalaska I.
Nikolski
58
156°
158°
160°
162°
164°
166°
168°
170°
172°
BRISTOL BAY - ST. GEORGE

In the second category, identification of species and communities present at possible impact points, studies are included that will enable BLM to determine if impact will or is likely to occur. These include the study of transport, which is designed to show, under specific sets of circumstances, where contaminants will appear and in what quantities. Included also are questions such as: (1) will aircraft flying over or near a rookery cause harassment that should be considered an impact? and (2) which particular habitats can be identified, as a result of an overall habitat assessment, as ones that are critical? (i.e., damage will produce a significant change in population of the species and permanent damage or removal will cause irreparable population change.)

The third type of question concerns the ability to quantify and/or validate the allegation of potential or real environmental impact. Partial answers are provided by trophic studies revealing dependence of one species on another, by studies of the physiological effect of oil on mammals and other groups of animals, and by studies that determine the relative toxicity of petrochemicals to one species or another. The ideal, of course, is an ecosystem model realistically incorporating a large volume of data into a scheme that objectively and rigorously quantifies the time-dependent effect of decimation of one or more species on the ecosystem.

In the following sections are discussions of some of the assumptions, explicit and implicit, which were made in formulating the existing program. The key issues are identified, the status of knowledge applicable to those issues is discussed, and, lastly, the general approach to be used to acquire the data products required to identify key issues and to answer the key questions is described.

3.1.1 Premises

It is desirable to set forth some of the assumptions which were also incorporated into OCSEAP planning for Bristol Bay.

- The studies will assess all impacts of OCS activities on the marine ecosystem extending shoreward to the strand line and will include possible hazards imposed by the environment on OCS activities.

- Although environmental hazards will be assessed, studies will not allow the design of structures to proceed without additional, site-specific engineering studies.
- OCSEAP studies will be confined to the acquisition of knowledge needed to predict and measure direct effects on the environment resulting from OCS development. Secondary effects (e.g., possible adverse effects on commercial fishing) will not be considered *per se*.
- The data collections are not presently intended to be so all inclusive as to meet all the needs and requirements for future monitoring programs.
- Interrelations (biological, oceanographic or OCS developmental) between lease areas must be considered; hence, there will not be complete separation of research units between lease areas.
- Comprehensive ecosystem studies are beyond the scope (time frame) of the program. However, selected critical components or processes will be studied when it appears that there exists a likelihood that OCS activities will affect such components and processes to the degree that severe, adverse environmental impact may result.
- Hazards due to ice may be addressed at least in part, by using knowledge gained in ice hazard studies conducted in the Beaufort Sea.
- OCSEAP will not determine sources of contaminants although assumptions as to sources must be made in order to describe trajectories of accidentally or operationally released materials.

3.2 KEY ISSUES AND STATUS OF KNOWLEDGE

Within the framework of the tasks described in Section 2.3.1 there are key issues which remain to be completely addressed as well as issues that have been resolved sufficiently for the current needs of the program in this area. The following material presents some judgment as to the degree to which present status of knowledge allows resolution of the issues or completion of the task. Thus, the evaluation includes a decision, based on presently existing data, as to the need to provide more answers to specific questions relating to potential impact.

3.2.1 Biota at Risk

Several subtasks require that lists of particular key species at risk, together with other features of their biology, be available for areas of possible impact by petroleum development. The status of knowledge, or the present capability to produce certain data products, are discussed in the following subsections.

Benthos

Species encountered in Bristol Bay and St. George Basin have been enumerated and their distributions mapped by Feder (RU 281), Feder and Mueller (RU 282), and Zimmerman (RU 78). Feder's data are from offshore; Zimmerman's from the intertidal area. Feder's maps include data from the literature as well as from his own studies of samples from 59 stations covering the lease area and areas downstream. Additional data were obtained by Feder from trawls conducted by Pereyra (RU 175) and analyzed by Feder. Only rare species are expected to be added to the over 600 identified as inhabiting the area.

Data products on hand include maps of distribution and some quantitative data in digital form. The data base is believed sufficient at present to address the key issue - species at risk and their seasonal location. Data from RU 281 and RU 78 may require combination into a single map showing benthic organisms on one chart or table. Selected species (of the 600 or more) need to be grouped in order to map them systematically.

Commercial Species

Because of the special interest in commercial species, they are considered here as a separate issue despite the fact that both demersal and pelagic fish are among the benthos and plankton.

Almost all of the major fishes have been commercially exploited during the past two decades. At risk are the commercial crabs, Tanner (or snow) and king, halibut, pollock, various flatfish, herring, shrimp, and salmon.

Studies prior to OCSEAP and during OCSEAP (Pereyra RU 175) have yielded a data base of sufficient detail to allow estimates to be made of biomass of all the commercial demersal fish and crabs, within the lease area and downstream of the area. These estimates are most accurate for the spring-summer season. Seasonal migrations and spawning areas of some species are known from data collected on cruises made by Pereyra. These data revealed the benthic limits of many species; deep in early spring and shallow in late summer.

The data base is considered sufficient to address the key issue that demersal fish and crabs are at risk and that they are likely to be most susceptible during their larval life in the plankton at a time when the larval forms and their food may be threatened by perturbations, and, also, when early life stages of some species are occupying shallow inland or coastal waters. Data on salmonids, including the migration routes and catch statistics of the several species of salmon, all of which are of undisputed commercial importance, were summarized by Stern, et al. (RU 483). Data on distribution of non-salmonid pelagic fish have been assembled by Wall and Macy (RU 64) and by Barton (RU 19) for herring.

The question of distribution of all pelagic fish of commercial importance is adequately addressed for present decision needs by currently available data.

Marine Birds

The species of marine birds inhabiting the St. George Basin have been enumerated and estimates of their distribution and abundance have been made by Myres and Guzman (RU 239) and Bartonek et al. (RU 337). Hunt (RU 83) also censused all pelagic species found in the foraging areas utilized by nesting colonies on St. Paul Island, and Divoky (RU 196) has provided data on birds inhabiting the ice edge.

Site-specific studies by Hunt (RU 83) have produced data on the foods and foraging areas of the colonial birds of St. Paul and St. George Islands. The species which utilize these habitats have been listed by Hunt (RU 83) and Hickey (RU 38), respectively. Population estimates, reproductive success rates, and timing of breeding have been determined. Hickey (RU 38) provided anecdotal evidence of potential for impact on nesting birds by low flying aircraft.

The data required to determine which marine bird species and major habitats are at risk are complete. Considerable data necessary to describe the effects of an oil spill or other impact are available. However, insufficient knowledge exists to predict recovery rates.

Marine Mammals

Studies conducted under the OCSEA program have included estimates of population size, seasonal abundance and distributions, identification of migration routes, foraging and breeding grounds, and other critical habitats for certain species of marine mammals. If activities related to petrochemical exploration and development occur in this lease area, adequate information is available on most species to evaluate locations of possible risk.

Sea Otters *(Enhydra lutris):*

Studies conducted by Schneider (RU 241) indicate that in 1975 an otter population estimated at 17,000 occupied the area between Cape Mordvinof and Cape Lieskof extending from shore to the 60m contour. This range was greatly reduced from that of previous years as a result of mortality and southwestward movement caused by extreme sea-ice conditions. The main factor limiting most sea otter populations concerns the availability of large quantities of food needed to support a high metabolic rate. Sea otters feed on sessile organisms. Thus, local changes in abundance of food could lead to marked, site-specific changes in numbers of otters. The population referred to appears to be a likely source of otters for the repopulation of the Fox and Krenitzin Islands. This population also tends to concentrate periodically, making it possible for a large spill to directly affect large numbers of otters.

Distribution and behavioral information on sea otters in this area is considered to be sufficient until further site-specific studies related for tract selections are necessary.

Ice-associated Seals:

Bearded seals *(Erignathus barbatus)* were found to be somewhat uniformly dispersed throughout Bristol Bay in April, occurring throughout the area of seasonal ice cover and migrating north in summer with the retreating ice. The total Bering Sea population is estimated at 300,000 of which approximately 8,000 - 10,000 are harvested annually by U.S. Eskimos and the U.S.S.R.

Largha seals *(Phoca largha)* are generally associated with the southern edge of the seasonal pack ice, moving north as the pack ice recedes in summer. During winter and spring, large concentrations extend from the Pribilof Islands east to Bristol Bay and north to Nunivak Island, generally 20-40 km offshore. The distance of the animals from the shore varies with the extent of the pack ice. The species is the most abundant seal found south of St. Lawrence Island during periods of ice cover. The adults eat pelagic fish, octopus, and crustaceans, but the young prefer amphipods, shrimp, and shoaling fish. The total population in the Bering Sea is an estimated 250,000 with an annual harvest of 7,000 by U.S. Eskimos and the U.S.S.R.

Ribbon seals *(Phoca fasciata)* and their distribution are related directly to ice conditions. During the winter and early spring the entire population of the Bering Sea can be found along the southern edge of the pack ice, in a band up to 150 km wide. During periods of parturition and lactation, ribbon seals usually keep to the seaward edge of floes in the center of large ice masses 50 - 250 km offshore. With the melting of the ice pack, molting seals move closer to shore, coming within 20 - 100 km. As the ice retreats northward in summer, ribbon seals leave the ice and disperse throughout the north Bering and Chukchi Seas. Their scarcity south of St. Matthew and Nunivak Islands may be related to a decrease in food. Shrimp, crabs, and mysids are the preferred foods in addition to fishes and cephalopods. The Bering Sea population, estimated at 100,000 seals, has been declining through the past decades, possibly due to heavy commercial harvests by the U.S.S.R.

Ringed seals *(Phoca hispida)* occur as far south as the Pribilof Islands during the winter and spring, but are considered rare in the Bering Sea when ice is absent.

Sea Lions and Harbor Seals:

The population of Steller sea lions *(Eumetopias jubatus)* in the eastern Aleutian Islands has declined by 40 percent over the past twenty years. Factors which may have contributed to the decline are: (1) a westwardly shift in distribution; (2) reduced food availability; (3) an increase in human and fisheries interaction; and (4) an as yet unidentified population controlling factor. On the sea ice this species is restricted to the first few miles of the ice front and is most abundant south of the Pribilof Islands. About 20 percent of the sea lion population occurs on nine islands of the Fox Islands group during the summer and fall months; the Amak Island group accounts for the remainder. Breeding activity begins in late May and pupping occurs throughout the month of June. Ugamak Island, Bogoslof Island and Cape Morgan (Akutan Island) are the major breeding areas. The most recent estimate of the population in the eastern Aleutian Islands is 23,000. The feeding grounds and food habits of this population are relatively unknown.

Harbor seals *(Phoca vitulina richardi)* are abundant throughout the Alaska Peninsula and Aleutian Islands on the coastal waters and up to 50 miles offshore. The largest concentration of animals (80%) was observed hauled out on sandbars, inlets, and bays at Port Moller and Port Heiden, and in the mouth of the Cinder River. During winter, some harbor seals are known to use the ice edge as a hauling area and a large concentration ($>6/nm^2$) of ice-breeding harbor seals was present in western Bristol Bay west to 178° 51' W in 1976. Both tide and weather are important determinants of hauling out behavior. The foods and numbers of the Bristol Bay - Alaska Peninsula population are unknown.

An assessment should be made of harbor seal and Steller sea lion movement onto and off rookeries and ice during the winter and early spring months. The harbor seals' apparent dependency on protected tidal bays may make them vulnerable to direct impact from petrochemical contaminants. There are other aspects of the biology of the Steller sea lion and harbor seal populations on the Alaska Peninsula that are not well-defined, e.g., food habits, and these should receive further study before oil-related activities begin in this area.

Cetaceans:

Present information on most species of cetaceans reveals that their temporal and spatial ranges are highly variable. In outer Bristol Bay and St. George Basin, assuming a heavy ice year, a fair amount of sighting information exists for spring and early summer, but is lacking for autumn and winter. Seven species of cetaceans are known to utilize Bristol Bay for feeding or breeding, or for transit through the area during their northward spring migration. The Dall porpoise may breed in Bristol Bay (and by inference St. George Basin). The belukha and harbor porpoise are believed to feed in the area the year around. Most large cetaceans appear to enter the southern Bering Sea in greatest numbers in June, via Unimak Pass and the eastern Aleutian Islands. One species, the gray whale, is known to enter the Bering Sea through Unimak Pass by early April, depending on ice conditions, and then into the northern Bering Sea by late May. Counts of 9,000 animals passing through Unimak Pass were made in April-May 1977. The route taken is predominantly coastal to Nunivak Island, after which the migration occurs offshore. An undetermined number of animals are also believed to migrate to and feed around the Pribilof Islands.

Due partly to the fact that Bristol Bay and St. George Basin encompass such a large area of open water, very little is known of the behavior, migrational patterns, and critical habitats of the various species of cetaceans found in the area, particularly during the fall and winter months. Although such information is difficult to collect during those seasons, additional research then, and at other times of the year as well, is necessary to define those populations using the area and for what purposes, how they are distributed temporally and spatially, and the degree to which they might be vulnerable to environmental perturbations, particularly nearshore.

Habitats

Some areas, due to geomorphology, the proximity of needed species' requirements, and/or other factors related to particular environmental conditions, have become habitats of importance to a species or to several species. These include bird or mammal rookeries which provide suitable breeding or resting areas and access to nearby food supplies. Some habitats are also comparatively more vulnerable than others to impact from oil spills due to their physical characteristics.

The studies listed below contribute to the knowledge of particular habitats which, when compared to others in the whole of St. George Basin, are for various reasons believed especially important or critical for certain species although the same species may also be found elsewhere:

1. The ice edge

   The edge of the sea ice, and an associated zone a few kilometers wide, has been found to be a unique habitat. In Bristol Bay, many species utilize the ice edge in ways that may be crucial to their survival and reproduction. Reasons for importance of the ice edge include:

- Primary productivity under and near the ice is a significant fraction of the total production and, in arctic areas, it is the site of the first bloom of the season.
- The secondary producers and fishes occur within the ice edge (zone) in such quantities that sea birds congregate there to feed in preference to open water.
- In addition, marine mammals congregate at the ice edge for parturition feeding, and hauling out.

Data showing the unique character of the ice edge as a preferred habitat for plankton and ichthyoplankton are contained in reports by Alexander (RU 427) and Cooney (RU 426), for pinnipeds in reports by Burns et al. (RU 248 and 230) and for birds in those of Bartonek et al. (RU 337) and Divoky (RU 196). Many questions are unanswered concerning the physical and biological processes that result in the high standing crops and productivity of many species along the ice edge, at all trophic levels. However, the data are sufficient to enumerate the species at risk and to indicate critical periods in the timing of their occurrence in and around the ice edge.

If a spill should occur, there is a real possibility of entrapment of oil in the leads between ice floes and in the uneven surface beneath the ice and thus contamination of the very area critical to the biota. No data exist concerning the mechanisms by which oil might be dispersed out of the zone of the ice front. Therefore, there exist no estimates of the length of time that exposure to oil would occur in this habitat.

2. Coastal Habitats for Marine Birds and Mammals

Marine and shore birds of many species congregate for breeding in isolated colonies. These have been catalogued and mapped by Bartonek (RU 341) and Hunt (RU 83) for the Pribilof Islands, and the data are sufficient to identify habitats at risk from contaminants, at least until site-specific studies of shore facilities are required.

Sears and Zimmerman (RU 78) of Auke Bay Fisheries Laboratory have compiled a detailed atlas describing the physical features (i.e., gravel, rocky, tide flat, etc.) of the entire coastline from Unimak Pass to Cape Newenham, plus Hagemeister, Walrus, Pribilof and Nunivak Islands; included are some observations of birds and mammals made during the survey.

3. Fur Seal Habitats

The fur seal habitats of the Pribilofs are well known, and the data necessary for impact assessment is available from the National Marine Fisheries Service.

Plankton

The plankton community of the Bering Sea has been described by Cooney (RU 426 and 156) and Alexander (RU 427). These authors include data on taxa found, nutrient levels, primary productivity, and usage made of zooplankton as food by fish. The special studies of primary productivity near the ice edge (Alexander, RU 427) highlight the unique features of the ice edge plankton community and support the conclusion that the ice edge is a critical habitat as described above.

The available data on plankton communities in the St. George Basin are sufficient to address the issue of those communities at risk under various environmental circumstances.

3.2.2 Transport

The extensive discussion of key issues of Transport studies given in the Bristol Bay TDP is also applicable to similar studies in the St. George Basin.

3.2.3 Contaminants

During FY 75 and FY 76, samples were collected to document the concentration and composition of petroleum-related contaminants in the

Bering Sea. Research units participating in this effort were: RU 162 -Burrell, Robertson (subcontract); RU 224 - Shaw, Kaplan (subcontract); RU 152 - Feely; RU 153 - Cline.

High molecular weight hydrocarbons: 21 sediment samples were collected by Kaplan and analyzed for hydrocarbons by gravimetry, GC and GC-MS. Total hydrocarbons ranged from 2 to 241 μg/gm sediments, with the average near 15 μg/gm. This value is similar to that found in sediments in the vicinity of the Mississippi Sound and greater than that found in offshore Gulf of Mexico sediments (Ref. Gearing et al., Geochim Cosmochim Acta. 40: 1005 (1976)). Terrigenous sources seem responsible for most of the sediment hydrocarbons in the Bering Sea. One sample, from sediments at the head of Pribilof Canyon (241 μg/gm), displayed many of the characteristics of weathered oil and demonstrated the possibility of seeps in the area. Also, a few benthic and pelagic biota have been analyzed by Shaw for heavy hydrocarbons with no petroleum contribution observed.

Low molecular weight hydrocarbons: 14 of the 21 sediment samples collected by Kaplan were also analyzed for C_1-C_6 hydrocarbons. Only methane was reported and that in concentrations from 0 to 21 μg/g of sediment. No obvious correlation exists between methane and total heavy hydrocarbons. Cline determined LMWH in the water column. A total of 72 stations were occupied and sampled at the surface, intermediate depth and near bottom. Methane concentration at the surface was highest in coastal lagoons (100 nl/l) and lower offshore. Near the bottom, values of 100 to 700 nl/l were observed offshore. Ethane concentrations were observed offshore, averaging 0.5 nl/l, as did propane. Evidence to date indicates these gases are of biogenic origin. The stations were located sufficiently far apart, however, that natural seeps, such as the one in Norton Sound, may not have been detected. This suggests the need for site-specific studies on a scale of 1-5 miles between stations when tracts are selected.

Metals

Burrell has determined the presence of selected metals in sediments, water and biota. Extractable Fe, Ni, Zn and Cu are closely correlated with the grain size fineness of sediments. The concentration of Mn is not as closely correlated. Dissolved metal concentrations in the Bering Sea differ little from oceanic mean concentrations. Selected metals in intertidal, benthic and pelagic biota have been determined. An unusual observation was the high Cu contents of the gut and reproductive organ of *Neptunea* (snail).

The present data base is sufficient until leasing plans are developed to the point where special sites may be investigated for seeps.

Note: Data over the St. George lease area were not collected. However, the data from Bristol Bay distinguish between Bering Sea water and coastal water. There is no reason to suspect that over the St. George Basin, levels are significantly different from adjacent areas of outer Bristol Bay. Hence, it is concluded that until site-specific data are needed, the data base is sufficient for both St. George Basin and Bristol Bay lease areas.

3.2.4 Hazards

In the St. George Basin lease area, it is assumed that negligible hazard exists from seismic and tectonic events. The data obtained coincidentally wth instrumentation of the Aleutian Islands and Alaskan Peninsula have justified that assumption, and continued monitoring of the active areas to the south of St. George Basin will yield additional information. A presently operating seismic net, primarily monitoring active areas south of the Aleutians (RU 16), has one network instrument operating on St. Paul Islnad; this will add data for the St. George and Bristol Bay areas.

Hazards to development closer to the Pribilof Islands and on the islands themselves, may be assessed, at least preliminarily, on the basis of data reported by Hopkins (RU 209). His report included locations of faults and their approximate frequency of activity, the locations and frequency of volcano eruptions, and the fragility of coastlines backed by sand dunes.

Data relevant to assessment of hazards due to ice appear incidentally in ice-habitat studies by Burns (RU 248), and descriptions of the nature of ice floes and the ice zone in the southeastern Bering Sea are available. These data, including satellite photos of distribution of ice (see Beaufort Sea TDP) are sufficient to establish that ice will occur in winter in the St. George Basin and Bristol Bay lease areas, and that its extent will be highly variable from year to year. Present plans are that the characteristics of the ice as a physical hazard will need to be determined by extrapolation from studies in the Beaufort and Chukchi seas.

3.2.5 Biological Process Studies

At various points in the process of making decisions on oil and gas development, it will be necessary to have knowledge sufficient to evaluate the importance of different species. It will also be essential to predict whether a seriously affected population can recover and, if so, how long recovery will take, and the degree to which other populations or species will be affected indirectly.

Laevastu, (RU 77) has developed an ecosystem model that includes components from all trophic levels. Preliminary and unverified conclusions resulting from use of the model include ones of importance in assessments of the possible effects of petroleum development:

1. Ecosystem structure and function is variable to the extent that it will be difficult, if not impossible, to distinguish between man-caused and natural influences of change in the marine environment.
2. Small time- and length-scale disturbances smooth out rapidly, with seemingly no generally effective method for propagating a small scale disturbance.

3. There are exceptions to item 2, along the coast.
4. It is difficult to establish that quantitative and determinable damage can be caused to a marine ecosystem by temporary accidental damage to a part of such a system.
5. It does not seem reasonable that any mortalities resulting from oil-related activities can reach a "significant" fraction of those induced by the top predators, (marine) mammals and man.

The model is still under development; however, several provocative reports relating to trophic studies are available. Verification of the results is needed and is continuing (it is recommended that FY 79 plans include critical review of the model).

Preliminary results from some empirical trophic studies, e.g., Feder et al. (RU 281), list food preferences of several demersal fishes. These preferences include several benthic invertebrates as well as other fish. Pollock are known to be very cannibalistic, the trait being noted by Feder as well as by Laevastu (RU 77).

Additional empirical data on foods eaten are available from stomach analyses of fish (Smith, RU 284), and birds (Bartonek et al., RU 337). Sanger and Baird (RU 77) have compiled an extensive report on distributions and feeding habits of marine birds (these data were used in the ecosystem model by Laevastu). Feder, Laevastu and Sanger and Baird have all developed food web diagrams. The one by Feder is especially complex and extends through all trophic levels.

In summary, present knowledge of marine environments in the Bering Sea does not allow assessments based on data to be made of interference in ecosystem function with the effects of contaminants on single species or groups of species at a particular site. It is possible to identify or postulate perturbations in some trophic relationships, but not possible to estimate reliably the degree of dependencies involved, although there are exceptions to this in some isolated instances.

3.3 APPROACH

The approach taken to resolve the key issues discussed in the preceding section groups the several tasks described in the PDP into primary objectives to produce the kinds of information needed by BLM at various points when decisions must be made in the leasing process.

3.3.1 Program Emphasis and Direction

Hazards to Development

The information to be acquired addresses the BLM's need to assess the hazards imposed by the environment on any structures or activities related to petroleum development. These hazards are enumerated under task C and include:

- seismic and tectonic events
- surface and near surface faulting
- sediment instability
- sea floor erosion and deposition
- coastal erosion and deposition
- stratigraphic (gas-charged sediments)
- ice stress
- ice gouging
- extreme oceanic events

Sea floor processes have been investigated, as noted previously, and no further work is planned with the exception of a review of existing data on sediment distribution. Hazards due to ice have not been addressed in this lease area except for collection of satellite photos.

Extreme oceanic events will not be specifically addressed in this lease area except as provided for by non-area-specific studies of sea wave heights and provision for storm surge simulation in the circulation model.

Biota at Risk

After tracts to be leased are identified, both the public and the BLM will have an immediate concern: What populations would be impacted and to what extent under any plausible set of circumstances accompanying any activities relating to the exploration for and development of petrochemical resources, including oil spills or other releases of contaminants? Figure 3-1 describes the organization and relationship of various tasks and information products to one another. The issue of populations at risk may be approached at two levels: (1) that all the species present in an area of plausible impact be identified and that there exist reasonably reliable estimates of their seasonal variation in occurrence and abundance; and (2) that there exists adequate knowledge of the relative importance of each species and their interrelationships, including trophic considerations, to determine the extent to which particular species might be impacted with or without serious and long-lasting (or irreversible) changes in the functioning of biological communities.

Habitat Characterization and Species Inventory

Studies to determine the distribution and abundance of principal species may be conducted as a portion of the effort to characterize habitats, or as a survey conducted using randomly or uniformly distributed points. Either method results in knowledge of species occurrence, distribution, and abundance. The resultant data are obviously more definitive for some species than for others, and emphasize knowledge of the dominant forms.

Data on the distribution and abundance of principal species are combined with transport data, as shown in Figure 3-1, to identify the species at risk. A list of the latter, coupled with knowledge of their relative susceptibility to contaminants, permits estimations of the probability of occurrence of serious perturbations.

