Environmental Assessment of the Alaskan Continental Shelf

Executive Summary

.IS

April 1978 - March 1979

GC
85.2
.A4
E571
1979

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

Environmental Assessment of the Alaskan Continental Shelf

EXECUTIVE SUMMARY

April 1978 — March 1979

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Boulder, Colorado 80303

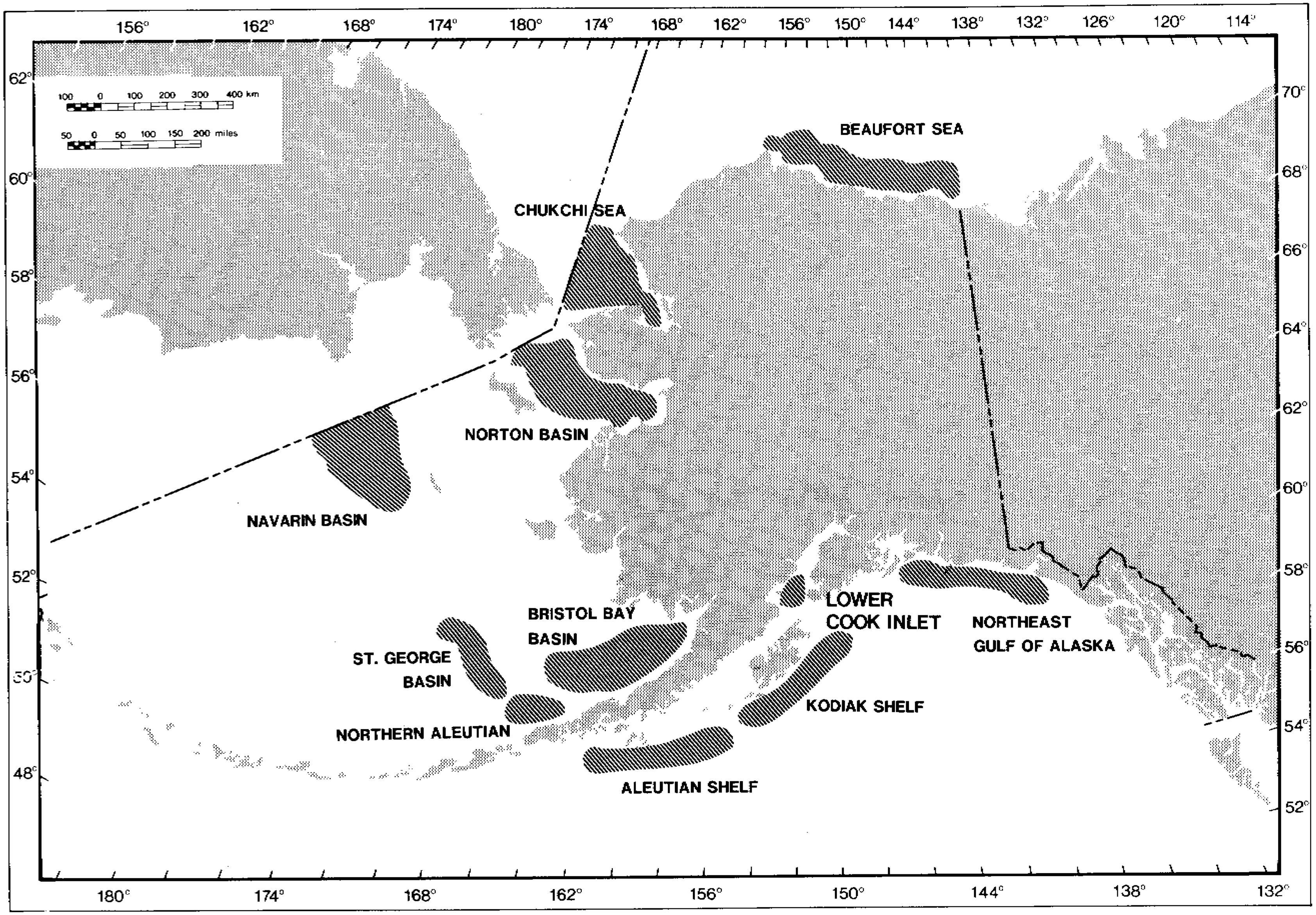

Figure 1. Map of Alaska showing lease areas

CONTENTS

CONTENTS
(cont.)