Transport Studies

Determination of the locality where a pollutant will affect the ecosystem, and how much pollutant will be present at the point of impact, is the subject of transport studies. One of the important end results

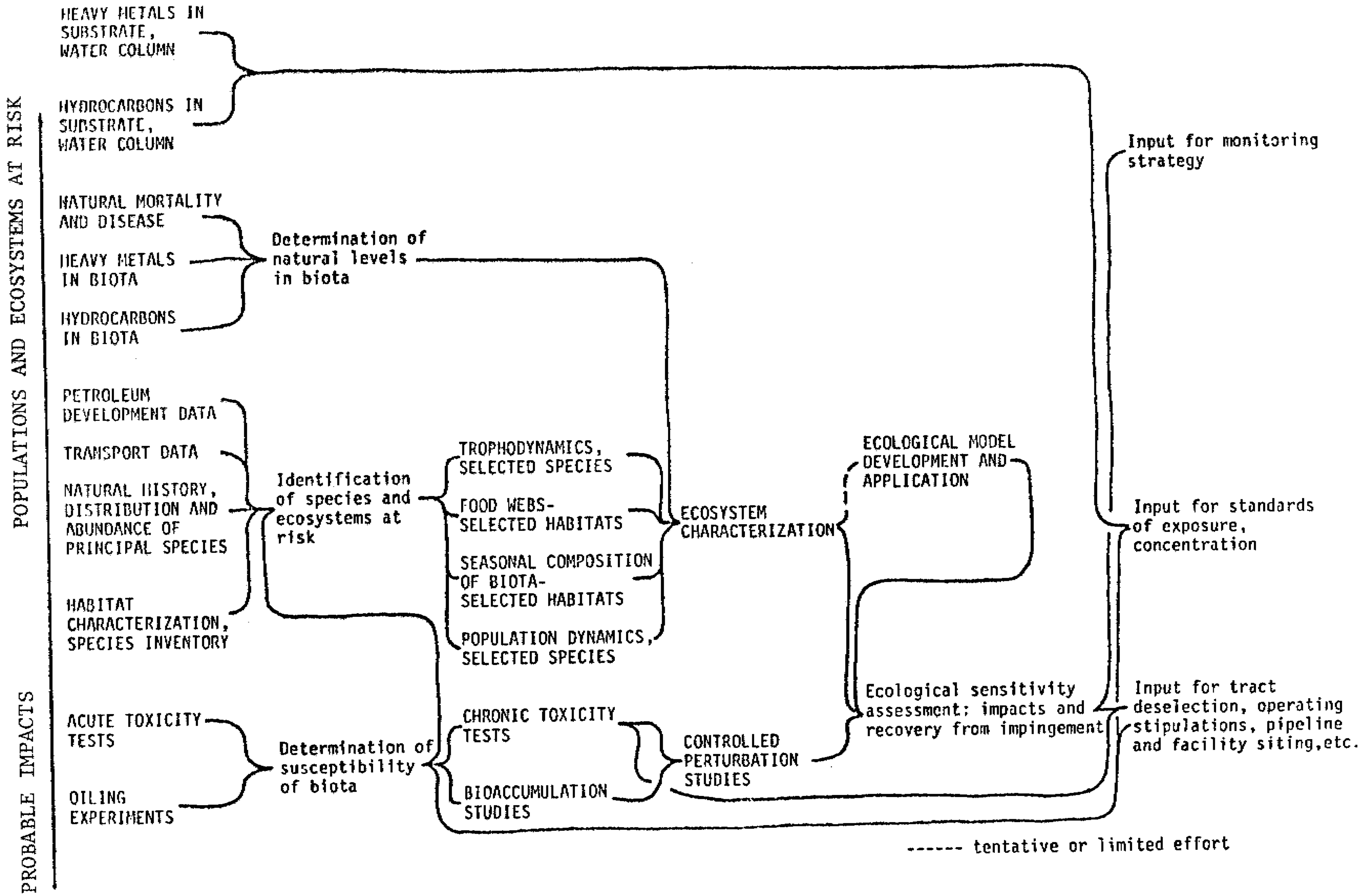


FIGURE 3-1. RELATIONSHIPS OF VARIOUS RISK AND IMPACT STUDIES

is the capability to derive trajectories of pollutant transport from any source under all conceivable meteorological conditions in all seasons. Because of the cost of the computer runs which compute trajectories, OCSEAP can provide only demonstration runs from typical sources with typical winds, to demonstrate a capability to make such identifications. In an actual field situation, a specified possible source will be identified by BLM, and that identification, considered with the time of the year and general weather conditions, will allow computer runs to be made to determine the trajectory of the contaminants. The species at risk are found by combining data on trajectories with those on species distributions for the season in question. It is also desirable, but difficult, to determine the amount of pollutants remaining after dilution by mixing and dispersion.

Three types of information on transport are required: (1) knowledge of all possible trajectories from a point source with a statement of probability by seston tows; (2) determinations of species along the route of all possible trajectories; and (3) identification of all coasts and ice edges where contaminants might arrive.

A detailed account of program emphasis in regard to transport modeling is to be found in the TDP for Bristol Bay. Figure 3-2 shows a Predictive Transport Model calculation diagram, with input from numerous research sources.

Biological Process Studies

The second level of detail or effort of OCSEAP studies is the determination, through various biological process studies, of the possible or likely relative damage to the ecosystem that might result from impact on or insult to different populations. There is a consensus that decimation of some populations in an area of impact may do greater damage to the ecosystem than decimation of others. There is no consensus as to how the process works or if it propagates through the system.

Various process studies have been undertaken to assess the differences in effects on the ecosystem caused by insult to or decimation of different populations. The conceptually simpler ones (certainly not simple in execution) are food web studies that determine trophic relationships sufficiently for assessments to be made of the effects on a species or population when its food is reduced or eliminated. This concern underlies studies of the feeding habits of colonial birds, for example.

The seasonal composition of biota in selected habitats details the characterization of habitats beyond mere species distributions and provides data that would allow for accuracy of impact assessment. These studies describe sequential habitat utilization; thus plausible inferences may be drawn as to how relatively important the protection of a particular habitat may be.

Many of the results of all the biologically-oriented studies described above are straight-forward statements of occurrence, behavior, numbers present, and sometimes life-stage, of species at risk. These data are available as maps, graphs, figures, and tabulations catalogued in the table of data products with relative completeness of the results.

In addition to a list of populations at risk, included in Figure 3-1 are more generalized studies, e.g., trophodynamics of selected species and ecosystem model development and application. The latter are attempts to characterize ecosystems, and thus to allow inferences to be made on the recovery rates of such systems following a possible insult.

Conceptually, the ecosystem model has the capability of describing the sequence of events occurring after a population or a community is disturbed. The model is intended to quantify the fluctuations in populations and the ultimate recovery of the ecosystem following changes in a population. All of the results of studies described earlier are, in principle, applicable to the development and operation of the model.

Data on species distribution, transport, climatology, tropho-dynamics, behavior and food web relations, and commercial fishing are included as inputs to model computations. The fully developed model will test inferences drawn from data suggesting the relative importance of species, and their vulnerability and recovery rates, and will require that such inferences be consistent with known dynamic relationships and variability in populations.

To assess ecological hazards, integration of the distribution data on species at risk with those on behavior, trophodynamics and habitat is conceived of as a tract or site-specific study. This task is partly subjective but it can possibly be performed according to more rigorous procedures by use of an ecological model. The model will be designed to address the issue of relative risk and possible trade-off by providing objective responses to queries concerning short and long-term effects of various aspects of petrochemical development.

3.3.2 Rationale for St. George Basin in FY 79

Because of budget restrictions and higher priority in other areas (St. George Basin leasing is not presently scheduled), few studies are planned here for FY 79. The rationale for choice of projects includes:

- o Those which show a high probability of yielding data that not only identify species and populations at risk but also explain processes.
- o Transport studies that proceed directly to predictive capability and which are prerequisite to site-specific studies.
- o Projects that require a long lead time.
- o Postponement of effects work may be possible to do between the end of FY 79 and the earliest possible sale date (assumed to be late 1981) in order to profit from effects studies in higher priority lease areas.

Tasks and research units proposed for funding in FY 79 are given in Section 3.4.

Hazards to Development

Since there is evidence that seismicity in the Bering Sea is slight, as are hazards, due to the nature of the sediments, no additional field work is presently planned. An effort to compile existing data on sediments is recommended, however. Any gaps will be apparent after existing data have been analyzed; at that time (end of FY 79) there will be sufficient time for the addition of any needed field studies. In the St. George Basin TDP there is a plan for maintaining a seismometer on St. Paul Island. Its purpose is to record seismic events in the Aleutians, but data from that effort will also include seismic events from Bristol Bay, if any occur.

Biota at Risk

No biological field studies are planned for FY 79 in St. George Basin. As shown in Section 3.2 on Issues and Status of Knowledge, much information is already available. Some of it requires analysis and integration into a form usable by the BLM; however, since the present leasing schedule shows no foreseeable need, no new analyses or reformatting will be attempted until OCSEAP has benefitted from experience by BLM with data products and syntheses designed for other lease areas. However, work on the ecosystem model (RU 77) applicable to the biota of Bristol Bay and St. George Basin, is scheduled to continue.

Reconnaissance studies are considered to be complete with the exception of synthesis of data from multiple sources. Planning of special studies, such as additional foodweb work and trophodynamics studies, will be postponed until OCSEAP review of FY 78 results, and after similar studies have been completed in Cook Inlet. Reviews will put emphasis on data available from the coastal lagoon systems of the Alaskan Peninsula to determine if they are sufficient to document the vulnerability of the lagoons to oil pollution and to determine if special studies will be advisable. If reviews by OCSEAP in FY 78 show data gaps or need for special studies beyond the reconnaissance level, they can be planned for FY 80. This is believed to be compatible with estimates that tract selection could not occur until July 1980 with a DEIS no earlier than April 1981.

Transport Studies

Additional current data will be acquired in FY 78 to supplement that obtained in FY 77. The data obtained in 1977 were provocative but until additional data are available, particularly under other weather conditions, the results will be considered inconclusive. A crucial requirement for the predictive transport model is availability of data on variability of currents. Whether used rigorously in the model or subjectively in conceptual models, data from repeated experiments are needed before conclusions as to flushing time or trajectories can be drawn from the drifter data. However, these will be delayed until firm leasing schedules are announced.

3.4 SELECTED PROJECTS

3.4.1 Tasks A-F

The OCSEAP Program Development Plan has defined the objectives of the Program in terms of tasks A through F, paraphrased here:

A. What are the existing distribution and concentration of potential contaminants associated with petroleum development?

B. What are the nature and magnitude of contaminants and environmental disturbances that may be assumed to accompany petroleum exploration and development of the Alaskan continental shelf?

C. What hazards does the environment pose to petroleum exploration and development?

D. How are contaminant discharges moved through the environment and altered by physical, chemical, and biological processes?

E. What are the populations and ecosystems most subject to impact from petroleum exploration and development?

F. What are the effects of contaminants and environmental alterations related to OCS oil and gas on individual organisms, populations, and ecosystems?

3.4.2 Specific Subtasks (FY 79)

Research units funded for FY 79 addressing the question of species and ecosystems at risk are listed below, together with the subtasks under which they were planned:

Hazards, subtask C-1

Seismic and tectonic hazards (RU 16) are part of an ongoing study in the Aleutian lease area due to the high seismicity there. However, one of the seismic recorders in the network is on St. Paul Island. This station is proposed for continuation of funding under RU 16 since it has been justified as necessary for the Aleutians, and because data for Bristol Bay and St. George will also result.

Transport, subtasks D-1 and D-2
RU's 87, 141, 267, 435, and 549

Analysis of data resulting from moored current meters, and CTD surveys conducted in FY 77 and 78, must be continued. The data are required for objective verifications of the circulation model. The results will be a refinement of the data base on which subsequent trajectory analyses will depend. RU 87, 141, 267, 435 and 549 will, therefore, be continued.

Subtasks C-2, C-4, C-5, C-9, D-1, D-2, D-5, D-6, D-8, D-9 and E-17

The circulation model (RU 435) is scheduled for verification and completion in FY 79. It will then be an operational tool for use in planning site-specific studies dependent on reliable trajectories. RU 435 will be continued.

Satellite data will continue to be gathered over all lease areas (RU 267).

The study of inteaction of oil with ice (RU 87) is largely a laboratory study with RU 88.

Task E (receptors) and A (contaminants)

All reconnaissance study will be terminated, except for RU's 196, 230, and 232. These studies are more concentrated in the Beaufort and Chukchi Seas but have applicability to St. George Basin and Bristol Bay lease areas.

Biological Process Studies (Effects)

There is a good probability that the studies of the bird colonies on the Pribilofs will result in data on the manner and degree to which the populations there would be impacted by both OCS and "nearshore" activities. Therefore, RU 83 will be continued for the purpose of analyzing results of field work for the previous years.

RU 77 Ecosystem Dynamics will be continued (subtask F-9).

4.0 RU AND P UNIT DESCRIPTIONS

Research and P Units are shown in the order of the tasks to which they relate. Some RU's are associated with more than one task. The following index will assist in locating particular P and RU descriptions.

	Page
RU 16	286
RU 77	312
RU 83	300
RU 87	290
RU 141	292
RU 230	303
RU 232	307
RU 435	295
RU 549	292

4.1 DESCRIPTIONS FOR PROJECTS IN TASK C (HAZARDS):

C-1: RU 016

(RU 16) A SEISMOTECTONIC ANALYSIS OF THE SEISMIC AND VOLCANIC HAZARDS IN THE PRIBILOF ISLANDS--EASTERN ALEUTIAN ISLANDS REGION OF THE BERING SEA

This research unit addresses subtask C-1 (BLM Study Types 10-Seismic Hazards, 11-Volcanic Hazards, and 12-Surface and Near Surface Faulting).

Estimated Costs, FY 79:		
	$72,100	Aleutians
	30,900	St. George
	$103,000	Total

Schedule: October 1978 - September 1979

Performing Agency:

University: Columbia University
P.I., Degree: John N. Davies, Ph.D.
Title: Research Associate
Percent of time devoted to project and role: 50%; directs and participates in all research.

Other Principal Scientist significantly involved in project:

P.I., Degree: Klaus H. Jacob, Ph.D.
Title: Senior Research Associate
Percent of time devoted to project and role: 40%; data synthesis and tectonic analysis.

Background:

This project is part of a combined DOE-OCSEAP study on the seismotectonics of the Alaska Peninsula and Aleutian chain; OCSEAP funds have permitted the extension of the seismic network to give better coverage of the Bering Sea and Gulf of Alaska Continental Shelf. This project is itself a continuation of a University of Alaska and Columbia University study (originally with NSF support) of the seismicity of the Aleutian Arc area that has been active since 1964. The DOE research concentrates upon the volcanism and geothermal energy potential of the region, while OCSEAP efforts are focused upon potential earthquake hazards on the continental shelf.

Objectives:

1. To record the locations and magnitudes of all detectable earthquakes within the study area and develop frequency of occurrence versus magnitude relationships.

2. To determine the seismic activity of surface and nearsurface faults identified by geologic mapping.

3. To develop acceleration/velocity versus distance relations for major earthquakes.

4. To evaluate the observed seismicity in cooperation with Research Units 210 and 251 towards development of an earthquake prediction capability in the Gulf of Alaska.

5. To monitor seismic activity of volcanoes within the study area, to evaluate volcanic hazards and to contribute to an understanding of the regional tectonics.

Methods:

The existing array of approximately 20 seismic stations will be maintained and upgraded to provide the necessary geographic coverage over as continuous a period as possible. In particular, FY 79 efforts will be devoted to:

1. Installation of three new stations in the Pribilof Islands to provide the minimum capability necessary for monitoring and locating earthquakes in the southern Bering Sea.

2. Conversion of the event-recording equipment at Dutch Harbor and Sand Point to more reliable digital systems.

3. Installation of one more short-period seismograph and two strong motion accelerometers near Dutch Harbor to take advantage of frequent strong earthquakes in this area to provide ground response information.

Output:

1. Narrative Reports: Reports will provide a detailed description of the operation of the seismic network, including number and spatial density of instruments and resulting accuracy of derived earthquake parameters. A summary of seismic and volcanic events recorded during the survey will be presented and interpreted. Reports will include an evaluation of frequency versus magnitude relationships, activity of surface and near-surface faults, and acceleration versus distance relationships.

2. Digital Data: Derived earthquake parameters (e.g., date, time, location, depth, magnitude) will be submitted on punch cards or magnetic tape in standard archive format.

3. Visual Data:

    1) Maps of hypocenter locations and magnitudes.

    2) Maps and graphs of earthquake magnitude versus frequency relationships for selected areas.

3) Maps with supportive text summarizing seismic activity of surface and nearsurface faults identified in geologic mapping.

4) Maps and figures with supportive text summarizing ground acceleration versus distance relationships.

5) Maps and reports summarizing volcanic activity.

6) Seismic and volcanic risk maps.

4.2 DESCRIPTIONS FOR PROJECTS IN TASK D (TRANSPORT):

D-1:	RU 141
	RU 435
	RU 549
D-2:	RU 435
D-8:	RU 87
D-10:	RU 87

(RU 87) THE INTERACTION OF OIL WITH SEA ICE

This research unit addresses subtasks D-8 and D-10 (not designated as to BLM study types).

Estimated Costs, FY 79:

$16,900	St. George
16,900	Bristol Bay
$33,800	Total

Schedule: October 1978 - September 1979

Performing Agency:

University: University of Washington
P.I., Degree: Seelye Martin, Ph. D.
Title: Research Associate Professor
Percent of time devoted to project and role: 50%; principal investigator; involved in all phases of the field work and analysis.

Background:

Laboratory studies of the behavior of crude oil in growing ice (in test tank, agitated by wind and waves to produce grease, slush, pancake ice, etc.) have shown the oil incorporation in the ice, pumping of oil by the ice and overflow of oil on the ice. Field experiments have studied the crystal structure, void spaces, brine channels and oil containment potential of annual and multi-year sea ice in the Beaufort Sea and in FY 79 will be extended to study the processes of potential oil-ice interaction at the edge of the ice in the Bering Sea on a larger scale, including the use of SEASAT satellite imagery. These studies cannot be effectively conducted in the Beaufort Sea, since the open ice front could only be studied for a brief time. The studies have therefore, somewhat arbitrarily, been assigned to the St. George and Bristol Bay lease areas, although results obtained will be applicable to ice fronts elsewhere. Laboratory studies will not be continued.

Objectives:

The most important objectives of this research project will be to determine the following ice properties and potential oil-ice interactions:

1. The response of the Bering Sea ice edge to changes in atmospheric forcing;

2. The scale of crack systems north of the ice edge as a function of ice thickness and temperature-salinity structure, and the response of these systems to atmospheric forcing;

3. The scale of the Langmuir ice plumes in the large polynya regions;

4. The interaction of ocean swell with the ice edge and the wave propagation into the pack; and

5. The forces which go into the formation of the filament-like structures which form at the ice edge.

Each of the features which occur at or near the ice edge, from the filaments to the spacing and direction of the crack systems, will be important to understanding the spread of pollutants in the pack ice. For example, the filament formations are evidence of convergence zones, so that spilled oil may accumulate in them. Also, the dynamics and scales of the regular crack systems above the edge, and their change in orientation with changes in atmospheric circulation will determine the spread and pumping of oil within the crack systems.

Methods:

This project will employ three different observational scales: SEASAT satellite images, aircraft overflights, and ice surface measurements consisting of the taking of ice cores and the recording of ocean waves propagating through the ice. About 18-24 stations will be occupied on the ice.

Output:

1. Narrative Reports: Methods and results of studies, including:
    a. Description of ice core data.
    b. Description of ice features and their changes in time and space.
    c. The dynamics responsible for these changes.
    d. The likely behavior of oil introduced into the area of observation.

2. Digital Data: None

3. Visual Data: Photographs and satellite images of the sea ice edge. Graphs of distribution and properties of the sea ice.

(RU 141/549) BRISTOL BAY/ST. GEORGE OCEANOGRAPHIC PROCESSES

This research unit addresses subtask D-1, (BLM Study Types 27-Currents and Tides and 29-Residence Times and Flushing Characteristics).

Estimated Costs, FY 79:		
	$ 50,000	Bristol Bay
	50,000	St. George
	$100,000	Total

Schedule: October 1978 - September 1979

Performing Agency:

University: University of Washington (RU 141)
P.I., Degree: L. K. Coachman, Ph.D.
Title: Professor of Oceanography
Percent of time devoted to project and role: 15%; responsible for data analysis and interpretation.

Agency; NOAA/ERL/PMEL (RU 549)
P. I., Degree: J. D. Schumacher, Ph.D.
Title: Oceanographer
Percent of time devoted to project and role: 25%; record analysis and interpretation.

P.I., Degree: R. Charnell, M.S.
Title: Supervisory Oceanographer
Percent of time devoted to project and role: 15%; supervisory responsibility for data, record analysis, and interpretation.

Background:

Since FY 76 research has been conducted on the physical processes affecting the transport of pollutants in Bristol Bay and St. George Basin. In particular, data have been obtained and analyzed from moored current meters, pressure gauges and CTD surveys and have resulted in an understanding of some of the physical processes.

Studies under RU 141 have demonstrated that currents in Bristol Bay and the St. George Basin are controlled largely by tides, winds, and atmospheric pressure. The currents are also affected by events in the Bering Sea that initiate long waves whose effects are propagated onto the shelf and into Bristol Bay.

Analyses of data gathered during FY 78 will refine the definition of physical processes, current systems and variability. These will be integrated with model results from RU 435 following FY 78 data collection.

The major efforts in FY 79 will be the processing, analysis and interpretation of data collected during FY 77 and 78.

Objectives:

The objectives of this study are to provide information leading to an improved understanding of the hydrography, circulation patterns, and dominant driving mechanisms in the southeastern Bering Sea. Specifically, these objectives are:

1. To understand and explain long-term current and pressure fluctuations.
2. To correlate current data and meteorological data.
3. To provide verification data for modeling efforts conducted under RU 435. This consists largely of description of natural events in the data and comparisons with results of simulation of those events in the model.
4. To obtain a better understanding of the formation mechanisms and hydrographic role of large scale density inversions.

Methods:

Methodology has been thoroughly developed for processing of current meter and pressure gauge data. Data from FY 77 and FY 78 will be processed to graphic form according to present procedures; (NOAA Tech. Memo ERL/PMEL-6).

Output:

1. Narrative Report: Reports will discuss relationships between currents, sea level, and meteorological conditions inferred from acquired data. Specifically, the report will discuss figures showing:
    - Seasonal temperature and salinity distributions.
    - Baroclinic circulation
    - Circulation based on empirical data from moorings
2. Digital Data: Current meter, pressure gauge and CTD data acquired will be digitized in accordance with existing procedures in formats 022, 017, and 015.
3. Visual Data: Currents, pressures, and meteorological data will be graphically displayed, including:
    a. Appropriately filtered time plots of tidal and non-tidal currents.

b. Charts of progressive vector diagrams.

c. Stick diagrams of currents, together with winds and pressure variations.

d. Charts showing hydrographic properties and locations of water mass mixing areas.

(RU 435) A DYNAMIC CIRCULATION MODEL OF THE BERING SEA

This research unit addresses subtasks D-1 and D-2 (BLM Study Types 27 - Current and Tides, 30 - Dispersion and Mixing and 32 - Trajectories of Oil Spills).

Estimated Costs, FY 79:

$ 29,600	Bristol Bay
109,600	Norton Sound
--20,800	St. George
$160,000	Total

Schedule: October 1978 - September 1979

Performing Agency:

Private: Rand Corporation
P.I., Degree: J. Leendertse, Ph.D.
Title: Project Director, Water Pollution Studies
Percent of time devoted to project and role: 25%; project director and co-principal investigator.

P.I., Degree: S. Liu, Ph.D.
Title; Physical Scientist
Percent of time devoted to project and role: 50%; co-principal investigator

Background:

A comprehensive OCSEAP investigation of Bering Sea shelf water mass dynamics and its driving mechanisms, underway since September 1975, has shown that semidiurnal tidal currents contribute about three-fourths of the observed variance in Eulerian current records. Episodic current pulses, attributed to water movements on and off the shelf, are at least in part responsible for the residual circulation. The current pulses are presumed to be responses to meteorological forcing in the form of regional pressure differences and sea surface wind stresses.

The above features are considered in a numerical predictive model of the stratification and circulation in Norton Sound, St. George Basin, and Bristol Bay initiated in FY 77 by the Principal Investigator. The model presently under development includes the effects of tides, wind stress, density stratification, bottom friction and momentum transfer. This study is part of an overall modeling effort to describe tidal and wind driven circulation in the entire eastern Bering Sea.

Objectives:

The nature and effectiveness of the main physical processes which transport pollutants in the Bering Sea are to be studied by use of the model along with determinations of transport. Specifically, the model will:

1. Support and guide transport studies.
2. Determine local currents and water quality responses to wind fields and tides.
3. Provide risk planning data for OCS petroleum development.
4. Furnish contaminant trajectory, landfall and other data needed for pollution event countermeasures and for planning of FY 80 studies.
5. Provide environmental monitoring station site location planning information.
6. Provide a means of determining the intensity and location of storm tides under various conditions.
7. Develop the capability to provide trajectories under ice-cover.

Methods:

An existing three-dimensional finite difference model of the southeastern Bering Sea is being refined and extended. The initial phase of the investigation emphasized:

1. Development of time-and space-varying boundary conditions (pressure, salinity, temperature, etc.) from available field data.
2. Optimization of the finite difference approximation over the vertical.
3. Adjustment of bottom and wind stress coefficients and coefficients for mass and momentum exchanges.

Results derived from the model, when driven by data obtained earlier, will be compared to field data to verify the model. Pollutant trajectories and current fields (including tidal wave components) will be generated following verification.

Output:

1. Narrative Reports: The Principal Investigators will provide a detailed report for Norton Sound and Southeastern Bering Sea, including:

   a. progress and strategy used in adjustment and verification of the model.

   b. graphic presentations of derived current data which can be compared to empirical data for verification of the model.

   c. pollutant trajectories from hypothetical spill locations under typical conditions.

   d. a discussion of results of verifications and implications of those results on accuracy of trajectory predictions.

2. Digital Data: Not required.

3. Visual Data: Numerous graphs and charts of simulation results showing:

   a. inputs
   b. pollutant trajectories
   c. horizontal and vertical velocity fields
   d. comparisons of field and other simulation data

4.3 DESCRIPTIONS FOR PROJECTS IN TASK E (RECEPTORS):

E-1: RU 230

E-2: RU 230

RU 232

E-3: RU 83

E-4: RU 83

E-6: RU 232

E-7: RU 232

E-17: RU 230

(RU 083) ECOLOGY AND VULNERABILITY OF PRIBILOF ISLAND SEABIRDS

This research unit addresses subtasks E-3 and E-4 (BLM Study Types 39 - Identification of Vulnerable Populations, 41 - Critical Habitats and Habitat Dependencies, 42 - Food Web Dependencies, and 46 - Classification of OCS Ecosystems).

Estimated Costs, FY 79: $87,000 St. George

Schedule: October 1978 - September 1979

Performing Agency:

University: University of California at Irvine
P.I., Degree: George L. Hunt, Ph.D.
Title: Associate Professor
Percent of time devoted to project and role: 25%; Project supervision, data interpretation and reporting.

Background:

During the 1975-78 field seasons, seabird productivity and trophic studies were conducted at major rookeries on St. Paul and St. George Islands. These studies identified species using each rookery, periods of occupancy and provided estimates of hatching and fledging success, relative abundance and food habits of dominant species. In addition, observations of feeding flocks were made along radial transects from the islands during those years.

The results of the previous years' research have furnished an adequate information base on dominant nesting seabird species for description of year-to-year variations in breeding behavior and productivity, determination of food habits and foraging behavior, and delineation of ocean areas in the vicinity of the islands that are important seabird foraging localities. The emphasis of FY 79 efforts will be on the synthesis and analysis of the preceding years' field data and the preparation of a comprehensive final report on the studies. The early data from the FY 78 field season indicate a significant decline in the kittiwake population. A FY 79 field effort may be necessary if later FY 78 results verify this.

Objectives:

Objectives of this study are primarily synthesis efforts to define the reproductive ecology, phenology and trophic relationships of selected marine bird species occupying major rookeries in the Pribilof Islands. Specifically, these objectives are:

1. To determine timing and use of major rookeries by marine birds.

2. To make annual estimates of species productivity (e.g., hatching and fledging success and reproductive output) at those rookeries.

3. To determine feeding habits for principal life stages of marine birds and growth rates of chicks.

4. To determine the distribution of foraging birds near the Pribilof Islands.

5. To provide data useful for seabird modeling investigations.

6. To furnish estimates of the mean values and "normal" variability in timing of breeding, reproductive success, growth rates of young, and food habits of dominant seabird species.

Methods:

These will be similar to those used by this research unit in preceding years.

Output:

1. Narrative Reports: A comprehensive report based on the results of all field work will be generated. It will include discussions of the past years' investigations, methods, and an analysis of the year-to-year variations of phenology, nesting success, food habits and foraging data for each of the species studies. Emphasis will be placed on determining the mean values of these parameters and their normal variability.

2. Digital Data: These will be provided on magnetic tape in OCSEAP defined format for archival in EDS. This study will produce digital data in the following File Types: FT 033 -Bird Sighting, FT 034 - Bird Sighting, FT 135 - Bird Colony, FT 038 - Sea Watch for Birds, and FT 040 - Bird Habitat.

3. Visual Data: These deliverables will include maps, charts, figures, and tables.

    a. Maps which illustrate:

        (1) Locations of rookeries selected for study.
        (2) Study sites, nest locations, etc. within selected rookeries.

b. Charts which illustrate:

   (1) Temporal changes in the use of each rookery.
   (2) Migration routes to and from foraging areas.
   (3) Temporal changes in areas selected for foraging.

c. Figures and tables which illustrate for major species:

   (1) The timing and use of each rookery.
   (2) Hatching success, fledging success and growth rates.
   (3) Food habits by size, age and sex.
   (4) Distances from rookeries to offshore foraging areas.

(RU 230) THE NATURAL HISTORY AND ECOLOGY OF THE BEARDED SEAL ERIGNATHUS BARBATUS AND THE RINGED SEAL PHOCA (PUSA) HISPIDA

This research unit addresses subtasks E-1, E-2, E-17, F-7 (BLM Study Types 40 - Life History Analyses, 41 - Critical Habitats and Habitat Dependencies, and 50 - Sublethal Effects of Oil).

Estimated Costs, FY 79:		
	$30,600	Beaufort
	29,700	Chukchi
	20,000	Norton Sound
	10,000	St. George
	$90,300	Total

Schedule: October 1978 - September 1979

Performing Agency:

Agency: Alaska Department of Fish and Game
P.I., Degree: Thomas J. Eley, M.S.
Title: Marine Mammal Biologist
Percent of time devoted to project and role: 100%; specimen collection, analysis.

P.I., Degree: John J. Burns, M.S.
Title: Marine Mammal Biologist
Percent of time devoted to project and role: 33%; overall guidance, writing, administration and scientific management, specimen collection, analysis.

P.I., Degree: Kathryn J. Frost, M.S.
Title: Marine Mammal Biologist
Percent of time devoted to project and role: 50%; specimen analysis, reporting, data management.

Background:

This multi-year study focuses on the biology and population dynamics of the two species of ice-inhabiting seals of greatest importance to coastal inhabitants of arctic Alaska. The two species differ widely in their biology as it is currently understood. The ringed seal is a small animal with greatest densities observed nearshore, in drifting and landfast ice. For food it is dependent on zooplankton and small fishes. The bearded seal is a large animal and the more completely independent of land of the two. It occurs mainly offshore and feeds on benthos obtained from drifting ice platforms.

Data required include: migration routes and timing, natality, mortality, growth (fetal and neonatal), population structure, longevity, age specific reproduction, habitat requirements and other process studies. The extent of dependency on these two species by Native Alaskans must also be monitored. These studies are required to develop an assessment of the vulnerability to, and recovery from perturbations.

Fieldwork depends in part on securing specimens from Native hunters, who make available bearded and ringed seals they harvest. Fieldwork also depends on securing specimens from key coastal sites where the investigators make use of their unique, privileged associations with Native hunters, who make available bearded and ringed seals they harvest. In important areas beyond the operating range of coastal-based hunters, project personnel obtain required samples by collection efforts from a variety of OCS-supported logistic platforms or from strategically located facilities on the coast (particularly in the Beaufort Sea where Native hunting is very limited).

Almost all specimen material will be analyzed in the Fairbanks laboratory. Data from shipboard and aerial surveys will also be acquired. Initial analysis will be accomplished at the University of Alaska Computer Center. Specimen material, as requested, will be made available to a variety of other investigators.

The project is characterized by taking the maximal amount of information from collected specimens, letting none of it go to waste, and making these analyses available to other projects (e.g., RU 232). Such a large number of determining parameters require extensive computer support for analytic work, and a multi-year systematic effort at data gathering. The 1978 effort was designed to shift emphasis to the Beaufort Sea, a region which has not been featured in previous years' work, because of relatively high costs of operation and low densities of these seals. However, the much larger harvest-based collections now undergoing analysis will provide the context of variability in which necessarily small Beaufort Sea samples can be interpreted. Successful continuation of Beaufort operations in spring and fall seasons will represent only the second year of effort in the region and will concentrate on integrated under-ice ecological studies. Emphasis will be on analysis and synthesis of data, with the field work filling only the most crucial data gaps. Final analysis and reporting on these objectives would occur in FY 80.

Objectives:

1. Synthesize knowledge of critical biological parameters as they relate to ringed and bearded seals including, but not limited to: various aspects of reproduction; age specific productivity; natal and neonatal growth; seasonal changes in condition; population structure; impact of predation and take by humans; habitat requirements; spatial and temporal distribution; migration patterns.

2. Document the patterns of occurrence of ringed and bearded seals principally investigated in FY 77 and 78 in relation to major coastal hunting sites and other locations of human activity.

3. Document the degree and extent of susceptibility of ringed and beared seals to typical elements of proposed OCS development, and the extent of current use by coastal residents.

4. To provide specimen material and information required by other projects, notably RU 232, 467, 356, 359, and 6.

5. To provide information on bearded and ringed seals in the Beaufort Sea in time for BLM's Beaufort Sea assessment process (target date: 1 April 1979). Prepare summary species accounts for bearded seals (target date: 1 July 1979) and ringed seals (targed date: 30 Sept. 1979).

Methods:

1. Shipboard, aerial observations, supplemented by satellite imagery to delineate ice features in large scale, to determine abundance and occurrence of seals by season, location and population cohort, to determine rates of polar bear predation.

2. Work with selected coastal villages to obtain any further samples required for biological studies and to determine extent of human utilization of these resources.

3. Standard measurement techniques:

    a. claw and cementum annuli for age.

    b. observation in the field and examination of parasite loads, other pathologic indications.

    c. reproductive tract examination and spermatogenic activity for reproductive history and fetal growth rates.

    d. standard weight-length measurements in addition to examination for pathologic conditions, and the taking of blubber, blood, tissue and organ samples from suitable specimens.

    e. provision of digestive tracts for R.U. 232.

    f. examination of diagnostic parts to determine discreteness of populations.

Outputs:

1. Narrative Reports: This project will report in narrative and tabular form on the parameters measured in both species of seals by field and laboratory observers, and correlative findings among major processes being examined.

2. Digital Data: Collection information, sex, specimen measurements, age, reproductive information, stomach contents, parasitology, pathology, census and ice data.

3. Visual Data: Various photographs, maps, figures and graphs as in project to date.

(RU 232) TROPHIC RELATIONSHIPS AMONG ICE-INHABITING PHOCID SEALS AND FUNCTIONALLY RELATED MARINE MAMMALS

This research unit addresses subtasks E-2, E-6, E-7, F-7, and F-10 (BLM Study Types 41 - Critical Habitats and Habitat Dependencies, 42 - Food Web Dependencies, and 50 - Sublethal Effects of Pollutants).

Estimated Costs, FY 79:		
	$ 61,000	Beaufort
	25,600	Chukchi
	13,400	Norton Sound
	13,400	St. George
	8,500	Bristol Bay
	$121,900	Total

Schedule: October 1978 - September 1979

Performing Agency:

Agency: Alaska Department of Fish and Game
P.I., Degree: Lloyd F. Lowry, M.S.
Title: Marine Mammal Biologist
Percent of time devoted to project and role: 100%; specimen collection, sorting, analysis, write-up

P.I., Degree: John J. Burns, M.S.
Title: Marine Mammal Biologist
Percent of time devoted to project and role: 33%; scientific administration, guidance, writing

P.I., Degree: Kathryn J. Frost, M.S.
Title: Marine Mammal Biologist
Percent of time devoted to project and role: 50%; specimen collection, sorting, analysis, writing, data management

Background:

This project is part of the integrated trophics studies in the Beaufort Sea, involving RU's 6, 29, 196, 230, 232 and 359. The project also undertakes the determining and interpreting prey dependencies among four species of seals in the Bering and the Chukchi and Beaufort Seas. These observations must be broken down into age classes, season, sex, and location and comparisons made with the best estimates of occurrence and abundance of prey species, invertebrates and fish. Simultaneous samples of the same species at different localities result in widely different representations of prey items. This emphasizes the need for large samples (often requiring several years of collection) at several areas in order to obtain site specific information. Key localities for spring hunting focus have been identified based on previous results. Generally, continued emphasis can be expected in the Beaufort Sea. This project has taken a lead role in the design of interdisciplinary icebreaker cruises in the Beaufort Sea and subsequent synthesis of trophics

information. This has led to a better understanding of the overall trophic system in the Beaufort Sea. The project will undertake to include analyses of belukha and related mammal trophics material, as part of the broader marine vertebrate consumer efforts that direct the integrated trophics analysis. Food web synthesis accounts focusing on phocid seals in the Beaufort Sea will be accomplished. Emphasis will be on analysis and synthesis of data.

Objectives:

1. Complete analysis of stomach contents from seals of known sex, collection location, and date in a sample grid designed to cover 5 lease areas, 4 species, 2 sexes, all age classes, and 4 seasons. This analysis and interpretation comes yearly into a more clearly focused picture for the western and northern Alaskan shelf, and will specifically be brought up to date in synthetic form for maximum utility to the environmental statement on the Beaufort Sea sale.

2. Synthesize the trophics information collected, including life cycle and productivity information on prey species where appropriate and necessary, for the Beaufort.

3. Analyze available belukha stomach data.

4. Complete food web account summaries for marine mammal-supporting systems in the Arctic lease areas.

Methods:

1. Collection (note: same sample collection base applies in part to R.U. 230)
    a. at hunter sites in cooperation with native harvest activities, largely in spring
    b. aircraft and ship-based collections in areas, seasons not utilized by traditional hunting

2. Analysis quantitative, by volume, number and percent composition/occurrence; standard sorting procedures

3. Availability studies on prey items: otter trawls

Output:

1. Narrative Reports: as required of all NOAA-OCSEAP projects. Specifically, this project will report in narrative/tabular form the spectrum of prey species encountered in stomachs of marine mammals, percent volume, numeric frequency analysis by age, sex, species, season, and location of these results. Key links in the Beaufort Sea trophic system will be identified.

2. Digital Data: Total volume of prey items, prey species, numbers total volume for each stomach; species of mammal, sex, time of year, geographic location.

3. Visual Data: Primarily distribution maps comparing predator and prey species in density. Pie diagrams and other innovative approaches to displaying trophics information can be expected.

4.4 DESCRIPTIONS FOR PROJECTS IN TASK F (EFFECTS):

F-7:	RU 230
	RU 232
F-9:	RU 77
F-10:	RU 232

(RU 77) ECOSYSTEM DYNAMICS, EASTERN BERING SEA

This research unit addresses subtask F-9 (BLM study types 39 - Vulnerable Populations, 42 - Food Web Dependencies, and 46 - Ecosystems).

Estimated Costs, FY 79:	$15,000	Bristol Bay
	15,000	St. George
	$30,000	Total

Schedule: October 1978 - September 1979

Performing Agency:

Agency: NMFS/Northwest and Alaska Fisheries Center
P.I., Degree: Taivo Laevastu, Ph.D.
Percent of time devoted to project and role: 50% - Project direction and model analysis.

Background:

The purpose of this research is to investigate the nature, size, complexity and feasibility of a multi-component, dynamic, numerical ecosystem model for the eastern Bering Sea and to construct a functional model permitting useful and reliable assessments of fluctuations in the eastern Bering Sea biomass. Development of the numerical ecosystem model was initiated in FY 76 and has evolved from an eight component, two-dimensional to a twenty-five component, four-dimensional model.

Preliminary results from this model show that the dynamics of the marine ecosystem such as intra- and interspecies competitions, interactions between species and the environment, and the effects of man's actions on the ecosystem, can now be simulated. Thus, during FY 79, this project will be used to integrate and synthesize the extensive data base generated through OCSEAP-sponsored research in the eastern Bering Sea.

Modeling effort will emphasize sensitivity analyses on the key species identified by BLM, those species with commercial, subsistence, or sport significance, unique, rare or endangered species, and those with pre-eminent or essential roles in the ecosystem in the eastern Bering Sea.

Objectives:

1. Identify key species, time periods or areas within the lease areas that may be especially sensitive to oil development.

2. Develop estimates of the effects of environmental perturbations, as identified by BLM, OCSEAP and the investigator, on populations of key species.

3. Identify major information gaps in the OCSEAP research program in the eastern Bering Sea.

Methods:

The existing model will be used to synthesize and evaluate the extensive data developed from OCSEAP research conducted during FY 76-77 and analyzed during FY 78.

Output:

1. Narrative Reports: Reports will provide detailed descriptions of the model with analysis and interpretation of results based on various inputs to the model. Major information gaps and sensitivity of populations to environemntal changes or oil development will be discussed.

2. Digital Data: New data will not be developed.

3. Visual Data: Visual displays or computer graphics will be developed to show:

    a. Areal and temporal changes in population densities and energy demands for major life stages of selected species or species groups.

    b. Effects of altering model constants or input variables (physical-chemical factors on estimates of population densities.

5.0 TIMING SCHEDULE AND PRODUCTS OF OCS STUDIES IN THE ST. GEORGE

The following products list and timing schedule of OCS studies addresses the St. George lease area. The list of deliverables is a shorthand approximation for a complex, interlocking set of studies that are often difficult to represent by codes only and in which many qualifiers are necessarily left out.

The Codes used to identify BLM-required temporal and spatial resolution are as tabulated below. The same code is used to indicate present and projected levels of resolution in columns headed 77, 78, and 79. Appearance of the code in the FY 79 column indicates that funding is planned for FY 79.

Temporal Resolution

N = no temporal resolution
A = annual
S = seasonal
St = short term, days to weeks
D = diurnal, diel

Spatial Resolution

0 = information in hand, literature review
1 = qualitative, area wide, cursory
2 = semi-quantitative, hundreds of square miles scale or 25 miles of coastline
3 = semi-quantitative, 3-10 tracts scale or 10 miles of coastline
4 = quantitative, tract specific (2 to 5 miles resolution)
5 = quantitative, site specific
6 = no spatial resolution (non-site specific)

Several codes are also used to indicate existing (Pre-1978) and Projected (1978 and on) status of the effort to attain the specific products in the Data Products List. The codes used are as follow:

1. The research is ongoing, i.e. funded for FY 79.
2. The research unit effort has been terminated, and there are no plans for its resumption. The available data are, or may be, sufficient to meet stated needs.
3. Data are available from non-OCSEAP sources.
4. The data are insufficient to meet stated needs but the project has been terminated due to budget restrictions or lease area priorities.
5. Proposed research units.

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
A	CONTAMINANT BASELINE																		
A-1	Distribution and concentration of hydrocarbons	Determine existing levels of hydrocarbons, prior to initiation of petroleum-related OCS activities.	Seasonal and spatial distribution patterns of hydrocarbons:																
			. in sediment	Narrative Table/Map	275 480					S2			S4	S5		S2	–	–	2
			. in benthic biota	"	275					S2			S4	S5		S2	–	–	2
			. in pelagic biota including neuston	"	275					S2			S4	S5		S2	–	–	2
			. dissolved in the water column	Narrative/ Table/Map Profile	275					S2			S4	S5		S2	–	–	2
			. in particulate matter within water column	"						S2			S4	S5		S2	–	–	2
		Determine probable sources of existing levels of hydrocarbons, i.e. biogenic or petroliferous.	Comparison of ratios of C_1/C_2+ with $^{13}C/^{12}C$	Narrative/ Table	480					S2			S4	S5		S2	S3	–	2
		Monitor hydro-levels over broad geographical areas to determine significant changes in ambient concentration patterns following OCS development.																	
A-2	Distribution and concentration of low molecular weight (LMW) hydrocarbons in the water column	Determine existing levels of LMW hydrocarbons prior to initiation of petroleum-related OCS activities	Seasonal and spatial distribution patterns of C_1-C_4 hydrocarbons																
			. in water column	Table/Map Narrative	153					S2			S4	S5		S2	S3	–	2
			. in sediments	"						S2			S4	S5		S2	S3	–	2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
Task	Product	Intended Use	Specific Product	Format	R.U.	Required										Projected			
						-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
A-2		Determine probable sources of existing levels of hydrocarbon, i.e., biogenic or petroliferous.	Comparison of methane and C_2-C_4 hydrocarbon concentrations.		153					S2			S4	S4		S2	S3	-	2
		Use LMW hydrocarbon as an indigenous tracer or detection parameter to discern accumulation of hydrocarbon during or after OCS development.			153					S2			S4	S5		S2	S3	-	2
		Examine the dispersion and diffusion of natural LMW hydrocarbons.																	
A-3	Distribution concentration and chemical speciation of selected toxic metals	Determine the concentration and distribution of nonvolatile petroleum components, especially toxic metals, prior to OCS development.	Seasonal and spatial distribution patterns selected metals:																
			. in sediment	Table/Map/ Narrative	162					S2			S4	S5		S2	S3	-	
			. in benthic biota		162 506					S2			S4	S5		S2	S3	-	2
			. in pelagic biota		162					S2			S4	S5		S2	S3	-	2
			. in water column (soluble and suspended forms)		162 506					S2			S4	S5		S2	S3	-	2
		Determine chemical speciation and transport mechanism of selected metals and characteristics of substrates to which they are adsorbed.	Elemental composition and distribution of suspended particulate matter.	Table/Map Narrative	152					S2			S4	S5		S2	S3	-	2
			Hydrocarbon adsorption characteristics of suspended matter.		152					S2			S4	S5		S2	S3	-	2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
A-3		Monitor selected metal concentrations over broad geographical areas to determine significant changes during and following OCS development	Will not be addressed (see section 3.1, Premises.)																