ALASKAN MARINE CONCERNS AND KEY ISSUES

A Message From the Director

The Outer Continental Shelf Environmental Assessment Program (OCSEAP) has focused on nine lease areas on the Alaskan Outer Continental Shelf (OCS), extending from the Northeast Gulf of Alaska (NEGOA), around the Aleutian Islands into the Bering Sea and above the Arctic Circle to the Beaufort Sea.* Two more areas (Navarin Basin and North Aleutians) were added in FY 79.

The vast geographic area included involves extreme environmental conditions, which makes for great difficulty in obtaining marine environmental information and is largely responsible for the scarcity of data on the Alaskan OCS, less than on any other shelf and coastal area of the United States. The existence of oil under the shelf, the demand for new domestic sources of energy, and recognition of the lack of the basic information required to protect the resources and beauty of the area have accented the need for a well-developed research program.

In each OCS area for which development is proposed, extensive environmental studies must be conducted before such development can proceed with safety. Through an interagency agreement with NOAA, the Bureau of Land Management requested that OCSEAP conduct such studies to provide a basis for decisions necessary in their leasing process. Four classes of information are required:

1) Location of the critical wildlife habitats that must be protected.
2) Prediction of the effects from any pollutant release or other insult.
3) Identification and development of new monitoring techniques.
4) Definition of stresses that the environment puts on man-made structures, so that the number of incidents involving safety and pollution may be reduced or avoided.

---

* See Figure 1.

To meet these information needs, especially the one of prediction of effects, a wide variety of essential biological and physical studies have been directed toward understanding the processes and relationships in the environment. The environment is complex; consequently the manner in which these studies relate to one another and to oil and gas development is not easily recognized.

OCSEAP is systematically developing all four classes of information in each of the areas proposed for leasing on the Alaskan OCS. This effort is described in OCSEAP's Program Development Plan, the Technical Development Plans for FY 80, and the many reports generated by the program. Within the context of the effort, a number of serious concerns or "key issues" have already been identified in the Alaskan marine environment. A short discussion of these illustrates the nature of OCS-related environmental problems confronting the OCSEAP. It also provides a brief overview of the scope of OCSEAP content and demonstrates the imperative nature of the studies. The key issues listed do not include socio-economic or non-petroleum contaminant issues, such as sewage disposal, nor certain engineering design issues which are not assigned to OCSEAP for planning and management, but which are known to be of considerable significance.

Rudolf J. Engelmann
Director, OCSEAP

1979 KEY CONCERNS AND ISSUES

The environmental issues and concerns arising as a consequence of the forthcoming OCS sales (see latest schedule, Fig. 2) are important as being pertinent to tract selection decisions and the formulation of operating orders and stipulations for exploration. It is probable that others will be added as a consequence of any oil discovery and its attendant development and production activities. These cannot be fully specified in advance as they will depend on the course of development.

The major environmental issues may presently be classified under four or five generic categories: (1) environmental hazards to OCS structures and activities; (2) pollutant transport patterns; (3) commercial fisheries; (4) habitats of major importance to biota; and (5) endangered species.

SUBARCTIC: NORTHEAST GULF OF ALASKA - Sale #55

Hazards

Geological processes are very active in the Yakutat region, as evidenced by frequent earthquakes and tectonism, pronounced localized erosion and sediment deposition, and seafloor faults and slumping. Furthermore, the region routinely experiences intense storms accompanied by large seas. Information on these hazards is crucial for deselection of tracts, platform design and siting, and pipeline design decisions. More specific needs are: to monitor the location of earthquake epicenters; to determine ground accelerations associated with major events and estimate seismic risk; to identify potentially active surface faults and correlate this activity with quake occurrence; to assess the seafloor sediments with respect to potential for slumping, liquefaction, load-bearing capacity failure, and erosion or deposition; and, finally, to determine extreme wind and wave probabilities. Failure to obtain such information could result in inadequate design, siting or emplacement of structures, possible loss of property or life, and, if oil is spilled, in environmental damage. Similarly, lack of information could result in overdesign or over-regulation, with consequent higher costs to industry and the public.