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
B-1	Locations of drilling platforms, pipelines and	Planning of OCSEAP field and related studies.	Information required from BLM.	Charts	N/A														
B-2	Quantity and nature of contaminants from each source.	Planning of OCSEAP field and related studies.	Information required from BLM.	Charts	N/A														
B-3	Areas of altered current patterns, removed habitats, or altered migration paths.	Planning of OCSEAP field and related studies.	Information required from BLM.	Charts	N/A														

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
										T	E	FS							
C-1	Description of seismic and volcanic activity.	To determine the potential hazards to platforms, pipelines and other structures due to earthquakes and volcanic equptions, as input to tract de-selection and design stipulations	Historical earthquake epicenters, focal depths, and magnitudes	Map	16 352	NO				D3	D4					D4 D3	D4 –	D4 –	1 2
			Earthquake magnitude vs. frequency relationships for selected areas.	Map Graph	16	NO				N2					N4	N2	N2	N2	1
			Seismic activity of surface and near-surface faults identified in geologic mapping.	Map Report	16	NO				N3		N4			N5	N3	N4	N4	1
			Relationships between earthquake magnitudes and strong ground motion.		–	NO				N2						–	–	–	0
			Description of volcanic activity and resulting phenomena such as flows and nuees ardentes.	Map Report	N/A	NO				N3		N4				–	–	–	0
			Seismic risk map.	Map	16	NO				N3		N4				N1	N1	N2	1
			Volcanic risk map	Map	N/A	NO				N3		N4							

66

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
										T	E	FS							
C-2	Description of the distribution and relative ages of surface and near-surface faults.	To determine the potential hazards to platforms, pipelines, and other structures due to active faulting; serves primarily as input to tract deselection and to provide geographic focus for earthquake studies.	Locations of surface and near-surface faults classified according to apparent recency of movement (from geologic relationships).	Map Report	206	N0				N3		N4			N5	N3	N3	-	2
C-3	Description of the types and extent of natural seafloor instability.	To determine the potential hazards to platforms, pipelines, and other structures due to slumping, compaction, and liquefaction of bottom sediments; serves as input to tract deselection and siting/design stipulations.	Delineation of existing and potential slumps and other unstable sediment masses, classified according to present relative stability.	Map	206	N0				N3		N4			N5	N3	N3	-	2
			Thickness of unconsolidated sediment.	Map	206	N0				N3		N4			N5	N3	N3	-	2
			Description of sediment physical properties.	Map Report	206	N0				N3		N4			N5	N3	N3	-	2
			Geologic cross-sections of potentially unstable sediment masses.	Profile	206	N0				N4		N4			N5	N3	N3	-	2
			Description of the geologic history of unconsolidated sediment units.	Map Report	206					N3						N3	N3	-	2

67

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
						-4	-3	-2	-1	0	+1	+2	+3	+4	+5				
Task	Product	Intended Use	Specific Product	Format	R.U.					T	E	FS				77	78	79	
C-4	Identification and description of areas of potentially hazardous seafloor erosion, deposition, and bedform movement.	To determine the potential hazards to platforms, pipelines, and other structures due to seafloor erosion, deposition, and beform movement; serves as input to tract deselection and siting/design stipulations.	Interpretation and description of the nature and severity of sediment instability.	Report	206	NO				N3		N4				N3	N3	-	2
			Locations of areas of of severe erosion and deposition (indicating rates where possible).	Map	206	NO				N3		N4			N5	N3	N3	-	2
			Distribution and description of large-scale mobile bedforms showing directions and rates of movement	Map Report	206	NO				N3		N4				N3	N3	-	2
			Interpretations regarding the nature and severity of erosion, deposition, and bedform movement.	Report	206	NO				N3		N4				N3	N3	N3	2
C-5	Identification and description of potential coastal hazards.	To determine the potential hazards to onshore development due to coastal erosion, accretion, faulting, and other onshore surface processes; serves primarily as input to siting/ design stipulations and development plan verification.	Identification of coastal areas with severe erosion or accretion, indicating rates where possible.	Map	-	NO					N2					-	-	-	0
			Description of nearshore sediment dynamics.	Map Reports	-	NO					N2				N5	-	-	-	0

77-969

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
										T	E	FS							
C-5			Description of coastal geology, including active faults and surface processes.	Map	209	NO					N2				N5	N3			2
			Interpretation of the potential hazards to coastal facilities.	Report	209	NO					N2				N5	N3	-	-	2
C-6	Not Applicable to St. George Basin or Bristol Bay.																		
C-7	Description of the geographic distribution of ice gouging, its severity, and frequency of occurrence.	To determine the potential hazards to pipelines and other seafloor installations due to ice gouging; serves as input to siting/design stipulations.	Description of ice gouging activity, distribution, frequency, and gouge depth.	Map Report	-	NO					N2				N5	-	-	-	0
			Interpretations regarding the nature and severity of ice gouging and its relation to ice structures and behavior.	Report	N/A	NO					N2				N5	-	-	-	0
C-8	Description of the distribution and nature of gas-charged sediments.	To determine the potential hazards to platforms, pipelines and other structures due to gas-charged sediments; serves primarily as input to siting/design stipulations.	Description of the distribution and depth of gas-charged sediments.	Map, Profile	206	NO				N3		N4				N3	N3	-	2
			Identification of oil and gas seeps.	Map	206	NO				N3		N4				N3	N3	-	2
			Descriptions of the origins and characteristics of gas-charged sediments and their potential hazards	Report	206	NO				N3		N4				N3	N3	-	2

69

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5				
										T	E	FS				77	78	79	
C-9	Stress - strain relationships in ice.	Calculation of ice forces and loads on structures.	1. Measurements of physical properties of various types of sea ice.	Narrative	265		Relevance of studies in the Beaufort (RU 265) to St. George Basin and Bristol Bay need to be determined.									-	-	-	0
			2. Estimates of ratios of stress to strain in various types of ice.		265											-	-	-	0
			3. Estimates of forces of extreme ice conditions.		265											-	-	-	0
			4. Calculations of ice forces and loading on structures.		265											-	-	-	0
C-10	Characterization of frequency, intensity and effects of extreme oceanic events	To identify hazards to OCS exploration, development, and production activities.	1. Observational and historic information on storm surges as a function of location, season, and magnitude.	Tables	-			S2								-	-	-	0
			2. Observational and historical information on coastal katabatic winds as a function of location, season, and magnitude.	Tables	-			S2								-	-	-	0
			3. Historical information on tsunamis (see Subtask C-1).	Tables	352			S2								-	-	-	4
			4. Marine and coastal climatology, including . temperature . wind . cloud cover . wave heights . storm tracks and frequencies . coastal flooding . vessel icing	Tables Graphs	347			S2								-	-	-	4

77-964

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5				
										T	E	FS				77	78	79	
D-1	Seasonal and shorter term description of water masses and circulation patterns in offshore regimes.	To predict or estimate trajectories of pollutants and time of impact.	1. Analyses of historic data in the literature and previously unreported data.	Narrative with maps.	307			S2	S3							S2	S2	S2	2
			2. Analyses of historical data on climatic systems and meteorological events for their effects on circulation.	Narrative with maps	347			S2	S3							S2	S2	S2	2
			3. Seasonal temperature and salinity distribution.	Narrative with maps.	141 549 307			S2	S3			S4				S2	S2	S2	1
			4. Baroclinic circulation.	-	141 549 307			S2	S3			S4				S2	S2	S2	1
			5. General circulation, based on moored current meter data.	Narrative with figures.	141 549			S2	S3			S4				S2	S2	S2	1
			6. Trajectories of drogues.	Maps and Narratives	217			S2	S3			S4				A2	S2	-	
			7. Discussion of mixing and estimates of lagrangian dispersion coefficients.	Narrative	217			S2	S3			S4				A2	A2	-	4
			8. Estimates of sea-surface slope.	Narrative	-			S2								-	-	-	0
			9. Measurements of local wind fields.	Narrative	-			S2								-	-	-	0
			10. Analyses of synoptic weather data to obtain local wind and temperature fields.	Narrative with maps.	-			S2	S3	S3	S3	S4				-	-	-	0

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
										T	E	FS							
D-1 cont.	Seasonal and shorter term description of water masses and circulation patterns in offshore regimes.	To predict or estimate trajectories of pollutants and time of impact.	11. A procedure for determining local wind fields when synoptic data and local station data are available.	Narrative			Resolution scale not appropriate.									-	-	-	4
			12. Currents, calculated by diagnostic model.	Narrative				S2		Not applicable						-	-	-	0
			13. Currents calculated by hydrodynamical model.	Map	435			S2								S4	S4	S4	1
D-2	Seasonal and shorter term description of water masses and circulation patterns in near-shore	To predict or estimate trajectories of pollutants and time of impact	1. Analyses of historic data in the literature and previously unreported data.	Narrative	307			S2								S2	S2	S2	2
			2. Analyses of historical data on climatic systems and meteorological events for their effects on circulation.	Narrative with maps	-			S2								-	-	-	0
			3. Seasonal temperature and salinity distribution.	Narrative with maps	141 549			S2								S2	S2	S2	1
			4. Baroclinic circulation.	Narrative with maps	141 549			S2								S2	S2	S2	1
			5. Near-shore circulation, based on moored current meter data.	Narrative with figures.	141 549			S2								S2	S2	S2	1
			6. Trajectories of drogues.	Maps and Narrative					S2							A2	S2	-	2

72

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5				
										T	E	FS				77	78	79	
D-2	Seasonal and shorter term description of water masses and circulation patterns in offshore regimes.	To predict or estimate trajectories of pollutants and time if impact.	7. Discussion of mixing and estimates of Lagrangian dispersion coefficients.	Narrative					S2									-	2
			8. Estimates of sea surface slope.	Narrative					S2							-	-	-	0
			9. Near shore currents by means of a current mapping radar.	Map					S4							-	-	-	0
			10. Analyses of satellite photos for oceanographic data.	Narrative	289				S2							S2	S2	-	2
			11. Surf zone dynamics; wave refraction diagrams, rip-current distributions.	Narrative with maps	-				S2							-	-	-	0
			12. Storm surge probability and intensity.	Narrative	347				S2							S2	S2	-	2
			13. Measurements of local wind fields near shore.	Narrative					S3							-	-	-	0
			14. Analyses of synoptic weather data to obtain local wind and temperature fields.	Narrative					S2							-	-	-	0
			15. A procedure for determining local wind fields when synoptic data and local station data are available.	Narrative	367				S2							S2	S3	-	4

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5				
										T	E	FS				77	78	79	
D-2	Seasonal and shorter term description of water masses and circulation patterns in offshore regimes.	Used to assess potential for air pollution by onshore development offshore facilities	16. Measurements of the stability of the surface (air) boundary layer and ice nuclei baseline.	Narrative	-				S3							-	-	-	0
			17. Results of analysis by models.	Narrative with:															
			a. General circulation.	Map	435			S2	S3			S4				S3	S3	S3	1
			b. Tidal current (hydro dynamical).	Maps	435			S2	S3			S4				S3	S3	S3	1
			c. Trajectory.	Maps	435			S2	S3			S4				S3	S3	S3	1
			d. Trajectory with plume dynamics.	Maps	-			S2	S3			S4				-	-	-	0
D-3	Description of oil spill plume behavior and oil weathering processes.	Evaluation of degree of impact, areal scale of impact and contingency requirements.	1. Oil spill weathering mechanisms and estimated rates.	Narrative	499			Resolution: Not Applicable								-	-	-	4
			2. Laboratory determined weathering rates.	Tables	499			Resolution: Not Applicable								-	-	-	0
			3. Field studies to determine weathering rates.	Tables	499			Resolution: Not Applicable								-	-	-	4
			4. Description of mechanisms which cause dispersal of oil plumes.	Narrative	-			Resolution: Not Applicable								-	-	-	1
			5. Pollutant dynamics model general.	Computer code and documentation	140			Resolution: Not Applicable								-	-	-	0
			6. Pollutant dynamics model subroutine accounting for weathering).	Computer code and report	499			Resolution: Not Applicable								-	-	-	0

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
										T	E	FS							
D-4	Description of the types and characteristics of bottom sediments and their probable interaction with oil and biota.	To determine the probable fate of oil in association with bottom sediments, its longevity, cleanup difficulty, and possible effects on intertidal and benthic biota; serves as input to tract deselection.	Description of sediment grain size properties.	Map	290					N2	N3					N3	-	-	2
			Description of coast-morphology, beach materials, and relative vulnerability of the coast to spilled oil.	Map Report	-					N2	N3					-	-	-	0
			Interpretation regarding the interaction between oil and bottom sediment, oil retention capability of the substrate, and implications regarding possible effects on intertidal and benthic biota.	Report	290					N2	N3					N3	-	-	2
D-5	Description of bottom sediment dynamics.	To determine the transport trajectory of oil in association with bottom sediments. Serves as input to tract deselection and to hazards studies.	Description of the directions and rates of bottom sediment movement.	Map	-					N2	N3					-	-	-	0
			Intrepation regarding the mechanisms of entrainment and transport of bottom sediment and their relationship to physical oceanographic processes.	Report						N2	N3					-	-	-	0

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5				
										T	E	FS				77	78	79	
D-6	Character of suspended particulates and their effectiveness as transporters of oil.	Assessment of the impact potential of oil spills.	1. Sediment and suspended sediment distributions.	Narrative with maps						S2	S3					-	-	-	0
			2. Sediment movements.	Narrative with maps						S2	S3					-	-	-	0
			3. Tabular data, indicating extent of oil/sediment interaction under varying environmental condition.	Narrative with maps						S2	S3					-	-	-	0
			4. Relation of suspended particulate matter to terrestrial and marine sources.	Narrative with maps						S2	S3					-	-	-	0
D-7	Description of seafloor topography.	To provide input to circulation studies and hazards studies	Description of seafloor topographic features.	Map Report				N4								N2	N2	-	2
D-8	Characterization of sea ice morphology including under-ice morphology.	Assessment of role of ice cover as a habitat and in transport of spilled oil.	Analysis of the historical records of ice conditions.	Report				N2								-	-	-	0
			Description of ice conditions, seasonally and areally from contemporary data; position of ice-front, ex.	Report seasonal maps	257			S2								S2	S2	-	2
			Under-ice morphology, and its potential as a trap for oil.	Report												-	-	-	0

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0 T	+1 E	+2 FS	+3	+4	+5	77	78	79	
D-9	Description of ice dynamics and their effects on transport of oil and safety of structures.	As input data to transport models and in evaluation of construction plans for safety.	Oil trajectories in over and under ice of various types.	Narrative with maps.	-			S2	S3			S4				-	-	-	0
			Model of ice motion under various environmental conditions.	Narrative Documentation of model	-			S2	S3			S4				-	-	-	0
D-10	Description of interaction between sea ice and oil and movement of oil in a ice field.	As input to transport models.	Model of behavior of oil incorporated in ice matrix.	Narrative with algorithms				Resolution scale not applicable											0
			Measurements of oil movement in the presence of ice in field.	Narrative with maps				Resolution scale not applicable.											0
			Comparison of model results with field results.	Narrative				Resolution scale not applicable.											0
D-11	Susceptibility of marshlands near the coast to inundation by oil transported by storm tides.	To assess the probability of insult to critical habitats.	Calculated probability of storm surge.	Narrative				S2								-	-	-	0
			Verification of probability of storm surge by field studies	Narrative				S2								-	-	-	0
			Analysis of historical storm surge records.	Narrative with tables				S2								S2	S2	S2	2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-1	Description of seasonal distribution and abundance of marine mammals.	To identify critical habitats and determine the likelihood of impingement based on transport data and probable sources.	1. Annotated bibliography of available marine mammal data and literature.	Narrative	067												NO		2
			2. Review of available literature and data on marine mammals.	Narrative	231 067 230 194												NO		2
			3. Seasonal distributions and relative abundance of marine mammals.	Map	248					S1	S2	S3				S2	S2	-	4
					034											S2	S2	-	2
					067											S2	S2	-	2
					230											S2	S2	S2	1
					231											S2	S2	--	2
					241											S2	S2	--	2
			4. Locations of marine mammal migration routes.	Map	67					S2	S2	S3				S2	S2	-	2
			5. Locations of breeding and concentration areas.	Map	230					S3	S4	S4				S2	S2	S2	1
E-2	Description of population dynamics and trophic relations of marine mammals.	To evaluate the potential effects of OCS activities on the stability of populations within a considered critical habitat.	1. Population dynamics of marine mammals, including: . reproductive biology . growth . population composition . habitat dependencies	Narrative	230					S2				S3		S2	S2	S2	1
			2. Trophics of marine mammals, including: . major prey species . foraging areas	Narrative	232					S2				S3		S2	S2	S2	1
			3. Behavioral aspects of marine mammals relative to OCS activities.							N6									

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-3	Description of seasonal distribution and abundance of marine birds.	To identify critical habitats and determine the likelihood of impingement based on transport data and probable sources.	1. Annotated bibliography of marine bird data and literature.	Narrative	003											S2	S2	–	2
					196											S2	S2	S2	1
			2. Review of marine bird data and literature.	Narrative	003											S2	S2	–	2
					339											NO	NO	–	2
			3. Seasonal distribution and abundance of marine birds.	Map	239					S2						S2	S2	–	2
					196											S2	S2	S2	1
					337											S2	S2	–	2
			4. Locations of marine bird breeding colonies.	Map	338					S5						S_t5	S_t5	–	2
			5. Locations of marine bird concentration areas.	Map	003					S2		S3				S3	S3	–	2
					341											S3	S3	–	2
			6. Locations of bird migration routes.	Map	340					S2						S2	S2	–	2
E-4	Description of population dynamics and trophic relations of marine birds.	To evaluate the potential effects of OCS activities on the stability of of populations within a considered critical habitat.	1. Population dynamics of marine birds, including: . breeding phenology . reproductive ecology . growth . habitat dependencies	Narrative	083					S2		S_t1		S_t1		S_t5	S_t5	S_t5	1
					038											S_t5	S_t5	–	2
					341											S_t5	S_t5	–	2
					108											S_t6	S_t6	–	2
					196											S2	S2	S2	1
			2. Trophics of marine birds, including: . Major prey species . foraging areas	Narrative	083					S2				S3		S2	S2	S2	1
					341											S2	S2	–	2
					108											S2	S2	–	2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-4	Description of seasonal distribution and abundance of marine birds.	To identify critical habitats and determine the likelihood of impingement based on transport data and probable sources.	3. Behavioral aspects of marine birds relative to OCS activities.	Narrative	038					S0						NG	N6	-	2
					108											S6	S6	-	2
E-5	Description of the seasonal distribution and abundance of marine fish.	To identify critical habitats and determine the likelihood of impingement based on transport data and probable sources.	1. Annotated bibliography of available marine fish data and literature.	Narrative	175					NO		NO				NO	-	-	2
					252											NO	-	-	2
					354											NO	NO	-	2
			2. Review of available marine fish data and literature.	Narrative	175					NO		NO				S2	-	-	2
			3. Seasonal distributions and relative abundance of marine fishes.	Map	019					S2						S2	S2	-	2
					175											S2	-	-	2
					437											S2	-	-	2
					483											S2	-	-	2
			4. Locations of spawning and concentration areas, and migration routes.		175					S2		S3				S2	-	-	2
			5. Locations of important commercial fishing areas.	Map	175					S2		S3				S2	-	-	2
					353											S2	-	-	2
					354											S2	S2	-	2
					437											S2	-	-	2
E-6	Description of population dynamics and trophic relations of marine fish.	To evaluate the potential effects of OCS activities on the stability of populations within a considered critical habitat.	1. Trophics of marine fishes, including: . identification of major prey species . foraging areas		077					N1		S2				S2	S2	S2	1

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
Task	Product	Intended Use	Specific Product	Format	R.U.	Required										Projected			
						-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-6	Description of population dynamics and trophic relations of marine fish.	To evaluate the potential effects of OCS activities on the stability of populations within a considered critical habitat.	2. Population dynamics of marine fishes including: . reproductive biology . growth . habitat dependencies	Narrative	175					N1		S2				S2	-	-	2
E-7	Description of seasonal distribution and abundance of benthic biota.	To identify criti- habitats and determine the likelihood of impingement based on transport data and probable sources.	1. Annotated bibliography of available literature and data on benthic biota.	Narrative	282											NO	-	-	2
			2. Review of available literature and data on benthic biota.	Narrative	282											NO	-	-	2
			3. Distribution and abundance of dominant benthic organisms.	Map	005 281					N2		S3				S2 S2	S2 S2	- -	2 2
	Description of population dynamics and trophic relations of benthic biota.	To evaluate the potential effects of OCS activities on the stability of populations within a considered critical habitat.	4. Population dynamics of benthic organisms, including: . Seasonal community structure . Seasonal abundance of dominant organisms . Productivity estimates	Narrative	005											S2	S2	-	2
			5. Trophic relations of selected benthic organisms including: . food webs . identification of major prey species	Narrative	005					N1		S1		S3		S2	S2	-	2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-8	Description of distribution and abundance of biota in littoral communities.	To identify critical habitats and determine the likelihood of impingement based on transport data and probable sources.	1. Annotated bibliography of available data and literature on littoral biota.	Narrative	078					NO						NO	NO	-	2
			2. Review of available data and literature on littoral biota.	Narrative	078											NO	NO	-	2
			3. Regional characterization of littoral habitat, including: . Substrate . Littoral community structure . Population density distributions	Narrative	078 003					S2		S3		S4		S2 S2	S2 S2	- -	2 2
E-9	Description of the ecosystem dynamics and relative abundance of biota in littoral communities.	To evaluate the potential effects of OCS activities on the stability of populations within a considered critical habitat	1. Population dynamics of intertidal biota, including: . Seasonal community structure . Productivity	Narrative	078					S2				S3		S2	S2	-	2
			2. Trophic relations of littoral fauna, including: . Food webs . Identification of major predator prey relations	Narrative	-					S2				S3		-	-	-	0

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-10	Seasonal density distributions of principal species of plankton.	To identify critical habitats and to determine the likelihood of impact based on transport data and probable sources.	1. Time of appearance	Narrative	426					S1		S2				S2	S2	-	2
					427											S2	S2	-	2
					380											S2	S2	-	2
			2. Quantitative distributions	Narrative	380											S2	S2	-	2
					426											S2	S2	-	2
					427											S2	S2	-	2
					156											S2	-	-	2
E-11	Seasonal indices of phytoplankton standing crop and production.	To identify critical habitats and to determine the likelihood of impact based on transport data and probable sources.	1. Composition	Narrative	427					N1		S2				S2	S2	-	2
					156											S2	-	-	2
			2. Standing crop	Narrative	427					N1		S2		S3		S2	S2	-	2
			3. Productivity	Narrative	427					N1		S2		S3		S2	S2	-	2
					156											S2	-	-	2
			4. Ecology of sea ice flora.	Narrative	427					N1		S2				S2	S2	-	2
E-12	Non-population dependent physiological and population parameters of plankton communities.				427											N6	N6	-	2
E-13	Identification and seasonal characterization of critical habitats for egg and larval stages of fish and shellfish species.	To identify critical habitats and to determine the likelihood of impact based on transport data and probable sources.	1. Time of appearance	Narrative	380					S1		S2		S3		S2	S2	-	2
			2. Quantitative distributions.	Map	380					S1				S6		S2	S2	-	2
E-14	Ichthyoplankton key for Alaskan waters.	OCSEA Program development.	Ichthyoplankton key.	Narrative	349				N6							N6	-	-	2
	Otolith Key	Ditto		Narrative	285				N6							N6	-	-	2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
E-15	Characterize marine microbial communities with regard to quantitative levels of indigenous heterotrophs, chemotrophs and pathogens.	To identify critical habitats and determine likelihood of impingements based on transport data and probable sources.	1. Geographical density distributions of physiological groups in: . Water . Sediments	Map	–					N2		S2				–	–	–	0
		To define the potential for petroleum degradation in specific habitats and, therefore, likelihood of impact.	2. Hydrocarbon degradation rates.	Narrative						N1		S1		S2		–	–	–	0
			3. Evaluation of techniques used to determine oil degradation in sediments.	Narrative	–					N6						–	–	–	0
E-16	Response of microorganisms to normal environmental stresses.	To obtain the range of variation in microbial activity in order to provide a basis for evaluating the effect of hydrocarbon contamination.	1. Microbial activity and respiration ratios.	Narrative	–					S1		S2				–	–	–	0
			2. Nitrogen fixation rates in: . Sediment . Animal guts		–					S1		S2				–	–	–	0
E-17	Relationship of ice movements and types to distributions and abundance of various living resources.	To identify critical habitats and determine the likelihood of impingement based on transport data and probable sources.	Species abundance and distributions relative to: . Ice characteristics . Ice movements.	Narrative	248											S2	S2	–	2
					232											S2	S2	S2	1
					196											S2	S2	S2	1
					230											S2	S2	S2	1
					231											S2	–	–	2
					426											S2	S2	–	2
					427											S2	S2	–	2
					067											S2	S2	–	2
					241											S2	–	–	2

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
F-1	Review of available literature and data on toxicity of crude oils as related to species, life stage and source of oil.	To provide a basis of information on which to set priorities for research exploring the effects of oil development of the Alaskan OCS.	Summary of available information on effects of oil on Alaskan marine organisms and ecosystems.	Narrative	075											N6			2
F-2	Acute and chronic effects of crude oil and other petroleum associated chemicals on selected organisms.	To provide a basis for assessment of the potential impact of oil development of the Alaskan OCS to the shelf areas and adjacent shorelines	1. Toxicity of oil to:																
			. marine mammals	Narrative	071											N6			1
			. marine birds													N0			0
			. fish	Narrative	072											N6			1
			. plankton																
			. benthos	Narrative	454											N6			1
			. bacteria																
			2. Sublethal effects on:																
			. marine mammals	Narrative	071											N6			1
			. marine birds	Narrative	423											N6			1
			. fish	Narrative	073											N6			1
			. plankton		-											N0			0
			. benthos	Narrative	454											N6			1
			. bacteria																

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
F-3	Effects of petroleum contaminants on metabolic and reproductive functions	To evaluate the potential for a petroleum contaminant to alter the stability of a population by affecting a key metabolic process in a way which increases the possibility of the organisms death before it reproduces.	1. Evaluation of effects of crude oil on carbon and nitrogen fixation in:																
			. sediments	Narrative	190											N6			1
			. guts of animals	Narrative	190											N0			0
			2. Evaluation of effects of crude oil on hatching success of bird eggs.	Narrative	096											St6			2
					243											St6			1
			3. Evaluation of effects of crude oil on thermoregulation of marine mammals	Narrative	071											N6			1
F-4	Characterization of release of toxic metals from oil impacted sediments and relative importance of metals uptake and effects on biota	To evaluate negative effects of metals associated with OCS activities on biota, to assist in siting stipulations for development.	1. Uptake/depuration of metals in benthic organisms.													N6			0
			2. Metabolic an other sublethal effects in benthos.	Narrative	454											N6			1
F-5	Bioaccumulation and effects of hydrocarbons, and other contaminants through various exposure pathways.	To determine areas of greatest sensitivity in marine organisms.	1. Evaluate accumulation of hydrocarbons through experimental food chains.	Narrative	073											N6			1
					275											N0	N6		1
					389											N6			4
			2. Evaluate accumulation through sediment-sorbed contaminants.	Narrative	454											N6			1

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
F-6	Characterization of responses of selected organisms and ecosystems to perturbations induced by contaminants or disturbances associated with OCS activities.	To identify ecosystems or organisms that are potentially susceptible to adverse impact from OCS activities.	1. Characterization of perturbations due to OCS activities on selected organisms and activities.	Narrative	072 073 275														1 1 1
			2. Recovery rate of selected communities in terms of:																
			. composition and density	Narrative	029											N2			1
			. productivity																
F-7	Types and incidences of diseases present in marine organisms.	Development of a baseline of information with which to evaluate future mortality and/or morbidity relative to OCS activities. Identify species highly susceptible to impact from OCS activities.	1. Incidence of pathological conditions in:																
			. marine mammals	Narrative	194											NO			1
			. marine birds		–											NO			3
			. marine fish	Narrative	332											NO	N1		3
			2. Identifications of pathological agents and causes in:																
			. marine mammals	Narrative	194											NO	N6		1
			. marine birds		–											NO			3
			. marine fish	Narrative	332											NO	N6		3
			3. Incidence of mortality or morbidity in natural populations of:																
			. marine mammals	Narrative	194 341													N1 N1	1 2
			. marine birds																

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
						Required										Projected			
Task	Product	Intended Use	Specific Product	Format	R.U.	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
			4. Effect of oil on disease susceptibility in:																
			. marine mammals	Narrative	071											N6			1
			. marine birds	Narrative	096											N6			4
			. marine fish	Narrative	073											N6			1
F-8	Ecological effects of oil spill countermeasures.	To provide data to be used in determining preferred countermeasures to oil spill.	1. Toxicity of dispersants to:																
			. marine birds	Narrative	072											N0		N6	0
			. marine fish		-											N0			-
			. marine mammals		-											N0			0
			2. Sublethal effects of dispersants in:																
			. marine fish	Narrative	073											N0	N6		1
			. marine birds		-											N0			0
			. marine mammals		-											N0			0
F-9	Characterization of structure and crit function of select- coastal ecosystems with respect to potential impacts of OCS development.	Identification of cal links in the food web relative to fish, benthos, birds, and mammals.	Descriptions of:		-											N1			0
			. seasonal community structure	Narrative	077			S2				S3				S2	S2	S2	1
			. trophic relations of key species																
			in various habitats at selected study sites.																

342

77-969

DATA PRODUCTS						Resolution Schedule for OCS Studies by Fiscal Year													Status
Task	Product	Intended Use	Specific Product	Format	R.U.	Required										Projected			
						-4	-3	-2	-1	0	+1	+2	+3	+4	+5	77	78	79	
F-1(	Characterization of structure and function of ice front ecosystem with respect to potential impacts of OCS development	Identification of critical links in the food web relative to fish benthos birds and mammals.	Descriptions of: . community structure . trophic relations of key species . primary and secondary production in the vicinity of the ice front.						See	Task	E-1					–	–	–	–
F-11	Descriptions of coastal detritus systems with respect to OCS development.	Identification of critical links in the food web relative to fish, benthos, birds and mammals.	1. Definition of seasonal composition and origin of organic detrital materials. 2. Role of detritus in ecosystem energetics.													NO			0

3.0 NON-SITE SPECIFIC PROGRAM

The studies included in this TDP focus generally on various aspects of the fate and effects of OCS-related contaminants or disturbances on Alaskan marine ecosystems. Also included is the development of Alaskan-wide summary accounts of the distribution, movements, habitat dependencies and OCS-related vulnerabilities for selected fauna, particularly birds and coral. It is expected that these studies will have applications to several or all of the OCS lease areas described in the companion TDP's for FY 79; hence they are designated as non-site-specific.

3.1 GENERAL SCOPE OF PROGRAM AND STATUS OF KNOWLEDGE

An in-depth review of current information on the biological effects of petroleum and toxic metals in arctic and subarctic marine environments was conducted for OCSEAP in FY 1976 (Malins, 1976), and a portion of this extensive report was published by Academic Press (Malins, 1977). In addition, several recent symposia have addressed the problems of fates and effects of petroleum hydrocarbons in marine systems, and these Proceedings are now appearing in print (AIBS 1976, 1978, Vander Meulen, 1978, Wolfe, 1977, API 1977). In view of this very extensive and recent literature base, no attempt is made here to review in any detail the current status of information on this topic. Furthermore, since the information base on fate and effects is so extensive and diverse, and is still expanding almost explosively, it is very difficult to project the content of a complete or even optimal program over the next few years. Two very real and important facts contribute to this situation: 1) although significant headway has begun in understanding the effects of contaminant exposure on important life processes of individual organisms, and it is now possible to predict with some degree of certainty the effect of the contaminant on the exposed individual, the understanding of biological and ecological interactions on the levels of populations and ecosystems is still so fragmented that the significance of those same low-level effects on whole systems cannot be interpreted realistically; and

2) the utility of effects information to environmental decision-makers still relies heavily on sometimes intuitive relationships, which have never been quantified from a systems view, and on the precedented use of pragmatic application factors (NAS 1972, EPA 1976), which have no basis in terms of actual mechanisms of action. It is in this rather poorly defined context that several funding agencies have staged numerous and diverse studies on fate and effects of contaminants. The difficulties of planning a complete and final applied research and development program are insurmountable in a rapidly evolving research field for which environmental decision-makers have high expectations but only poorly defined mechanisms to apply the results.

Despite these difficulties, however, OCSEAP has identified numerous tasks that represent obvious information gaps in the area of contaminant fates and effects as they specifically apply to Alaskan OCS development. These tasks, identified in the OCSEAP PDP, must be addressed generally through a program of laboratory and field experimentation, not specific to any particular lease area but with broad applicability to several Alaskan OCS areas. Those tasks and subtasks that fall into the non-site-specific, fate and effects category are listed and discussed in Section 3.4 of this TDP. Two major tasks, D and F, are represented there with several subtasks. The research units proposed to address these subtasks are described in Section 4. Recent progress of those Research Units to be continued in FY 1979 is described very briefly under the individual RU descriptions. Complete reports of research status and results are contained in the Annual Reports of the Principal Investigators (NOAA 1976, 1977).

In general, the emphasis of OCSEAP's research units under Tasks D and F is consistent with the recommendation made during a Panel Discussion at the recent NOAA-EPA Symposium on Fate and Effects of Petroleum Hydrocarbons in Marine Organisms and Ecosystems (Wolfe 1977a). These recommendations were summarized at a recent EPA Project Review (Wolfe, 1977b):

1. Acute Toxicity Bioassays should generally be de-emphasized in favor of longer-term exposures and sublethal effects. Earlier

static bioassays should be repeated using flow-through systems to improve estimates of relative species sensitivities. Additional species or life stages suspected to be highly sensitive should be tested. Larval and juvenile stages still appear to be the best candidates for research animals in effects studies. Petroleum effects on birds should be assessed under realistic exposure conditions (both long-term and short-term). All bioassay experiments, whether acute or chronic, should use realistic dosetime exposure regimes (based on concentrations and compositions likely to occur in natural systems) to assess potential effects. Uptake and turnover of compounds should be documented by thorough chemical analysis of tissues, and subsequent experimental and analytical emphasis should be on those specific compounds actually accumulated by the exposed organisms (instead of on some measure of total hydrocarbons present in the exposure medium).

2. Long-term effects will very likely manifest themselves as subtle behavioral or pathological changes from contaminant exposure, possibly not readily detectable at the population level. Attention should therefore be directed at documenting in the laboratory the effects of contaminant exposure on physiological, biochemical, pathological and behavioral parameters which might logically be expected to exert population effects (even though such effects will probably not be detectable in natural populations). Parameters to be studied should include the following, some of which (a, c, f) have additional potential as indicator or monitoring tools.
    a) behavior (feeding, reproductive, migrational)
    b) carcinogenicity
    c) cellular ultrastructure
    d) chemosensory mechanisms
    e) disease incidence and susceptibility

    f) enzyme activities
    g) growth
    h) immune responses
    i) mutagenicity
    j) reproduction

3. Effects of petroleum components other than hydrocarbons should be examined, as should intermediary metabolites of hydrocarbons. The relative toxic effects of various petroleum constituents should be assessed. Past emphasis has been on hydrocarbons *per se* mainly because of the relative ease of analysis and not because they are the known direct causative agents in manifesting the effects.
4. Potential transfer through food webs should be examined for hydrocarbon metabolites and nonhydrocarbon components of petroleum. Persistence of metabolites in organisms is a corollary problem that could be examined through the use of radiotracers.
5. Various physical and chemical forms of contaminants, including chemically complexed forms, should be tested for relative bioavailability, metabolism, and toxicity to marine organisms. For example, soluble versus dispersed hydrocarbons, ionic versus organically complexed metals, and free versus protein-bound hydrocarbons, might be examined. The natural occurrence and rates of formation of such complexes should be determined in marine systems.
6. Petroleum sediment interactions should be characterized, and the transfer of sediment-associated petroleum constituents to organisms should be quantified.
7. Synergisms among different types of contaminants and among contaminants and physical parameters (e.g., temperature and salinity) should be examined.
8. Field studies should be designed and conducted to corroborate laboratory results. Such studies might involve in-

tentional perturbation under controlled conditions, long-term studies of oil spills, ecological and physiological studies of chronically-polluted areas and areas of natural seeps. Field experiments require very careful and thorough planning to ensure that causality of effects will be documented, and that sampling frequency and intensity are adequate to demonstrate statistically the expected level of effect.

9. Models of contaminant cycling in the environment should be refined to include the kinetics of physical and biological transport processes (solution, evaporation, adsorption, bioaccumulation, etc.) and chemical and biological modification processes (photooxidation, biodegradation, etc.). Compositional changes in petroleum should be determined and should serve as a basis for experimental design in effects studies.

The foregoing suggestions and recommendations clearly do not represent an exhaustive list of all imaginable research topics that will be of value to researchers and environmental decision-makers over the next several years. Instead, they represent the current thinking of a few highly perceptive scientists who have been heavily involved in research or research management in this topical area for several years. At the time these suggested research areas and recommended approaches were formulated, no attempt was made to prioritize the research. These recommendations, however, are being considered at least annually by OCSEAP in planning and evaluating future research directions in Fates and Effects. Research needs are continually reassessed, and detailed plans and proposals are scrutinized in the context of work already underway at the time and in terms of the availability, competency, and operational readiness of investigators to perform the work. The following section of this TDP presents the non-site-specific research proposed for FY 1979, and establishes the general program context for each project.

3.2 PROGRAM EMPHASIS AND DIRECTION FOR FY 1979

3.2.1 Chemical Intercalibration

The Quality Assurance Program for Hydrocarbon Analysis (RU 557) is coordinated with the ongoing analytical efforts both of field chemists and of experimentalists to ensure that analytical results from different investigators, at different times and places can be readily compared and interpreted. This research unit will prepare and distribute interim reference materials, which will be analyzed by numerous investigators to provide a basis for intercomparison of analytical results. It is expected that the intercalibration effort will continue for as long as petroleum hydrocarbon analyses are performed in any aspect of the program.

3.2.2 Petroleum Transport and Weathering

Most of OCSEAP's effort on petroleum transport is described in the lease area TDP's, and consists of area-specific studies of oceanic circulation or ice movement. These studies will produce ocean current fields which, in conjunction with data on regional or local wind fields, will be used to predict potential directions and rates of transport of oil for each of the lease area trajectories. Also needed, however, are generic studies or rates of oil solubilization, evaporation, biodegradation, photooxidation and adsorption onto suspended particulate. Such data are required to estimate the ultimate concentrations and compositions of oil to which organisms will be exposed at different distances downstream in the trajectory. These processes were the subject of a literature analysis in FY's 77 and 78 (RU 499). In addition, the NOAA SOR Team visited several spills of opportunity in FY 77 to obtain physical data on oil behavior under various spill conditions. Based on the outputs of these past efforts, a major project (P 035) will be implemented in FY 79 to examine and quantify the various processes important in the weathering of crude petroleum in the marine environment. The study will be conducted primarily in the field, but will involve controlled laboratory studies where necessary.

Laboratory and field studies on weathering of Prudhoe Bay and Cook Inlet crude oils will be undertaken to determine the composition and concentrations of petroleum that remain at various times after its introduction into the marine environment. Such studies will be conducted for different temperature, salinity and wave regimes on open water and also for oil stranded in intertidal zones. This information is required to determine realistic estimates of petroleum exposure likely to be encountered by marine organisms, and to improve models of transport of spilled petroleum in the ocean. The outputs of RU 499 during FY 77 and FY 78 will serve to guide the proper formulation of weathering experiments so the results will be most useful to trajectory modeling and effects research.

Additional information on weathering of petroleum in marine systems will be derived from field perturbation experiments (P 911), which will be designed to validate the results of laboratory observations under realistic field conditions. Results of both P 035 and P 911 will be used to define the exposure concentrations, compositions, pathways, and durations to which organisms will be subjected in the environment. Unfortunately, a fundamental dilemma exists in the design of such studies. A relatively large amount of information is currently available on the concentrations and persistence of normal alkanes and low-molecular-weight aromatics in marine systems, and the effects of these transient compounds are fairly well documented. The remaining areas of greatest concern are the high-molecular-weight aromatics and the heterocyclic compounds, which occur in small concentrations and are characterized rather poorly both in the petroleum and in the environment. Yet these compounds may persist in the environment for long periods where they are likely to accumulate in long-lived organisms and exert pathological effects. Understanding these relationships will require coordination of results for: 1) long-term field observations after accidental spills, 2) weathering and effects studies under field conditions, and 3) laboratory effects studies using artifically high concentrations of selected compounds to document that these compound are in fact causative agents in sublethal effects.

3.2.3 Effects of Petroleum on Marine Fish and Invertebrates

Very little information was available prior to 1976 on the sensitivities of Alaskan marine organisms to petroleum exposure. Early acute toxicity studies were conducted at the NMFS/Auke Bay Laboratory (Rice et al. 1976a) under the support of the petroleum industry. The first year's support of the expanded OCSEA Program extended these acute toxicity measurements to several additional species (Rice et al. 1976b), and also broadened the studies to include a variety of sublethal effects on several species (Malins et al. 1976, DeVries 1977, Caldwell et al. 1977, Kooyman 1977). A few of these studies were continued through FY 77 and 78, or started in FY 77, and are proposed for continuation into FY 79 (RUs 72, 73, 454, and 500).

These studies are directed at identification of the deleterious effects of specific petroleum constituents on marine organisms and at quantification of the exposure levels and durations of time under which the effects can be expected to occur. After such effects are quantified, the observations will also be tested under field conditions to determine the probability that the threshold exposure regimes would occur under actual spill circumstances. Three distinct approaches are used to determine what petroleum constituents are most toxic: 1) organisms are exposed to whole crude petroleum as it may be fractionated under environmental conditions, i.e. water-soluble fraction, sediment-sorbed fraction, etc. (RU 72, 73, 454); 2) organisms are exposed to mixtures of pure, commercially available hydrocarbons (RU 72, 73); and 3) organisms are exposed to chemically-separated subfractions of whole crude petroleum (RU 454, 500). The outputs of these multiple efforts address three specific needs of decision-makers in the processes of leasing and development on the Outer Continental Shelf: 1) Threshold concentrations for deleterious effects (both acute toxicity and sublethal chronic effects) to serve as the basis for discharge stipulations; 2) Identification of most toxic fractions of petroleum to guide the design of analytical monitoring programs for environmental quality; and 3) Certain sublethal biological responses, such as changes in cellular ultrastructure or enzymatic activities, valuable as early warning indicators of low-level petroleum contamination or as monitoring parameters for prior petroleum exposure. In addition to these three benefits, insight is gained as to which food species affecting fish, birds, and mammals in food webs are potentially most sensitive to petroleum exposure. Studies on metabolism and accumulation and turnover kinetics indicate whether specific compounds are likely to accumulate in upper trophic levels of the food web and therefore pose a threat to human health. It is visualized that this general effort will continue for the duration of the OCSEA Program. The program trends for FY 79 are discussed below and under the specific project descriptions in Section 4.0.

Acute toxicity measurements will be de-emphasized further in FY 79 and will continue to use flow-through bioassay techniques instead of static bioassays. This approach provides for much better control of exposure concentrations and improved estimates of the relative sensitivities of different species or life stages. In addition, longer exposures at lower concentrations are possible, allowing better extrapolation to conditions of chronic exposure. Exposure protocols will be expanded to include selected chemical dispersants in addition to petroleum, since the use of dispersants may be considered in Alaskan spill situations to alleviate effects of spilled oil on birds. It has been recommended (McAuliffe 1977) that chemical dispersants offer the best available means of avoiding serious impacts of spilled oil on birds, both in open water and in the intertidal zone. It is therefore important to extend present studies of crude oil toxicity to include the effects of oil in combination with various dispersants, to assess the potential use of this spill countermeasure on marine organisms.

Particularly sensitive species or life stages, indicated previously by acute static bioassays, will be retested and confirmed in flow-through systems. Previously untested species and life stages will also be tested. Emphasis will continue on species found to be significant components of food webs leading to commercially and esthetically important organisms. Increased emphasis will also be placed on arctic organisms which have not yet been examined to any great degree. Joint bioassay studies will be conducted at NARL (P 320) and at NMFS Auke Bay Lab (RU 72) to ascertain the sensitivities of selected arctic species to petroleum exposure.

Sublethal effects research will build upon the program initiated at NWAFC (Malins, RU 73). In FY 79 this program will continue to examine the accumulation, biotransformations and effects of petroleum hydrocarbons and their metabolites, and nonhydrocarbon components of petroleum. This emphasis is facilitated by the NOAA National Analytical Facility, now operable within the NWAFC Environmental Conservation Division. This program will emphasize biochemical, morphological, histopathological and behavioral indices of the effects of petroleum exposure on a few selected species of fish and shellfish. In FY 79 this research unit will continue experiments to test the effects of petroleum exposure on disease susceptibility. Pathogenic organisms, previously identified and isolated from wild Alaskan populations, are presented to healthy experimental animals with and without simultaneous petroleum exposure. Effects of petroleum will thus be examined on this subtle, but potentially significant, sublethal aspect.

As the sublethal effects of petroleum exposure are characterized, they are evaluated for their utility as monitoring parameters (or biological indicators) for petroleum in the marine environment. That is, an unusually elevated level of a certain enzyme, a particular histopathologic condition or an anomalous behavioral pattern may serve as a specific measure of prior petroleum exposure in wild populations.

The fractional toxicities of crude oil components (RUs 500 and 454) must be analyzed to determine which compounds and compound classes of Alaskan petroleum are major contributors to petroleum toxicity. These would be major candidates for future detailed effects studies and for petroleum composition studies because of the lack of focus on a few compounds or compound classes. OCS hydrocarbon reference efforts are striving presently for complete compositional analysis on a quantitative basis, a goal that is difficult, expensive, and probably unnecessary for environmental assessment and monitoring purposes. Also, the non-hydrocarbon components of petroleum are presently overlooked analytically. To alleviate these problems, Alaskan crude petroleum is being fractionated chemically into various compound classes (RU 500), which will be tested individually for biological sensitivity. Initial screening in FY 78 was by a microbial mutagenesis assay, but testing in FY 79 will be exclusively with marine organisms (RU 454). The compound classes found most reactive biologically will be further fractionated and retested to determine the specific compounds that should be emphasized by future analytical methodology.

3.2.4 Effects of Petroleum and OCS Developmenton Marine Mammals and Birds

Research on the direct effects of petroleum exposure on marine mammals is severely restricted by the protective regulations of the Marine Mammal Act. Under permits issued by the Marine Mammal Commission, it is difficult to use sufficient numbers of experimental animals for statistically reliable results. Furthermore, it is very unpopular to subject experimental animals to any stress which may result in death of the animals. From FY 76 through FY 78, OCSEAP supported limited research on the metabolic and behavioral effects of oil fouling in fur seals and sea otters (RU 71). This research determined the increased losses of body heat that might be expected for various species of pinnipeds (Kooyman et al. 1977), and the resulting increased levels of metabolism. No further research along this line is anticipated, and in FY 79 RU 71 will complete a final report on studies to date. Two important remaining questions regarding potential oil effects on sea otters are 1) whether or not the otters are able to detect and avoid floating oil, either at the edge or from the bottom of a slick and 2) whether or not the oiling of an otter's fur (without subsequent removal of the oil) will lead to death. Results to date on these questions are inconclusive and OCSEAP will explore whether an adequate experiment could be implemented in FY 79 or succeeding years.

In FY's 77 and 78, OCSEAP funded research on the effects of direct egg oiling on hatchability and chick survival. This field effort (RU 96) complemented studies conducted by the USFWS at Patuxent Wildlife Research Center with similar results. External doses in the range of 510μℓ of Alaskan crude oil caused 50% mortality in developing embryos and chicks for a variety of species, including eiders and gulls. It is proposed to extend this work in FY 79 to include the effects of dispersants which are proposed as one means of mitigating oil effects in birds. If funds are available in FY 79, P 040 will examine effects of oil-dispersant mixtures on egg hatchability and on physiology of surviving chicks.

Acute dietary exposures of petroleum were examined in FY's 77 and 78 for effects on egglaying and hatchability in gulls and auklets (RU 423), with no detectable deleterious effects. The test birds either regurgitated or passed the petroleum doses very effectively. This work will be completed in FY 79 after limited field work in Alaska on additional species.

In addition to direct effects of petroleum on birds, OCS development will have secondary impacts on bird populations. Some examples are habitat disruptions by low-flying aircraft over colonies or by the mere presence of humans, changes in food availability as a result of shoreline changes or waste management, and changes in natural predation between species as a result of predator removal from or introduction into a developing area. In FY 79 OCSEAP proposes to design and conduct specific perturbation experiments (P 915 and P 924) to test the significance of these secondary effects.

Considerable attention and interest have recently been directed towards the concept of frightening waterbirds from oil spill areas to prevent wholesale contamination. This interest results from the facts that (1) oil spills have historically caused extensive mortality to marine birds, (2) impacts to waterbirds will continue due to future spills, (3) methods of oiled bird rehabilitation are not adequate or effective and (4) waterbird deterrent systems for oil spills appear promising but are generally still undeveloped. OCSEAP will implement a study (P 917) in FY 79 to address the above concerns with the following objectives:

1. Quantitatively evaluate the spatial and temporal effectiveness of various avian deterrent and dispersal devices and systems in repelling waterbirds from several types of coastal habitats.
2. Prepare waterbird deterrent and dispersal system plans that could be used during oil spill situations for various coastal habitat types.

3.2.5 Effects of Drilling Chemicals and Cuttings

Acute toxicity and sublethal effects of exposure of Alaskan organisms to drilling chemicals was proposed for study in FY 78. Recent studies by EPA (Richards 1977) suggested that drilling mud components may be ingested by filter-feeding and scavenging organisms, with possible adverse effects greater than previously believed. Recent *in situ* bioassay studies sponsored by Union Oil Company and ARCO, however, suggest that actual concentrations of suspended drill cuttings and drilling chemicals found at rig locations are well below those that cause acute mortalities in a variety of organisms. Furthermore, the observed concentrations were very transient, reducing even further the likelihood of significant effects. In view of these observations, OCSEAP does not propose to implement P 318 in FY 79.

3.3 SYNTHESIS OF EXISTING INFORMATION RELATING TO POTENTIAL OCS IMPACTS OF SELECTED ORGANISMS

Under OCSEAP and other sources of support, a large mass of information has been developed on the distribution and abundance, migratory routes, and habitat requirements of various species potentially vulnerable to impacts from OCS development. This information is available in principal investigators' reports and the open scientific literature and is oriented toward studies at particular colonies or in particular lease areas. In order to assess the vulnerability of a particular species to impact from OCS development, it is necessary to synthesize the available data from phases of the life history of the species to determine the relationships between subpopulations and the importance of Alaskan OCS areas to the overall continuity of the species. This analysis is particularly important for wide-ranging species, such as birds and fishes, especially if the species is subjected to significant stresses from other sources or in other geographic regions (e.g., commercial explotation of fish, hunting or egging pressure on some birds). All available information on Alaskan populations of selected species of birds and marine mammals (P 916) and fishes (P 920) will be assembled and analyzed to determine the OCS-related sensitivities peculiar to those species and any gaps that must be filled to obtain a good understanding of probable OCS impacts on the species. In addition, accounts of past OCS developments will be thoroughly analyzed as a basis for prioritizing information needs for environmental assessment of impacts resulting from Alaskan OCS development (P 921). A special example of a potential OCS-related effect is the population explosion of gulls which has accompanied increased human population densities on the U.S. Atlantic and European coasts. These past changes will be reviewed and specific experimental approaches developed for evaluating the potential for such a transition in Alaska (P 915). Finally, in response to a developing fishery for coral in Alaskan waters, a review of coral distribution and OCS vulnerability will be undertaken as a basis for design of future work (P 922).

REFERENCES

American Institute of Biological Sciences (AIBS) (1976). Sources, Effects and Sinks of Hydrocarbons in the Aquatic Environment, Proceedings of the Symposium, American University, 9-11 August 1976, Washington, D.C. 578 pp.

American Institute of Biological Sciences (AIBS) 1978. Assessment of Ecological Impacts of Oil Spills. Proceedings of the Symposium, 14-17 June 1978, Keystone, Colorado. In press.

American Petroleum Institute (API) (1977). The 1977 Oil Spill Conference (Prevention, Behavior, Control, Cleanup), 8-10 March 1977, New Orleans.

Caldwell, R.S., E.M. Caldarone, and M.H. Mallon (1977). Effects of a sea-water-soluble fraction of Cook Inlet crude oil and its major aromatic components on larval stages of the dungeness crab, Cancer magister Dana, In Fate and Effects of Petroleum Hydrocarbons in Marine Ecosystems and Organisms, D.A. Wolfe (ed.), Pergamon Press, N. Y. pp. 210-220

DeVries, A.L. 1977. The effect of naphthalene on survival and protein synthesis in Bering Sea fishes. Personal communication.

Environmental Protection Agency (1976). Quality Criteria for Water XIV + 256 pp. Washington, D.C.

Kooyman, G.L., R.W. Davis, and M.A. Castellini (1977). Thermal conductance of immersed pinniped and sea otter pelts before and after oiling with Prudhoe Bay crude. In Fate and Effects of Petroleum Hydrocarbons in Marine Ecosystems and Organisms, D.A. Wolfe (ed.), Pergamon Press, N.Y. pp. 151-157

Malins, D.C. et al. (1976). Sublethal effects as reflected by Morphological, Chemical, Physiological and Behavioral Indices, and Identification of Major Processes in Biotransformations of Petroleum Hydrocarbons and Trace Metals, In Environmental Assessment of the Alaskan Continental Shelf, Principal Investigators' Reports for the year ending March 1976, Volume 8, Effects, NOAA Environmental Research Laboratories, Boulder, CO. pp.119-154

Malins, D.C. (Ed.) (1977). Effects of Petroleum on Arctic and Subarctic Marine Environments and Organisms. Volume 1. Nature and Fate of Petroleum; Volume 2. Biological Effects; Academic Press, New York.

McAuliffe, C.D. (1977). Dispersal and alteration of oil discharged on a water surface. In Fate and Effects of Petroleum Hydrocarbons in Marine Ecosystem and Organisms, D.A. Wolfe (ed.), Pergamon Press, N.Y. pp. 19-35.

National Academy of Sciences (NAS) (1973). Water Quality Criteria 1972, a report of the Committee on Water Quality Criteria, National Academy of Sciences EAP-R3-73-033 Washington, D.C.

National Oceanic and Atmospheric Administration (1976). Environmental Assessment of the Alaskan Continental Shelf, Principal Investigators' Reports for the Year Ending March 1976. Volume 8, Effects of Contaminants. 389 pp.

National Oceanic and Atmospheric Administration (1977). Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the year ending March 1977. Volume 12, Effects. 822 pp.

Rice, S.D. et al. (1976). Acute toxicity and uptake-depuration studies with Cook Inlet crude oil, Prudhoe Bay crude oil, No. 2 fuel oil and several subarctic marine organisms, N.M.F.S. Northwest Fisheries Center Processed Report, May 1976. 90 pp.

Rice, S.D., J.W. Short, and J.F. Karinen (1976). Toxicity of Cook Inlet crude oil and No. 2 fuel oil to several Alaskan marine fishes and invertebrates. pp. 394-406. In AIBS "Sources, Effects and Sinks of Hydrocarbons in the Aquatic Environment", Washington, D.C. pp. 161-173.

Richards, N. (1977). The effects of drilling mud components on marine organisms. In Program Review Proceedings: Environmental Effects of Energy Related Activities on Marine/Estuarine Ecosystems; Environmental Protection Agency, EPA-600/7-77-111, OEMI-77-025. pp. 161-173

Vandermeulen, J.H. (1978). Recovery Potential of Oiled Marine Northern Environments, Proceedings of a Symposium of 10-14 October 1977, Halifax, Nova Scotia. J. Fisheries Res. Bd. Canada Spec. Publ. (In Press).

Wolfe, D.A. (Ed.) (1977). Fate and Effects of Petroleum Hydrocarbons on Marine Ecosystems and Organisms, Proceedings of a Symposium, 10-12 November 1976, Seattle, Wash. Pergamon Press, New York, 472 pp.

Wolfe, D.A. 1977. Fate and effects of contaminants in marine ecosystems and organisms, In Program Review Proceedings: Environmental Effects of Energy Related Activities on Marine/Estuarine Ecosystems. Environmental Protection Agency EPA600/777111, OEMI77025. pp. 93-105

3.4 TASKS AND SUBTASKS ADDRESSED BY TDP

Of the six major tasks outlined in the OCSEAP PDP, non-site-specific studies primarily address two. These are Task D, movement and alteration of contaminant discharges, and Task F, effects of contaminant discharges. In addition, one research unit is directed toward the analytical quality assurance in OCSEAP's hydrocarbon analytical program. Thus, the non-site-specific studies focus almost exclusively on various aspects of the fate and effects of petroleum and associated contaminants or disturbances in the marine environment. However, not all of the subtasks under Tasks D and F fall into the category of this TDP; many aspects of fate and effects studies will be conducted on a site-specific basis by OCS lease area. These subtasks and the Research Units designed to address them are described in the TDPs for the appropriate lease area. Primary examples of such site-specific studies are mesoscale and inshore oceanographic circulation, and ice transport studies. The following discussion of OCSEAP tasks is restricted to those relevant to the non-site-specific program, and provides only a brief overview. For a more thorough discussion of the overall scope of the OCSEAP tasks, see the Program Development Plan (PDP). The following tasks and subtasks are those categorized generally as Fate and Effects objectives to be addressed by non-site-specific studies. The Research Units proposed to address these Tasks are outlined and described in Section 4.0.

3.4.1 Task A

The distribution of potential petroleum-related contaminants will be described before development of petroleum resources on the OCS; thus later changes, if any, in concentration or occurrence of a contaminant can be detected and examined for possible correlation with stages of development and with concurrent ecological changes. Four types of chemical compounds have been selected for measurement: light hydrocarbons (C_1-C_4), high-molecular-weight petroleum hydrocarbons, selected metals, and inorganic nutrients. Inorganic nutrients are included for correlation with associated biological measurements, particularly microbiological studies.

During environmental reconnaissance phases the Alaskan research program emphasized the high-molecular-weight petroleum hydrocarbons and metals in each lease area. Before OCS development subtask A-1 will be addressed in all lease areas to document the natural occurrence and concentrations of selected hydrocarbons in marine environmental samples. These analyses will form the basis for assessing distribution and transport of introduced contaminants and for subsequent identification of changes in hydrocarbon concentrations. Most of the effort toward this subtask was lease-area specific, and was described in the appropriate TDP. However, many analysts are involved in the overall program, and the results of analyses in the chemical reconnaissance program must be comparable to results obtained in laboratory and field effects research. Also, the current state-of-the-art in hydrocarbon analysis is rapidly changing. It is, therefore, necessary that the overall program be accompanied by an extensive analytical intercalibration effort to ensure comparability of results from hydrocarbon analyses in various aspects of the program. Coordination of analytical intercalibration will continue in FY 79 under RU 557.

3.4.2 Task D

Petroleum or other contaminants introduced into the environment are transported in the atmosphere, water column and sea ice acting as an intercoupled system. Winds will disperse and transport pollutants reaching the atmosphere. Currents can transport contaminants over great distances, while simultaneously diffusion, dispersion and turbulence processes result in changes in concentration and exposure. Various constituents in the water mass, including suspended sediments, floating ice and free-floating biological elements, such as phytoplankton and zooplankton, tend to collect contaminants. Suspended sediment may remove contaminants as it settles out of the water. During the transport process, oil and other contaminants undergo continual physical and chemical changes brought about by such processes as evaporation, flocculation, emulsification, weathering, biodegradation, and chemical decomposition. Spills occurring on or adjacent to sea ice can be entrained, transported, and forced by the ice edge to concentrate in narrow open leads of water.

The general goal of the transport program is to quantify the paths that OCS contaminants will follow, and the extent and character of the exposure of contaminants to biota along and at the ends of the transport. The approach is to model the water mass, surface wind and oil trajectories using observations from past studies and the ongoing program. Then models such as those of spreading, downward mixing, removal by suspended sediments, evaporation, weathering, emulsification, diffusion, chemical change, and biodegradation, will be superimposed on the trajectories in order to arrive at predictions of the extent and nature of exposure to the biota along the trajectories. Subtask D-3 is composed of the following elements:

a. Oil slick dynamics

Oil slick dynamics studies will be both observational and theoretical. Detailed observational data on oil slicks at sea are needed to evaluate existing models and upgrade the formulations and parameterizations used in trajectory calculations. In addition, observations will provide new data for upgrading model design to include more accurate descriptions of physical processes. Initially, spills of opportunity will be observed, followed by controlled planned oil spill field tests. Controlled spills will be conducted only after adequate planning and coordination with cognizant groups. Theoretical studies will answer many remaining questions as to how an oil slick interacts with various flows in the marine environment. These studies, to be carried out early in the program, will provide valuable insights into how wave fields, mixed layer depth, and upper layer circulation affect oil spreading. This knowledge will make improvement of the models for prediction possible. In FY 78, the Spilled Oil Research (SOR) Teams derived detailed observational data on behavior of selected oil slicks at sea under RU 555. This work will continue in FY 79 under direct NOAA support and so no longer is part of this TDP.

b. Weathering Studies

Field studies with either spills of opportunity or planned oil spills should document the changes due to volatilization, solubility, emulsification, adsorption onto suspended particulates, microbial biodegradation, and photoxidation of petroleum components. The chemical composition of contaminants remaining in the slick and those present in the water column below the slick should be determined. These measurements will be particularly valuable in assessing the persistence of various compounds or compound classes, as well as bulk petroleum, both in trajectory analysis of moving slicks and in petroleum residence time after landfall. However, such studies may have only limited utility for evaluating the potential long-term persistence and effects of trace high-molecular-weight constituents. Problems of mass balance and logistics (i.e., not being able to use enough material and continue the observations long enough) may prevent documentation of the distributions, compositions and concentrations meaningful for a chronic input situation or for the aftermath of a large accidental spill. Laboratory studies will also be useful in identifying these changes, and the results will be used as input to design experiments on effects of relative toxicities of petroleum in different stages of weathering. Laboratory and field studies will be undertaken in FY 79 under P 035.

c. Modeling

The modeling program will develop two models to support other studies and improve basic predictive ability. The fundamental distribution model, for use in trajectory analysis as well as suspended sediment studies, is a set of algorithms incorporating advective and diffusive formulations with source/sink and use terms. This general model will be developed as an operational tool early in the program so that it can be used as interactive feedback with all physical oceanography observational and modeling components studies. A pollutant dynamics model, simulating the physical behavior of pollutants, including weathering, will be developed in coordination with the theoretical and observational studies. As these model components are developed and verified, they will be incorporated into improved versions of the distribution model. In FY 78, RU 499 completed an evaluation of various weathering processes as they may be incorporated into the overall pollutant dynamics model. Additional inputs in FY 79 will be derived from P 035 and P 911.

Subtask D-6

Understanding sediment source, transport, and fate is important because contaminants (e.g., hydrocarbons, toxic elements) attached to suspended sediment particles are transported by the sediment, and because contaminants (e.g., petroleum and drilling mud) that are added can affect the properties of existing sediment particles. It is particularly important to understand the interactions of contaminants with suspended and bottom sediments, and the potential bioavailability from these sources, which are parts of subtask D-6 (see also subtask F-5).

Pollutants may be adsorbed onto or react with suspended particulates, which may later settle to the bottom. Thus suspended sediments may act as a natural mechanism for dispersing oil in the environment and for removing oil from the water column. Theoretical and observational studies of oil-sediment interaction are required to understand the importance of these processes. This task is being addressed by field studies in Lower Cook Inlet in FY 79, and in the laboratory by RU 454 in terms of the potential bioavailability of sediment-sorbed hydrocarbons and metals.

3.4.3 Task E

A major incentive for conducting studies of biological populations is to determine which populations, communities, and ecosystems are at risk from either acute or chronic impacts. Estimates of the distribution and abundance, migration, feeding sites, and behavior of populations are among the first studies undertaken to establish potential vulnerability. When vulnerability is indicated, detailed site-specific studies are undertaken to focus on processes, positions in food webs, population dynamics, sensitivity to disturbance, ability to recover from disturbances, mobility, habitat and feeding dependence, and physiological characteristics.

These reconnaissance studies and the site-specific studies tend to focus on specific lease areas. Yet many species, especially birds, mammals and fish, tend to be highly migratory and are therefore susceptible to impacts in several lease areas and from non-OCS related effects, either within or beyond the limits of any OCS area. To assess properly the direct and indirect effects of OCS leasing and development on such species requires a good understanding of the population characteristics and movements throughout its range. Therefore the information resulting from the general reconnaissance and site-intensive studies in each lease area must be assembled by species (or cluster of species) for analyzing the potential sensitivity of the species to the activities within any one lease area. These "species accounts" will be developed for several taxonomic groups during FY 79. Since the accounts encompass several lease areas, yet have applicability to any in which the species occur, they are included in the non-site-specific TDP. The efforts projected for FY 79 will synthesize information on birds and mammals (P 915, P 916), forage fish (P 920), and Alaskan corals (P 922). These projects will assume the form of collation and analysis of data and synthesis and interpretation of information and will address subtasks E-1, E-2, E-3, E-4, E-5, E-6 and E-7, which are discussed in detail in the OCSEAP Program Development Plan and Section 2.3 of this TDP.

3.4.4 Task F

Knowledge of the effects of petroleum on marine organisms is an essential part of the environmental assessment process. The OCSEAP will attempt to determine the deleterious effects of petroleum exposure and the threshold concentrations that cause these effects. Then, in conjunction with knowledge of the distribution and abundance of organisms, one can estimate the potential risks of releasing petroleum contaminants into the environment.

This approach is limited, however, in that controlled laboratory conditions and real field conditions are dissimilar, and there is much uncertainty about how added stress from contaminant exposure will interact with other biological/ecological stresses, such as those associated with reproduction, growth, and predation (including fishing pressure by man). It is probably not possible to quantify experimentally the effects that will actually prevail from a particular level of contamination in the marine environment. However, it is possible to surmise that if effects are observed in laboratory experiments using the best state-of-the-art design, then similar effects may quite likely occur in nature. Such extrapolations are probably best for acute toxicity tests. Their direct applicability (but not their potential importance) then decreases through chronic toxicity tests to sublethal physiological effects.

Once the most important species of the marine ecosystem have been surveyed for lethal and sublethal effects of contaminant exposure in the laboratory, a test will be made for applicability of the results to a field situation through the use of controlled spill experiments. In order to take advantage of the growing body of information on ecosystem structure and function derived from OCSEAP's biological program, these experiments are planned for FY 1979 and succeeding years. Controlled spills will be conducted only after adequate planning and coordination with cognizant groups.

This effort will be guided by other biological elements of the study program. In selecting the relatively few species for testing, there will be considered (not in order of priority): (1) species of direct value to man, i.e., commercial and sports organisms, (2) species found to be important forage organisms, (3) species that are abundant and may control ecosystem structure or species composition through their own predatory or grazing activity, (4) species deemed "endangered" or "rare" or otherwise of esthetic value, (5) species that are readily available and compatible with laboratory maintenance. Experimental organisms will be tested at every possible life stage considered particularly vulnerable to OCS impact.

The effects program will document the chemical composition of the contaminants used in exposure experiments and the contaminants contained in the organisms showing the effects. Effects studies, to be most readily applied to environmental circumstances, will use analytical chemistry techniques comparable to those used by environmental chemists measuring contaminant levels in the environment.

Effects studies tend to be non-site-specific, and have broad applicability to all lease areas where the test organisms occur. The initial program emphasized acute toxic effects of contaminants on individuals of selected species. As the program develops, this emphasis will shift toward the effects of chronic exposures and the results related to the ultimate effects on populations and ecosystems.

Subtask F-1

The critical evaluation of existing information under subtask F-1 will serve to form a coherent basis for preliminary assessment of potential impacts of contaminant releases into Alaskan OCS and coastal waters and to guide the setting of priorities for further research on the acute and chronic effects of petroleum exposure in Alaskan marine organisms and ecosystems.

Subtask F-1 will not be addressed specifically by any units in FY 79 as it was by RU 75 in FY 75 and 76. However, all units conducting research on fate and effects will evaluate and interpret current literature as part of their projects.

Subtask F-2

Although there is some literature on the toxicity of crude oil and its components, very little data had been obtained under arctic or subarctic conditions prior to OCSEAP's work in this area.

Under subtask F-2 organisms and life stages selected as "important" or "critical" are being tested for sensitivity to potentially realistic exposure regimes (concentration and duration) for various classes of petroleum-associated toxicants. Thus, for the highly volatile and water-soluble benzenes and naphthalenes, acute toxicity tests are most appropriate; but for the potentially toxic polynuclear aromatic fractions, which are very poorly soluble, exposures to low concentrations should be maintained for as long as is technically feasible to determine accumulation rates and effects. The most sensitive life stages of important organisms will also be determined for various types of contaminant and exposure regimes.

Research on sublethal effects will focus principally on those physiological or behavioral parameters that can be related most directly to survival or productivity of the organism: growth rates, metabolic rates, reproductive potential, disease susceptibility, food-locating ability, migratory behavior. In addition, effort will be placed on development of biological monitoring parameters for petroleum exposure. To this end, effort will be placed on identifying biochemical, pathological, and subcellular morphological effects of petroleum exposure, particularly when these observations can be correlated with known effects of other contaminants or with normal characteristics of the wild population as a function of petroleum exposure history.

Several research units will address subtask F-2 during FY 79. RU's 72 and 73 and P 320 will examine acute and chronic effects of petroleum exposure on marine fish and shellfish species, as will RU's 454 and 500, although these latter two are primarily oriented toward other subtasks. Subtask F-2 as it pertains to birds will be addressed by P 040 and RU 423. Questions of petroleum composition and toxicity of component petroleum fractions will be addressed by RU 500 during FY 79.

Subtask F-3

Subtask F-3 addresses the effect of coating by oil, which represents a major hazard, especially to marine birds and mammals. Oil reduces the air holding capacity and the insulating quality of fur and feathers and this results in excessive loss of body heat. All furbearing mammals and young hair seals are especially vulnerable because, until they have developed a thick layer of fat, they are completely dependent on a fine layer of hair for thermal insulation. Further biological damage through ingestion is possible as the animal attempts to remove the oil through preening or other grooming activities.

During FY 79, subtask F-3 will be addressed by RU 71 for completion of earlier experimental results on sea otters. If possible, experiments will also be conducted to determine whether sea otters can detect and avoid floating oil. Under P 040 and RU 423, subtask F-3 will be addressed for birds, in terms of the effects of oil and oil-dispersant mixtures on survival and metabolism of seabirds.

Subtask F-4

Since sediments are a major reservoir of trace heavy metals in the marine environment, it is necessary to determine the effects that petroleum exposure may have on natural distributions of metals among water, sediments, and biota (subtask F-4). Experimentation was designed in FY 77 and 78 under RU 454 to verify if potential changes in bioavailability or toxicity of heavy metals may result from OCS petroleum development. Results of this work and other non-OCSEAP projects indicate that oil impaction of sediments does not cause substantial changes in trace metal distributions, and subtask F-4 will not be addressed by OCSEAP in FY 79.

Subtask F-5

Experiments under subtask F-5 are required to assess the relative effectiveness of various exposure pathways for eliciting contaminant effects in different forms of biota. Such research is necessary to ensure that initial analytical efforts, as well as acute and sublethal challenge experiments, are properly designed to measure the most important or sensitive parameters.

In FY 79, RU 73 will address accumulation of petroleum from food by selected test species; RU 454 will address bioaccumulation of sediment-sorbed petroleum; and RU 500 will address differential toxicity of various petroleum fractions.

Subtask F-6

The degree and speed of recovery of organisms exposed to contaminants will be examined whenever possible in all experiments under subtasks F-2 to F-5. After exposure to the challenging contaminant, the contaminant will be removed from the system, and the physiological and behavioral parameters being tested will be examined for response to this removal. In addition, exposed organisms will be measured for depuration or removal of bioaccumulated contaminants to determine turnover rates of the contaminants or clearance times for the organisms' recovery.

During FY 79, organism recovery after petroleum exposure will be determined as part of the standard experimental protocol in RU's 72, 73, 423, 454, and P 320.

By using both accidental petroleum spills and carefully controlled experimental exposures in the field, these effects on total communities or ecosystems will also be examined. OCSEAP will rely heavily on recovery observations made as followup to significant oil spills anywhere in the world, e.g., METULA. However, design criteria will also be developed for experimental petroleum spills in various types of controlled marine ecosystems (P 911). Study design will be based on analysis previously observed or hypothesized impacts related to OCS development and spilled petroleum in the marine environment (P 921). If possible, sampling design should be suitable for testing how potentially sensitive ecological parameters (trophodynamics, i.e., pathways and rates of energy flow, distribution and abundance of organisms, species diversity, growth and reproduction of organisms, accumulation and turnover of contaminants in organisms and in the whole system, and biological productivity of the system) respond to various exposure regimes (acute, pulsed, chronic) of petroleum hydrocarbon introduction. The study design should include post-exposure measurements to demonstrate the speed and extent of ecosystem recovery from the contaminant impacts.

Subtask F-7

Prior to OCSEAP, very limited knowledge was available concerning the pathology of species in the North Pacific marine environment. During regular biological sampling schedules in FY 76 through 78, specimens suspected of being diseased were preserved for examination. Incidence of pathological types in the natural population was determined under subtask F-7 as a reference against which future change could be compared. Tissue samples from marine birds, mammals, fish, and shellfish were obtained for chemical analyses of hydrocarbon and metals. Data will be examined for correlations between incidence of disease and levels of contaminants.

Petroleum contains components that have been demonstrated to be carcinogens in mammals, and compounds that are immuno-suppressives (those which decrease disease resistance and adaptive responses). Exposure of marine animals to such compounds may have a profound effect on tumor incidence, susceptibility to infectious disease, and ultimate survival. In FY 79, RU 73 will examine the effects of petroleum exposure on the susceptibility of selected marine organisms to artificial infection by pathogens isolated during the earlier field efforts.

Subtask F-8

Although cleanup and countermeasures against oil spills will be difficult and perhaps impossible due to severe environmental conditions and logistics difficulties in Alaskan coastal areas, the potential impacts of various countermeasures must be determined under subtask F-8, including burning or petroleum and the use of detergents. This subtask will use both laboratory and field efforts on effects and synthesize those results with information on structure and function of ecosystems and population dynamics developed under Task E in order to determine preferred types of countermeasures. Studies will determine the relative extent of environmental impact by location, season, and environmental conditions.

In FY 79, RUs 072 and 073 will examine the effects of chemical dispersants and dispersed oil on selected marine organisms. P 917 will explore the feasibility of scaring birds from vicinities impacted by oil spills in order to avoid bird mortalities.

4.0 RU AND P UNIT DESCRIPTIONS

Each Research Unit and P Unit in the FY 79 non-site-specific program is described in the following section. They are shown in the order of the tasks to which they relate. Some RU's and P units are associated with more than one task. The following index will assist in locating particular P and RU descriptions.

	Page		Page
RU 71	396	P 35	381
RU 72	398	P 320	406
RU 73	401	P 911	408
RU 454	404	P 913	384
RU 555	378	P 916	390
		P 920	392
		P 921	412
		P 924	413
		P 929	386

4.1 DESCRIPTIONS FOR PROJECTS IN TASK D (TRANSPORT):

D-2:		P 913
D-3:	RU 555	P 035
D-6:	RU 454	
D-8:		P 929

(RU 555) OCSEAP/ALASKAN BLM SPILLED OIL RESEARCH (SOR) TEAM

This research unit addresses subtask D-3 (BLM Study Types 33 - Oil Slick Dynamics, 45 - Microbial Degradation of Hydrocarbons, 48 - Behavior of Vulnerable Species, 49 - Toxicity of Oil, 55 - Environmental Recovery Rates of Ecosystems, and 56 - Ecosystem Vulnerability Indices).

Estimated Costs, FY 79: $90,000 Non-Site-Specific

Schedule: October 1978 - September 1979

Performing Agency:

Departments: NOAA/ERL/OCSEAP
Acting Project Manager: LT John Kineman
NOAA Commissioned Corps
Percent of time devoted to project: 100%

Background:

Accidental oil spills provide a rare opportunity to test hypotheses on the behavioral and biological effects of petroleum under real environmental conditions. A quick responding team of properly trained and equipped scientists can capitalize on the research potential of an accidental spill and maximize the scientific benefits of an oil spill study.

The OCSEAP/BLM SOR Team was formed in November 1976 with the initial goal of providing field data to verify models for the physical transport of oil. As techniques were developed, a secondary objective of studying the chemical fate and weathering of spilled oil was added. Current planning reflects the addition of a biological objective as well.

The newly formed team responded to the Argo Merchant oil spill in December 1976, immediately following its first training session, and has since responded to more than 15 spills with physical and chemical experiments. Of the many spills investigated for short-term phenomena, four have developed into significant long-term follow-up studies involving SOR Team scientists. Six responses have been made to foreign spills; these have resulted in a cooperative sampling program conducted with Danish scientists following the USNS Potomac spill in Greenland, a long-term cooperative biological and chemical study carried out by Swedish and SOR Team scientists to study the Tsesis oil spill, and close work between the SOR Team and French scientists in the conduct of geological, chemical, and biological studies in the aftermath of the Amoco Cadiz oil spill.

The functions of assessment of effects of spills and of providing support to the on-scene coordinator rest with another NOAA component and do not fall within the scope of the OCSEAP FY 79 SOR effort described here.

Objectives:

1. To pre-plan a scientific research program to be conducted at selected spills. Scientific objectives will be developed by SOR Team members through the establishment of a solid literature and information base and by consultation with OCSEAP and BLM staff and other appropriate scientists. Emphasis will be placed on Alaskan or analogous cold water spills; however, all spills will be evaluated for their relevance to SOR Team goals since it is processes which must be analogous, not situations or environments. These goals will be met by either short-term studies or by studies which, if begun quickly and properly, can be continued into the long-term by other researchers. Topics for studies will include:

    a. Surface oil spill trajectories with emphasis on nearshore dynamics.
    b. Physio-chemical and biological weathering of spilled oil.
    c. Transport of oil to the various biological receptors and physical reservoirs.
    d. Retention of oil in organisms and physical reservoirs (for example, sediments).
    e. Geomorphological influences on the behavior of beached oil.
    f. Food web effects (for example, bioaccumulation).
    g. Histopathological investigations.
    h. Effects on population and community dynamics and community structure.
    i. Observable changes in behavior and physiology associated with exposure to oil.
    j. Other topics on the fate and effects of spilled oil that become feasible as this program develops.

2. To implement the scientific plan in response to appropriate spills of opportunity that meet established criteria for significant research potential.

3. To cooperate fully with USCG, NOAA, EPA, State, or other officials during an oil spill response, and with the appropriate authorities when foreign spills are involved.

4. To plan, organize, perform, or otherwise provide for the evaluation and synthesis of information gathered at oil spills and through other information bases (e.g., literature, laboratory work, and other response teams).

Methods:

1. Literature review and summary.

2. Planning sessions among SOR Team members and associated PI's. PI's will be identified in advance, to obtain commitments and proper clearances to allow for three phases of participation: pre-spill experiment design, guidance or conduct of field work, and guidance or conduct of final analysis and write-up.

3. Training sessions for field techniques. A SOR team manual has already been prepared.

4. Spill response experiments carried out by SOR Team members, under the guidance of the designated PI's (not necessarily in the field).

5. Write-up and publication. This will be through the combined efforts of PI's (final technical editing and review, or lead writing), SOR Team members, the project office, and when necessary, outside contracts. Contracting, especially for synthesis efforts, may be necessary since all SOR personnel except the project manager are part-time participants.

6. Maintaining files in the Boulder Project Office for administration, operations, management, technical development, and technical information. In addition, a keyword file of literature abstracts will be developed for use in research management and as a quick reference to the literature base.

Products:

I. Reports will be of the following types:

   1. OCSEAP reports documenting field techniques and experimental design.

   2. Publications on results of oil spill investigations, on a per-spill basis, possibly assembled under contract with appropriate participation of PI's and SOR Team members.

   3. Publication of significant findings in the open literature when possible and appropriate.

(P 035) OIL WEATHERING EXPERIMENTS

This unit addresses subtask D-3 (BLM study types 30 - Dispersion and Mixing of Contaminants, 33 - Oil Slick Dynamics, and 45 - Microbial Degradation)

Estimated Costs, FY 79: $250,000 Non-Site-Specific

Schedule: October 1978 - September 1979

Performing Agency: To be determined.

Background:

Once introduced into the marine environment, petroleum undergoes alterations as a result of several concomitant processes: evaporation, dissolution, photo-oxidation, autoxidation, emulsification, adsorption onto suspended material, and biodegradation. The effects of these processes on the chemical composition and physical characteristics (e.g., viscosity, density) of the residual material are poorly understood especially for the cold water environment. In order to improve predictive capability of the transport and behavior of petroleum as it changes with time and to improve analytical capability, especially for those parent and derived molecules which have demonstrated biological impact, and to better understand the biological effects of petroleum as the composition changes with time, it is essential to determine fundamental aspects of petroleum weathering under various environmental conditions. Preliminary field work was conducted under RU 555 at accidental spill sites.

A series of small, controlled spills will be conducted under simulated or natural Alaskan environmental conditions. Spill conditions and circumstances will be varied to assess spilled oil behavior under a variety of realistic environmental conditions. To successfully accomplish the above general goals, a minimum three-year effort is required for the physico-chemical and analytical phases.

The methodologies used in and results obtained from this experimental study will be of special importance to several other BLM/NOAA-sponsored projects. The development of oil-spill weathering and advection models will be enhanced by the availability of data from this project. The Spilled Oil Research Team will be able to better define their response to real spill situations as a result of the data and sampling and analytical procedures developed under the oil weathering study. Likewise, field observations made by the SOR Team will influence the design of the experimental spills. A major goal of the entire OCSEAP study is to understand the biological impact of spilled oil. This study will address that goal in two distinct ways. Laboratory biological effects studies will use the data on weathering, dispersal and chemical or microbiological oxidation to define the nature and concentration of petroleum-derived toxicants used in their experiments. In fact, residual oil and dispersed material from the weathering study could be used as the toxicant in the laboratory work. A second mechanism for integrating the weathering and effects work will be to conduct effects research in the experimental spill container. This should be feasible in the late stages of the weathering project, but will require additional funding.

Objectives:

A planning workshop will be held in August 1978 to develop the detailed plans for the experimental design. This design must address the need to acquire short-term information, such as is needed for developing a mass balance of spilled oil, and determining residence times in various forms, as well as longer-term information such as fractionation of various molecular classes, formation of derived molecules, and biological impact of these materials. The resulting experimental design will be reviewed by BLM/NOAA and the scientific community to ensure scientific adequacy and relevance. During FY 79, the principal objectives will be:

1. Review of existing literature on oil weathering to be conducted during and following the workshop. The workshop will identify the limitations inherent in the experimental design.

2. A sampling design to be established by the workshop will designate the priorities among objectives of the study and relate them to experimental feasibility, "need-to-know" importance, and applicability to real spill conditions. Further output of the workshop will be a recommendation for an experimental protocol.

3. Initiation of experiments designed to measure the physical changes in spilled oil which result from evaporation, dissolution, emulsion formation, tarball formation, adsorption on particulates, and microbial activity.

4. Estimation of the rates of the processes in (2).

5. Analytical determination of the molecular classes and/or component molecules which are involved in the process in (2).

Steps 2-4 will be done under varying environmental conditions and will continue in FY 80. Additional objectives for FY 80 and beyond will include, as a minimum:

1. Evaluate the role of photo-oxidation in slick weathering.

2. Measure the effects of dispersants on the processes and measurements in steps 2-4 above.

3. Evaluate the possibility of mobilization of sedimentary metals following deposition of oil in sediments.

4. Refine and/or develop analytical techniques that are sensitive to the biologically significant components of spilled oil or its breakdown products.

5. Undertake meaningful effects experiments in the controlled spill containers.

Throughout the entire course of the oil-weathering project, there must be continuous feedback between laboratory effects investigators, oil spill response teams and the weathering investigators.

Methods:

Detailed methodology awaits the formulation of more specific objectives. Heavy hydrocarbon analyses will be based on extraction, g.c., G.C.-M.S. techniques. The utility of alternate, less sophisticated analytical methods, such as extraction-UV fluorescence and *in situ* UV fluorescence will be evaluated for use in real spill situations. Light hydrocarbons will be determined by adsorption-desorption, g.c. methods. Other analytical methods may be employed, particularly for the non-hydrocarbon components which may be biologically important.

Output:

1. Narrative Reports: Reports will provide detailed statements of experimental design, analytical methodology, discussion of relevant data and information from the literature, and discussion and conclusions from the results. Mathematical algorithms may be presented, discussed and rationalized for each aspect of weathering under study.

2. Digital Data: None.

3. Visual Data: Charts and graphs illustrating the oil-weathering process will be included in the narrative reports.

(P 913) ICE EDGE CURRENTS

This research unit addresses subtask D-2 (BLM Study Type 27 - Currents and Tides).

Estimated Costs, FY 79: $95,000 Non-Site-Specific

Schedule: October 1978 - September 1979

Performing Agency: To be determined

Background:

All lease areas north of the Alaska Peninsula have in common the high probability that at unpredictable interals ice fronts will occur near any petroleum development. The path taken by any accidental oil spill is therefore likely to be intersected by the ice edge, a habitat that has been shown to be a critical one at some times and places. It is necessary, therefore, to obtain knowledge of the interaction of sea ice and petroleum, e.g., how the ice edge affects movement of surface-borne oil.

It has been observed that waves with periods equivalent to that of tides (and lower) are damped by the presence of ice. It is not known whether the effect is felt on the water along the ice front or what the directional effect may be on wave-associated currents.

It seems certain, however, that waves of all periods will be partly reflected, partly absorbed, and partly transmitted by the ice covered water. Therefore, the currents at the ice edge are expected to undergo a change in speed and direction; this must be known if their effect on oil spill trajectories is to be predicted.

Objectives:

The objectives of this study will be to:

1. Search the literature for existing knowledge on the subject of waves and currents near an ice edge.
2. Determine the degree of direct applicability of the results of earlier studies to ice fronts in the Bering, Chukchi, and Beaufort Seas.
3. Form a hypothesis on the characteristics of the current field near the ice edge including, in particular, visible surface ramifications.
4. Design an observational experiment proving or disproving the hypothesis.

Methods:

No field work is anticipated. However, it is expected that analyses of existing current meter and other data will require computer time.

Output:

1. A narrative report will be provided including results obtained in meeting each of the objectives. Results will be expressed, if appropriate, in a form to be used with a general circulation model.

(P 929) ACQUISITION OF SIDE-LOOKING AIRBORNE RADAR IMAGERY DURING FORMATION OF FAST ICE

This research unit will address subtask D-8 (not designated as to BLM study type).

Estimated Cost, FY 79: $75,000 Non-Site-Specific

Schedule: October 1978 - April 1979

Performing Agency: To be determined

Background:

Beaufort Sea fast ice is formed during the period November-January. However, very little is known about the dynamics of this process because it takes place when Landsat imagery is not available due to inadequate lighting conditions. Based on examination of Landsat imagery and other data available during February, it appears that ice can be formed nearshore, rafted away, fractured, refrozen and deformed again several times during November through January. Nearly all the major grounded ice features inshore from the continuous 20 m isobath are created during this time. Flaw leads and ridging events taking place between February and May characteristically occur seaward of this line. Hence little is known about the formation mechanisms of the ice features to be reckoned with during nearshore break up and how these features may be modified by man-made structures. Further, very little is known about this very dynamic period and attendant hazards within the nearshore zone. For instance, there are large areas which are known to be extremely stable following February. Does this stability begin in January? This research unit is designed to give OCSEAP investigators data with which to answer such questions.

Objectives:

Collect Side-Looking Airborne Radar imagery of the nearshore regions (50 km seaward of the mean coastline) in a repetitive fashion during the period of fast ice formation between November and late January.

Methods:

1. Aircraft containing Side-Looking Airborne Radar systems of established reliability will be flown on patterns designed to yield 1:250,000 scale imagery along the Beaufort coast from shore to a line 50 km seaward from the mean coastline.

2. Imagery will be obtained several times during November-January depending on meteorological conditions judged to have caused ice movement.

3. Flight coordination and scheduling will be performed by the Arctic Project Office in conjunction with Principal Investigators of research units using the data obtained.

Outputs:

Map-like radar imagery of Beaufort Sea ice conditions at 1:250,000 scale from shore to a line 50 km seaward of the mean shoreline.

4.2 DESCRIPTIONS FOR PROJECTS IN TASK E (RECEPTORS):

E-1: P 916

E-2: P 916

E-3: P 916

E-4: P 916

E-5: P 920

E-6: P 920

(P 916) BIRD AND MAMMAL SPECIES ACCOUNTS OF TOTAL ANNUAL CYCLE EXPOSURE TO OFFSHORE PETROLEUM RISKS IN CONTEXT WITH OTHER GLOBAL RISKS

This P-unit addresses subtasks E-1 through E-4, (BLM Study Type 39-Vulnerable Populations, 40-Life History, and 41-Critical Habitats).

Estimated Cost, FY 79: $44,000 Non-Site Specific

Schedule: October 1978 - September 1979

Performing Agency: To be determined.

Background:

A species-by-species account of major vertebrate consumer species in Alaskan marine locations would serve as an important organizer of knowledge gained during OCSEAP. Such organization would be useful in the event of offshore threats to population survival in Alaska, or in the event of unexplained population changes in Alaska. This organization of knowledge would tie together numerous site-specific studies, to help the future manager to concentrate mitigative measures in the most responsible way. The actual format of species accounts is under development presently, with draft formats in existence from both the USFWS and OCSEAP.

Objectives:

In general the purpose of this study is to provide regulatory authorities with relative risk information on major Alaskan species of marine birds and mammals at risk from offshore petroleum activities. This requires the development of species accounts, grouped under broad taxonomic categories (e.g., pinnipeds, shorebirds, alcids), including information on:

1. seasonal habitat use
2. seasonal distribution
3. migration routes and timing
4. seasonal population status
5. breeding ecology
6. feeding ecology
7. critical habitats
8. potential vulnerabilities relative to OCS oil and gas activities
9. concerns for special management stipulations/regulations
10. references

Methods:

Combination of literature review and intensive work with current investigators to summarize and distill species accounts from the large body of knowledge in and outside OCSEAP.

Outputs:

1. Narrative Reports: To convey information described above under objectives.

2. Digital Data: None.

3. Visual Data: Maps, graphs, tables.

(P 920) ALASKAN FORAGE FISHES: A SYNTHESIS OF AVAILABLE INFORMATION

This research unit addresses subtasks E-5 and E-6 (BLM Study Types 39-42, 49 and 50 are addressed directly, and input data for objectives F, H, and U are furnished.)

Estimated Costs, FY 79: $55,000 Non-Site-Specific

Schedule: October 1978 - September 1979

Performing Agency: To be determined.

Background:

A significant amount of information is available on Alaskan forage fishes as a result of state and federal resource assessment surveys and OCSEAP studies. However, since the data are widely scattered, e.g., obtained during the course of seabird and marine mammal trophic studies, from nearshore finfish studies, and from demersal trawl studies, they are not of adequate utility. Thus, it is proposed here to compile and organize all available data, emphasizing synthesis on species of economic significance as well as those judged critical to the functioning of an ecosystem.

Objectives:

1. To compile a bibliography of available data on forage fish in Alaska.
2. To prepare species accounts on principal forage fishes.
3. The results should be separately reported for three regions.

Methods:

Search of the relevant literature, including computerized data banks.

Output:

1. The provision of a narrative report including an annotated bibliography and species accounts, as follows:

   a. Annotated bibliography.

      For data sources identify:

      - species
      - investigator

- data volume
- locality and date of data collection
- data source (gillnet catch, gut contents, etc.)
- data availability

For reference materials provide:

- complete bibliographic citation
- short description of subject matter

The above should be cross-referenced by species, investigator, institution and region.

b. Species accounts. These should include the available information on:

- Species distribution
- Life history (growth, fecundity, reproduction, etc.)
- Major information sources
- Commercial/subsistence usage
- Susceptibility to impingements from OCS development
- Habitat preferences
- Gaps in knowledge

2. Digital Data: None required.

3. Visual Data: Charts showing:

a. Location or areas from which data were collected
b. Species distributions
c. Spawning areas
d. Concentration areas
e. Migration routes
f. Fishing/subsistence use localities

4.3 DESCRIPTIONS FOR PROJECTS IN TASK F (EFFECTS):

F-2:	RU 72	P 320
	RU 73	
F-3:	RU 71	
F-4:	RU 454	
F-5:	RU 454	
F-6:	RU 71	P 921
	RU 72	P 924
	RU 73	
F-7:	RU 73	
F-8:	RU 72	
	RU 73	
F-9:		P 911

(RU 071) EFFECTS OF OILING ON SURVIVAL POTENTIAL AND FEEDING BEHAVIOR OF SEA OTTERS

This research unit addresses subtask F-3 and F-6 (BLM Study Types 49 - Toxicity of Oil and 51 - Combined Effects of Pollutants).

Estimated Costs, FY 79: $50,000 Non-Site Specific

Schedule: October 1978 - September 1979

Performing Agency:

Department: Scripps Institution of Oceanography
P.I., Degree: Gerald L. Kooyman, Ph.D. Daniel Costa, Ph.D.
Percent time devoted to Project and role: 15%, Project manager and scientist.

Background:

This project was initiated in FY 76 as a subcontract through the NWAFC (Gentry-McAllister) and continued in FY 77-78 as a direct contract. Initial studies focused on the effects of petroleum fouling on the thermoregulation, metabolism, and diving and feeding behavior in fur seals and was extended subsequently to include sea otters. In addition, the effect of petroleum on thermal conductance of pelts was measured for a variety of pinnipeds and for sea otters. These studies showed that small amounts of oil do not affect thermal conductance of non-fur-bearing pelts, but greatly affected the fur-bearers. The metabolic rate of fur seals was increased by about 50% when 30% of the animal's coat was lightly oiled. It was inferred that profound effects on fur seal health would follow from oiling due to greatly increased metabolic demand and reluctance to enter the water to feed. In FY 77-78, sea otters were similarly shown to be susceptible to thermoregulatory problems from oil fouling, undergoing increases in respiration after oiling. In FY 79 this work will be completed with field studies designed to determine whether oiling of wild otters leads to death or other sublethal effects.

Objectives:

1. To analyze the responses of an otter which becomes covered with weathered crude oil or oil/water emulsions after a spill. Specifically:
    - a. To establish a range of percentages of fur oiled, within which death from exposure is likely to occur;
    - b. To determine whether foraging and diving behavior is altered in instances when an otter becomes oiled but death from exposure is not immediate or is not likely to occur (such as oiling of only a small amount of fur).

2. To draw conclusions, on the basis of existing information about Alaskan otters and the experiments conducted in this RU, about

    a. the number of otters likely to be killed directly from oiling, per kilometer of oiled coastline or square kilometer of nearshore area;

    b. the survival potential of otters that are residents of an impacted area but escape direct contamination or are oiled only to a sublethal degree. Given their feeding behavior and range, and the concentrations of otters in Alaska, will these otters be able to find enough food in the impacted area or reestablish themselves in an adjacent area?

    c. potential to capture and rehabilitate oiled otters.

Methods:

It is proposed that these experiments be done on wild otters captured in Prince William Sound, Alaska. Otters will be oiled by immersion in an oil slick, and tracked for one to two weeks by means of radio transmitters to determine survival ability. Feeding and diving behavior of oiled and of control otters will be monitored by means of depth recorders which measure number of dives and depth of each dive. Efforts will be made to rehabilitate oiled otters to avoid possible death to the experimental animals.

Output:

1. Narrative Reports: The reports will address all work to date, and will contain a full description of experimental design, methods used and parameters measured, discussion of data and information from the current literature, statistical methods used, tabular and graphic results with accompanying discussion, conclusions and recommendations for further research.

2. Digital Data: None

3. Visual Data: Tables and graphs will be presented illustrating the effects of petroleum fouling on survival ability and feeding and diving behavior of sea otters.

(RU 072) LETHAL AND SUBLETHAL EFFECTS ON SELECTED ALASKAN MARINE SPECIES AFTER ACUTE AND LONGTERM EXPOSURE TO OIL AND OIL COMPONENTS

This research unit addresses subtasks F-2, F-6, F-8 (BLM Study Types 49 - Toxicity of Oil, 50 - Sublethal Effects of Oil and 54 - Tainting of Commercial Species).

Estimated Costs, FY 79: $125,000 Non-Site-Specific

Schedule: October 1978 - September 1979

Performing Agency:

Department: NMFS/Northwest and Alaska Fisheries Center,
Auke Bay Fisheries Laboratory
P.I., Degree: John F. Karinen, M.S. and Stanley D. Rice, Ph.D.
Percent time devoted to Project and role: 75% each - jointly plan and supervise project.

Other principal scientists significantly involved in Project:

P.I., Degree: Sid Korn, B.A.
Percent time devoted to Project and role: 100% - wet lab supervisor.

Background:

During the first year of the project (FY 76), numerous marine species were screened for sensitivity to acute exposures to water-soluble fractions of Cook Inlet and Prudhoe Bay crude oils and No. 2 fuel oil. These tests were conducted mostly as static bioassays. The laboratory upgraded its facilities and in FY 77 had flow-through bioassay capability so that organisms could be exposed for long periods to constant concentrations of petroleum water-soluble fractions. In FY 78, emphasis was placed on flow-through tests of acute toxicity on species previously tested under static conditions and on untested larval species. Chemical analysis was used to determine uptake and depuration of petroleum hydrocarbons in tissues of exposed animals and to ascertain exposure concentrations. Attempts were begun to identify toxic components within water-soluble fractions by comparing the toxicity of natural and synthetic water-soluble fractions and by determing if certain petroleum hydrocarbons have synergistic effects. Preliminary literature research was done on dispersants.

Objectives:

Determine the acute toxicity and selected sublethal effects of North Slope crude oil on "key" arctic fish and crustaceans for purposes of comparison with existing data on subarctic organisms. Specifically:

1. To determine the acute toxicity of water-soluble fractions of North Slope crude oil to different life stages of 8-10 "key" species of arctic fish and invertebrates, including, if possible, <u>Boreogadus saida</u> and <u>Thysanoessa</u> spp.
2. To measure the toxicity of water-soluble fractions of North Slope crude oil to life stages of several arctic species exposed for 40 days.
3. To measure the uptake and depuration of specific petroleum components in the tissues of exposed organisms. Correlations should be made between exposure regimes and the presence and concentrations of oil components in specific tissues, to address the possibility of tainting. If possible, total metabolites should also be quantified.
4. To determine the effects of exposure to North Slope crude oil on respiration rates and other vital physiological parameters in selected arctic species.
5. To synthesize existing data collected by RU 72 on the toxicity of Alaskan petroleum fractions to subarctic fish and invertebrates with data collected during FY 79 on arctic organisms, and to draw conclusions from the compiled data about the relative vulnerabilities of the two groups.

Methods:

Toxicity will be measured by standard flow-through bioassays at several temperatures and salinities representative of arctic conditions. Exposure concentrations of water-soluble fractions of petroleum will be verified by ultraviolet spectrophotometry, and compositional analyses will be performed using gas chromatography-mass spectrometry. Arctic species will be collected in the Beaufort Sea and transported to Auke Bay under conditions identical to those in which they were collected. All experiments will be performed at the Auke Bay Laboratory. The PI will participate in an OCSEAP-sponsored intercalibration and quality assurance program.

Output:

Reports containing detailed descriptions of the following:

1. Experimental methodology, including protocols for collection and maintenance of test organisms, generation of natural and synthetic water-soluble fractions and bioassays.

2. Results, including figures and tables illustrating TLM's (mean tolerance limit = concentration required to kill 50% of the test animals in a specified time period) for arctic and subarctic organisms exposed to natural and synthetic water-soluble fractions as a function of temperature and salinity.

3. Interpretation of results, conclusions, recommendations for future study.

(RU 073) SUBLETHAL EFFECTS OF PETROLEUM HYDROCARBONS AND TRACE METALS, INCLUDING BIOTRANSFORMATIONS, AS REFLECTED BY MORPHOLOGICAL, CHEMICAL, PHYSIOLOGICAL, PATHOLOGICAL, AND BEHAVIORAL INDICES

This research unit addresses subtasks F-2, F-6, F-7 and F-8 (BLM Study Types 48 - Behavior of Vulnerable Species to Oil, 50 - Sublethal Effects of Oil, and 54 - Tainting of Commercial Species).

Estimated Costs, FY 79: $258,000 Non-Site-Specific

Schedule: October 1, 1978 - September 30, 1979

Performing Agency:

Department: NMFS/Northwest and Alaska Fisheries Center
P.I., Degree: Donald C. Malins, Ph.D.
Percent time devoted to project and role: 20%, Project Manager.

Other Principal Scientists significantly involved in Project:

P.I., Degree: Edward H. Gruger, Jr., Ph.D.
Title: Research Chemist
Percent time devoted to project and role: 50%

P.I., Degree: Harold O. Hodgins, Ph.D.
Title: Fishery Research Biologist
Percent time devoted to project and role: 50%

P.I., Degree: Douglas D. Weber, MS.
Title: Fishery Research Biologist
Percent time devoted to project and role: 50%

Background:

Studies were begun in FY 77 and 78 on the inhibition of reproductive behavior and the formation of metabolites in salmon, flatfish, and invertebrates exposed to petroleum hydrocarbons in water or sediments. In FY 78 hydrocarbons and their total metabolites were measured in larval forms and through a planktonic food web. Tissues and eggs of exposed organisms were examined for pathological and structural abnormalities.

Objectives:

The objectives in FY 79 cover three general areas: sublethal effects of petroleum-impacted sediments on flat fish and crustaceans, petroleum-induced lens abnormalities in salmon, and effects of petroleum on development of salmon and flatfish eggs and larvae. Specific directives follow:

Petroleum-Impacted Sediments

1. To explore the behavioral responses of selected crustaceans (king crab, dungeness crab, Pandalid shrimp) and flatfish (starry flounder, rock sole) to sediments (gravel/cobble, sand, mud) containing petroleum, to determine whether or not the organisms can detect and avoid contaminated sediments and to establish the threshold concentrations of petroleum eliciting avoidance behavior;

2. To determine what gross pathological changes occur in the organisms exposed to sediments containing petroleum at concentrations below those eliciting avoidance;

3. To determine whether observed abnormalities affect the organism's ability to survive, by measuring activity levels in exposed fish;

4. To correlate abnormalities and activity levels with the presence of specific oil components in water and sediment samples and exposed organisms. Correlations should be made between exposure regimes and the presence and concentrations of specific oil components in tissues, to establish the possibility of tainting and causal factors of effects.

Lens Abnormalities

1. To establish the cause/effect relationship between cloudy hydrated lenses in salmon and petroleum pollution through dose/response laboratory experimentation,

2. To examine samples of fish exposed in the field to determine how widespread the lens effect is, to determine the possible correlation of these effects with specific petroleum components and metabolites in the tissues of organisms;

3. To determine whether lens abnormalities affect the organism's ability to survive, for example by decreasing its "activity level."

Eggs and Larvae

To determine the petroleum exposure levels necessary to elicit behavioral or development abnormalities in eggs and larvae of flatfish and salmon when exposed to petroleum, and to correlate the presence of morphological or pathological abnormalities to specific oil components or metabolites, and to the survival ability of the organisms.

Methods:

Pathological effects will be evaluated by light and electron microscopy and hematology. Scanning and transmission electron microscopy will be used to analyze ultra-structural changes. Identification of petroleum components will be via gas chromatography and integrated GC-MS techniques. Statistically valid experimental methodology will be used in all cases, and the PI will participate in an OCSEAP-sponsored intercalibration and quality assurance program.

Output:

Reports containing detailed descriptions of the following:

1. Methodology for collection and maintenance of organisms, and experiments dealing with behavior, pathology, and morphology of organisms to petroleum hydrocarbons.

2. Results showing:

    a. Correlations betweeen alterations in behavior, pathology, and survival ability of crustaceans and flatfish exposed to petroleum-impacted sediments, and the petroleum components causing them;

    b. Correlations between petroleum components/metabolites, lens abnormalities and survival ability in salmon;

    c. Correlations between alterations in development of flatfish and salmon eggs and larvae and specific petroleum components/metabolites;

    d. Electron micrographs of lens tissues of exposed adult organisms and exposed eggs and larvae. Additional tissues will be examined if available funding permits.

    e. Interpretations of the above.

(RU 454) ACCUMULATION OF ORGANIC CONSTITUENTS FROM PETROLEUM-IMPACTED SEDIMENTS BY MARINE DETRITIVORES

This research unit addresses subtasks D-6, F-4, F-5 (BLM Study Types 50 -Sublethal Effects of Oil, 54 - Tainting of Commercial Species and 56 -Ecosystem Vulnerability Indices).

Estimated Costs, FY 79: $80,000 Non-Site Specific

Schedule: October 1, 1978 - September 30, 1979

Performing Agency:

Department: Battelle Memorial Institute
P.I., Degree: Jack W. Anderson, Ph.D.
Percent time devoted to Project and role: 15% - Project Manager and experimentalist.

Other Principal Scientists significantly involved in Project:

P.I., Degree: J. W. Blaylock, M.S.
Percent time devoted to Project and role: Organic analytical chemist.

P.I., Degree: J. Richard Vanderhorst, Ph.D. cand.
Percent time devoted to Project and role: Biologist.

Background:

This project was implemented in mid-FY 76 to examine two interacting objectives: the biological accumulation of petroleum constituents from oil-impacted sediments, and the effects of oil-impaction on the biological availability of potentially toxic heavy metals from sediments. This project (in conjunction with RU 278, which terminated after FY 77) provided evidence by the end of FY 77 on the significance of heavy metals concentrations and effects to the overall OCS effort. Petroleum exposure did not cause significant changes in the bioaccumulation of metals, and therefore the relevance of metals analysis to the OCS effort remains uncertain. Since no effects were noted, heavy metals were deemphasized in FY 78 and the project focused on the bioaccumulation of sediment-associated petroleum under different environmental conditions. In FY 79, this project will continue to examine bioaccumulation of petroleum as a function of sediment type.

Objectives:

1. To determine the responses of selected behavioral (feeding) and physiological (condition index, free amino acid content) indices in marine detritivores upon exposure to petroleum-impacted sediments. Different sediment types (mud, sand,

gravel) will be utilized and correlations made between observed response and sediment type and grain-size. Test organisms will be native to the Alaskan environment, such as *Macoma inquinata* and *Abarenicola pacifica*.

2. To correlate exposure regimes and responses with concentrations of specific petroleum components in water, tissue and sediment samples, to establish the possibility of tainting. Rates of uptake and depuration will be measured, and metabolites quantified whenever possible.

3. To evaluate the toxicity of activity-directed fractionations of Prudhoe Bay crude (conducted under RU 500) on a representative Alaska test species.

Methods:

Sediments will be impacted with oil by several methods currently employed and organisms then will be exposed to the sediments. The concentrations of petroleum constituents will be determined in the sediments, the organisms, and the water column at various intervals after the exposure starts to determine bioaccumulation. Chemical analyses will be performed by gas chromatography-mass spectrometry and high-pressure liquid chromatography for petroleum constituents. Initial tests for bioaccumulation and rate studies will use radioactively-labeled compounds. Statistically valid methods will be used in all cases, and the PI will participate in an OCSEAP-sponsored intercalibration and quality assurance program, using "Toxicity of Chemical Fractionation" methodology.

Output:

1. Narrative Reports: Reports will provide detailed descriptions of experimental design, methods and analyses used. Data and information from the literature will be discussed. Results obtained will be discussed as well as conclusions and recommendations for further research.

2. Digital Data: None

3. Visual Data: Tabular and graphic presentations will describe results of hydrocarbon (and metals) accumulation by experimental organisms based on duration of exposure, mode of exposure, and sediment characteristics.

(P 320) EFFECTS ON ARCTIC MARINE FOOD SPECIES OF ACUTE AND CHRONIC EXPOSURE TO PETROLEUM HYDROCARBONS

This research unit addresses subtask F-2 (BLM Study Types 49 - Toxicity of Oil, 50 - Sublethal Effects of Oil, and 54 - Tainting of Commercial Species).

Estimated Costs, FY 79: $75,000 Non-Site-Specific

Schedule: October 1978 - September 1979

Performing Agency: To be determined.

Background:

Beaufort and Chukchi Sea studies in the areas of marine trophic systems through CY 1977 have identified the polar cod (*Boreogadus saida*) and several arctic species of euphausiid shrimp (*Thysanoessa* spp) as supporting major elements of the vertebrate consumer trophic level in these regions. Now that these relationships have been demonstrated, basic species natural history studies and effects studies on the forage species are in order. The laboratory effects effort, to be conducted at an arctic location, will be coordinated with ongoing bioassay and effects studies under RUs 072 and 073.

Objectives:

1. To measure acute toxicity, changes in respiration rates, behavioral activity changes, and other selected sublethal parameters for key arctic species, including *Boreogadus saida* and *Thysanoessa* species.
2. To establish threshold concentrations for the measured sublethal effects identified in 1.
3. To correlate biological parameters with concentrations and compositions of petroleum components and metabolites in water and tissues.

Methods:

1. Exposures will be conducted under standard flow-through bioassay conditions using natural Beaufort Sea water, realistic concentrations of Prudhoe Bay crude oil, and a full range of Beaufort temperatures and salinities.
2. Bioassays will be conducted in a statistically valid manner.

3. Chemical analyses will be conducted using glass capillary gas chromatography and combined GC-MS techniques. The PI will participate in an OCSEAP-sponsored intercalibration and quality assurance program.

4. The experiments will be conducted jointly by a qualified marine biologist and an analytical hydrocarbon chemist.

Outputs:

1. Narrative Reports: Periodic progress - and result - reporting, as required of all NOAA/OCSEAP projects. Specifically this project will report on the methodologies and experimental protocol developed in the course of this study. Recommendations for applying similar effects studies to a wider range of species and under a regime to test the effects of additional contaminants should be part of the final report.

2. Digital Data: None

3. Visual Data: Graphs, tables and figures to support the text.

(P 911) EFFECTS OF HYDROCARBONS ON CONTAINED ECOSYSTEMS

This research unit addresses subtasks F-9 (BLM Study Types 49 - Toxicity of Oil, 50 - Sublethal Effects of Oil, 51 - Combined Effects of Pollutants, 52 - Toxicity of Drilling Muds, 54 - Tainting of Commercial Species, 55 - Environmental Recovery Rates of Ecosystems, and 57 - Effects of Contaminants on Normal Microbial Activity).

Estimated Costs, FY 79:	$ 50,000	Workshop Planning
	150,000	Facilities and Development (contingent upon satisfactory plan)
	$200,000	Total Non-Site-Specific

Schedule: October 1978 - September 1979.

Performing Agency: To be determined.

Background:

OCSEAP is pursuing efforts to investigate the biological effects of petroleum contamination. These investigations are conducted almost exclusively in the laboratory. To understand fully the biological impact of petroleum contamination, experiments must be conducted with natural populations under real environmental conditions. In addition to the effects caused by the presence of the contaminants, one needs to know the degree and rate of recovery of exposed organisms after the natural removal of the pollutant stress as well as the effects of contaminants on whole ecosystems.

OCSEAP's initial approach to understanding the effects of hydrocarbons on ecosystems and in individual organisms exposed under natural conditions includes: establishment of large microcosms (biological models) of natural ecosystems, within which it is possible to carry out controlled experiments on the effects of various petroleum-related perturbations on the systems, and on the pathways, fluxes, and transformations of the substances which are added to the systems under a variety of conditions. These contained ecosystems simulate "nature" more closely than experiments on single organisms in aquaria, yet provide for a degree of control not possible with uncontained studies. Lack of control presently results in little success in establishing cause/effect relationships between oil and changes in individual organisms or ecosystems.

These controlled field studies will principally address the intertidal and shallow subtidal areas of the Alaskan marine environment, since major impacts of OCS oil and gas development are possible here as a result of chronic or acute spillage of oil. Ideally, the contained ecosystems will be mobile so that communities can be established in several locations representative of different coastal habitats in

Alaska. Initial efforts will probably favor a subarctic location, such as Cook Inlet, in order to refine the system under less severe environmental conditions. At a later time the studies will be moved to an arctic location to model the more extreme and easily perturbed environment found there.

Objectives:

This research is a multi-year effort designed to evaluate the effects of petroleum contaminants on contained ecosystems and on the species found in them. It is another step toward effects studies in totally uncontained environments, the true field situation.

General objectives of the total effort are:

1. To design, develop and operate experimental marine ecosystems.
2. To investigate the dynamic nature of these systems and the organisms which live in them, and to study the effects of oil contaminants on individual species, interspecies interactions, and on the properties and processes of the whole system.
3. To correlate objective 2 with the environmental behavior of petroleum related contaminants in these complex enclosed ecosystems.

The first year of the project will be used to develop long-range objectives and plans for the study, perfect the design of the contained ecosystems, and refine the methodology to be used in measuring ecosystem and species effects.

Actual effects studies on the intertidal (macrophyte, invertebrate) and shallow subtidal (phytoplankton, zooplankton, including eggs and larvae of key commercial species, benthos) communities will be initiated in early FY 80, and will continue for two to three years. A workshop will be held to develop a list of the most relevant parameters to be measured, and therefore they cannot be defined precisely at this time. However, based on a current analysis of information needs, a minimum effort should measure the effects of sublethal levels of oil pollution on the following parameters:

1. phytoplankton productivity, biomass, species composition and diversity, and physiological responses;
2. zooplankton abundance, composition and diversity, and physiological responses;
3. macro- and meiobenthos abundance species composition, diversity and aspects of physiological condition and activity;

4. viability of eggs and larvae of key commercial fish and crustacean species;

5. intertidal invertebrate productivity, abundance, species composition and diversity, and some physiological responses;

6. energy transfer through photosynthetic and detrital food webs;

7. composition and numbers of the bacterial community in the water column and sediments.

Potential organism responses will be sought which can be used as "indicators" of oil pollution in uncontained field experiments to be conducted later. Attempts will be made to confirm the occurrence of petroleum effects identified in the OCSEAP-sponsored laboratory Effects studies and to correlate these effects with their causative agents (i.e., concentrations of specific petroleum components in tissue, water, and sediment samples). Such measurements may include the effects of oil on:

1. condition index and free amino acid content in bivalves;

2. feeding behavior of polychaetes;

3. physiology and survival ability of juvenile salmon and crabs;

4. molting behavior of crabs;

5. induction of pathological abnormalities in juvenile flatfish and crustaceans.

<u>Specific objectives for FY 79</u> are as follows:

1. To conduct a planning workshop with OCSEAP/BLM staff and outside scientists to:

    a. Design a contained ecosystem which models the intertidal and shallow subtidal areas of Alaskan coastal ecosystems.

    b. Identify parameters to be measured in the contained ecosystem experiments and in subsequent uncontained field studies and evaluate the capabilities and limitations of various experimental designs. (The initial workshop will be held in October 1978, and subsequent workshops will be held as necessary.)

    c. Develop objectives and experimental plans for the study (by NOAA, BLM and other concerned agencies) reviewing an FY 80 experimental program.

2. Contingent upon the successful outcome of this workshop, to commence construction of facilities for an FY 80 program.

Methods:

The basic contained ecosystems will consist of large enclosures containing flowing seawater systems and benthic and intertidal substrates and communities derived directly from the natural environment. This system may resemble the contained ecosystems in use at the MERL facility at the University of Rhode Island. If feasible, the enclosures will be mobile, so that they can be used at a variety of Alaskan locations to study oil effects on different types of intertidal and shallow subtidal ecosystems. It is anticipated that the study will be correlated with P035, the oil weathering study, to further the understanding of the relationships between effects and petroleum components.

Output:

1. Narrative Reports: These reports will detail the results of the planning workshop and will discuss and interpret the feasibility and utility of the experimental design.
2. Digital Data: None
3. Visual Data: None

(P 921) ENVIRONMENTAL IMPACTS DUE TO OIL AND GAS DEVELOPMENT

This research unit addresses subtask F-6 (BLM Study Types 58 - Effects of Offshore and Onshore Structures, 59 - Effects of Activities, and 60 - Vulnerability of Structures to Environmental Hazards).

Estimated Costs, FY 79: $35,000 Non-Site-Specific

Schedule: October 1978 - September 1979

Performing Agency: To be determined

Background:

The environmental analysis process of the OCS program involves the evaluation of certain natural resources on an individual and separate basis. These individual judgments are then summarized to describe the aggregate nature of critical or non-critical habitats, or ecosystems with respect to potential disturbance through various oil and gas development activities. To date no single reference exists for actual impacts on individual marine ecosystems from offshore or onshore oil and gas development activities world-wide. The completion of such a volume would provide a valuable overview of the potential effects on large ecosystems and perturbations such a compendium would assist in decision-making and in the design of future approaches to environmental studies.

Objectives:

To provide an in-depth summary of the existing knowledge of the environmental impacts resulting from the operational activities of OCS oil and gas development in other parts of the world. Emphasis should be placed on impacts related to activities other than the accidental spillage of oil.

Method and Output:

The report will be a status of knowledge summary, not tailored exclusively to Alaska, and will include impartial assessment of conflicting, inconsistent, and negative information.

Impacts should be organized according to causal technology and/or activity of OCS exploration and development.

(P-924) EFFECTS OF OILING ON INTERTIDAL AND LITTORAL BIOTA

This research unit addresses subtask F-6 (BLM study types 54 - Tainting of Commercial Species, 55 - Environmental Recovery Rates of Ecosystems, and 56 - Ecosystem Vulnerability Indices).

Estimated Costs, FY 79: $25,000 Non-Site Specific

Schedule: January 1979 - September 1979

Performing Agency: To be determined.

Background:

Intertidal and littoral zones are highly subject to OCS perturbations including petroleum and other pollutant discharges. Several Alaskan littoral areas are well understood in terms of the normal trophic relations between invertebrates and birds and behavior of the birds. There is only anecdotal information on the responses in this trophic transfer step to disruptive forces or pollutants. By means of controlled limited perturbations (for example 1-100m2 of test oil application plots) it is proposed that selected locations be field tested in 1979. Possible candidate locations are Copper River Delta, Nelson Lagoon, Yukon River Delta, and arctic gravel spits. With short-term experiments of small-scale perturbation, we expect to learn avoidance behavior by birds and some basic information on invertebrate mortality.

The purposes of this study are to examine the direct effects of oiling on an intertidal or litoral area on invertebrates and their avian predators, and the indirect effects of changes in invertebrate communities on birds.

Objectives:

1. What are the gross initial responses of the intertidal invertebrates to oiling, including mortality, behavior change, absorption of the pollutant, and if applicable, recolonization or immigration over the period of 30 days into test plots?

2. What is the persistence of the oil, and what are the effects subsequent to the initial oiling? What are the recovery rates of the habitat with regard to repopulation (recolonization, immigration) and habitat usage by predators?

3. How do the birds as predators respond to the affected test plots and to possibly tainted prey? Can they discriminate and avoid, or not?

Methods:

The adequacy of test and control designs will be evaluated for a series of proposed locations. Realism of test doses, replicability of sampling, and the quality of physical-chemical sampling following test applications will also be criteria in the selection of one study. Total oil concentrations in the sediments leading to the responses identified in the objectives will be estimated by UV-fluorescence, IR gravimetric techniques. Weathering studies will be coordinated and incorporated where possible.

The mechanism for determining a site from candidate areas (listed above) is an autumn 1978 disciplinary meeting at which OCSEAP/BLM and others will advance study plans for a comparative review. The site and associated plan with the greatest degree of feasibility and the widest apparent applicability of results will be selected. If the consensus of the meeting is that none of these study plans has a suitably high probability of success none of the work would go forward in 1979.

Outputs:

1. Narrative Reports: Description of site, methods, results, and implications both for further study and indications as to countermeasures to the perturbation or event mimicked by the experiment.

2. Digital Data: None

3. Visual Data: Maps, graphs, tables.

5.0 INTERIM PRODUCT LIST

The following table summarizes the products to be generated by the research units described in the Non-Site-Specific TDP, and shows their intended uses and projected schedules. These products are non-site-specific and none of them exhibit spatial or temporal resolution. The table therefore shows a projected duration for each activity instead of attempting to define a BLM specification for resolution.

DATA PRODUCTS

Task	Product	Intended Use	Specific Product	Format	R.U.	Status	Project Duration (Yrs.)
A-1	Tables and graphs showing comparative analytical results of multiple investigators for Hcs in various type reference samples.	Intercomparison of analytical procedure and capabilities of principal investigators performing hydrocarbon analyses. Quality Assurance.	Charts and graphs describing analytical results concentrations in selected reference environmental samples. Gas chromatograms and and mass spectrograms to illustrate results.		43 557	Ongoing	Indefinite continuation for program duration.
D-3	Graphs showing weathering and degradation of oil slicks with time.	In conjunction with trajectory models, used for prediction of location and composition, and therefore effects, of spilled petroleum.	Report on experimental design and methodology, information from literature, algorithms. Report on existing literature on weathering process and development of algorithms.	Modeling Algorithms Graphs Tables Narrative	499	FY 78 Completion	2
			Data and reports on compositional changes of spilled oil with time.	Data Reports Charts Graphs	555	Ongoing	3-5
			Reports of laboratory and field experimental results on oil weathering.	Data Reports Charts Graphs	P035	FY 79 Start	3
D-6	Algorithms for suspended sediment -petroleum interactions	To evaluate importance of suspended particulate in transport of petroleum in marine environment.	(Same as product column)	Narrative Report Equations	499	FY 78 Completion	2

DATA PRODUCTS

Task	Product	Intended Use	Specific Product	Format	R.U.	Status	Project Duration (Yrs.)
	Tables, graphs, and narrative presentation of hydrocarbon and metal accumulation from oil-contaminated sediments.	To evaluate effects of petroleum on bioavailability of metals to organisms.	(Same as product column)	Tables Graphs Narrative Report	454	FY 78 Completion	3
E-1, E-2	Species accounts of marine mammal distributions, movements, feeding and reproductive ecology, and OCS sensitivities.	Synthesis of information on species for all areas; identification of information gaps.	Detailed comprehensive report.	Narrative Report Graphs Charts Tables	P916	FY 79 Start	1
E-3, E-4	Species accounts of marine bird distributions, movements, feeding and reproductive ecology, and OCS sensitivities.	Synthesis of information on species for all areas; identification of information gaps.	Detailed comprehensive report.	Narrative Report Graphs Charts Tables	P915 P916	FY 79 Start	1-3 1
E-5, E-6	Species accounts of forage fish distributions, movements, feeding and reproductive ecology, and OCS sensitivities.	Synthesis of information on species for all areas; identification of information gaps.	Detailed comprehensive report.	Narrative Report Graphs Charts Tables	P920	FY 79 Start	1
E-7, E-9	Detailed account of coral distributions, abundance, habitat requirements, sensitivities to commercial harvest and OCS developments.	Synthesis of information for all areas identification of information gaps.	Detailed comprehensive report.	Narrative Report Graphs Charts Tables	P922	FY 79 Start	1

DATA PRODUCTS							
Task	Product	Intended Use	Specific Product	Format	R.U.	Status	Project Duration (Yrs.)
F-1	Literature Survey on Biological Effects of Petroleum and Metal in Arctic/ Subarctic Marine Systems.	Background for future work.	(Same as product column)	Narrative Report	75	FY 76 Completion	1
F-2	Graphs and tables showing acute effects of crude oil on: -zooplankton -littoral and benthic biota -nearshore fishes -pinnipeds and sea otters -herring roe hatching survival -Dungeness crab eggs and larvae -birds	Prediction of field effects of contaminants on organisms as basis for developing discharge regulations and operating stipulations.	Figures and reports on effects of acute exposure to Alaskan crude oil on survival of selected marine organisms, including interactions of petroleum effects with environmental parameters (mostly for experiemental design of sublethal exposures).	Narrative Reports Charts Graphs Tables	072 P320 500	Ongoing FY 78 Start FY 79 Completion	3-5
			Reports and tables on relative biological effects of various chemical fractions of petroleum. Reports, graphs, and tables documenting effects on survival of seabirds.	"	423 096	FY79 Complet. FY78 "	2-3

DATA PRODUCTS							
Task	Product	Intended Use	Specific Product	Format	R.U.	Status	Project Duration (Yrs.)
			Tables and graphs showing turnover of contaminants, tissue distribution, and effects on growth, metabolism, reproductive, behavioral and biochemical parameters.	Narrative Reports Graphs Charts Tables	072 073 P320 500	Ongoing Ongoing FY 78 Start FY 79 Completion	6-10
			Photomicrographs of histopathology of exposed organisms compared to control organisms.	"	P040 423 096	FY 78 Start FY79 Complet. FY78 Complet.	6-10
F-3	Graphs showing effects of petroleum contaminants on thermoregulatory mechanisms.		Graphs illustrating effects of petroleum fouling on metabolism, temperature regulation and behavior of sea otters; behavioral reactions of sea otters to floating oil.	"	071	FY 79 Completion	4-5
F-4 & F-5	Graphs showing bioaccumulation of hydrocarbons and other OCS contaminants through various exposure pathways.	To evaluate probable exposure pathways for contaminant impingement on organisms, and resultant effects as a basis for developing discharge regulations and operating stipulations.	Tables and graphs showing hydrocarbon and metal accumulation by experimental organisms. Graphs showing accumulation and turnover of petroleum constituents at each trophic level of an experimental food chain.	"	454 073 500 389	Ongoing Ongoing FY79 Complet. FY78 Complet.	6-10

DATA PRODUCTS							
Task	Product	Intended Use	Specific Product	Format	R.U.	Status	Project Duration (Yrs.)
F-6	Graphs of recovery rates of selected organisms and ecosystems from perturbations caused by petroleum development.	To evaluate recovery potential of organisms exposed to contaminants in terms of probably survival and food quality.	Graphs of hydrocarbon depuration by selected marine organisms.	Graphs Narrative Reports	071 072 073	FY79 Complet. Ongoing Ongoing	6-10
F-6	Summary report on nature and extent of biological and ecological impacts associated with past OCS developments worldwide.	Synthesis of information; identification of information gaps; project design.	Comprehensive Report	Narrative Report Charts Graphs Tables	P921	FY 79 Start	1-2
F-6	Experimental data on effects of OCS-related perturbations on Alaskan bird colonies.	Establishment of casual relationships, nature and magnitude of OCS effects.	Graphs and tables illustrating types of effects, extent of change, and recovery rates.	Narrative Report Charts Graphs Tables	P924	FY 79 Start	2-4
F-7	Graphs and pictures of types and incidences of disease and effects of petroleum on disease susceptability in fish, shellfish, birds and mammals.	Measure of effects as basis for developing discharge regulations and operating stipulations.	Graphs and tables on histopathologic and metabolic upsets as a result of oil exposure.	Narrative Report Graphs Tables	073	Ongoing	6-10
		Benchmark on disease incidence for future comparison.	Graphs on disease incidence in nearshore marine organisms.		332	FY 78 Completion	6-10

DATA PRODUCTS							
Task	Product	Intended Use	Specific Product	Format	R.U.	Status	Project Duration (Yrs.)
F-8	Graphs showing ecological effects of alternative countermeasures to oil spills.	Measure of effects as basis for discharge regulations and operating stipulations.	Graphs showing toxicological effects of exposure to drilling chemicals and dispersants in marine organisms.	Maps Charts	072 073	FY 78 Start	By Sale Date
F-8	Experimental data on effectiveness of deterrent and scare devices for avoiding damage to birds from spilled oil.	Development of techniques to mitigate spill effects.	Graphs and tables illustrating effectiveness of different techniques.	Narrative Report Charts Graphs Tables	P917	FY 79 Start	1-2

☆ U.S. GOVERNMENT PRINTING OFFICE:1979—677-072 / 1239