Figure 2. PROPOSED OCS OIL AND GAS LEASE SALE SCHEDULE

JUNE 1979

SALE AREA	1979[1]	1980	1981	1982	1983	1984	1985
A62 Gulf of Mexico	E H	F P SC R N S					
55 Gulf of Alaska	E H	F P SC R N S					
62 Gulf of Mexico	E H	F P SC R N S					
46 Kodiak	E	H F P SC R N S					
53 Central N. Calif.		E H F P	SC R N S				
A66 Gulf of Mexico	C D T	E H F	P SC R N S				
56 South Atlantic	C D T	E H	F P SC R N S				
60 Cook Inlet	D T	E H	F P SC R N S				
66 Gulf of Mexico	C D T	E H F	P SC R N S				
59 Mid-Atlantic	C D T	E	H F P SC R N S				
67 Gulf of Mexico		C D T	E H F P SC	R N S			
68 Southern California[2]	C	D T	E H F	P SC R N S			
52 North Atlantic	C D	T	E H	F P SC R N S			
57 Norton Basin	C D	T	E H	F P SC R N S			
69 Gulf of Mexico		C D T	E H	F P SC R N S			
70 St. George Basin	C D	T	E	H F P SC R N S			
71 Beaufort Sea	C D	T	E	H F P SC R	N S		
72 Gulf of Mexico			C D T	E H F P SC	R N S		
73 California		C	D T	E H F P	SC R N S		
74 Gulf of Mexico			C D T	E H	F P SC R N S		
75 No. Aleutian Shelf		C D T		E H	F P SC R N S		
76 Mid-Atlantic			C D T	E H	F P SC R N S		
77 Gulf of Mexico[3]			C D	T E	H F P SC R N S		
78 So. Atlantic/Blake			C D T	E	H F P R N	S	
79 Gulf of Mexico				C D T	E H F P SC	R N S	
80 California			C D	T	E H F	P SC R N S	
81 Gulf of Mexico				C D T	E H F	P SC R N S	
82 North Atlantic				C D T	E H	F P SC R N S	
83 Navarin Basin			C D	T	E	H F P SC R N S	
84 Gulf of Mexico				C	D T	E H F P SC R N	S
85 Chukchi Sea			C D	T	E	H F P SC R	N S

C - Call for Nominations
D - Nominations Due
T - Tentative Tract Selection
E - Draft Environmental Statement
H - Public Hearing
F - Final Environmental Statement
P - Proposed Notice of Sale
SC - State Comments Due
R - Energy Review
N - Notice of Sale
S - Sale

[1] The 1979 Column is included to indicate the pre-lease actions required for OCS lease sales scheduled for the period 3/80 - 2/85. Sales scheduled for dates in the latter half of 1979 include:
48 So. California June 1979; 58A Gulf of Mexico Nov. 1979; 58 Gulf of Mexico July 1979; Beaufort Sea Dec. 1979; 42 North Atlantic Oct. 1979

[2] Includes Santa Barbara Channel.

[3] This sale has been included in this schedule in order that planning may be commenced. Subsequent events (e.g., deletion of another sale from this schedule) will determine whether this sale will be held as indicated, held at some other time during the 5-year period, deleted or postponed until after February 1985.

Transport

Seasonal current patterns in the Yakutat region are not well known. More refined observational data are needed to improve the predictions of the probable directions and rates of transport of surface-borne pollutants from sources in the areas of the lease sales and to identify habitats and biota that may be at risk. Coastal vulnerability studies indicate that petroleum reaching the beaches on the eastern side of Yakutat Bay may remain for years. Also, strand lines inside river estuaries in the region suggest that a major spill event accompanying a severe storm could result in oil overwashing sand spits at estuary mouths and impacting the relatively vulnerable habitats within.

Commercial Fisheries

The region of Sale #55 and adjacent Fairweather Grounds support significant domestic fisheries for Dungeness and Tanner (snow) crabs, several species of salmon, and halibut. The fisheries are major contributors to the local economy and also provide income to fishermen from other parts of Alaska and elsewhere. The outer part of the continental shelf has been a consistently productive area for foreign trawl fisheries targeting on Pacific ocean perch, sablefish, walleye pollock, and several flatfish species. With the advent of the 200-mile fisheries jurisdiction, it is likely that the offshore groundfish stocks will be increasingly exploited by American fishermen.

Currently, little is known about the seasonal distributions of early life history stages of commercial finfish and shellfish in this region. Therefore it is not possible to assess the vulnerability of these species to contaminants. Millions of juvenile salmon annually migrate through the sale area during the spring-fall period. Young fish seem to concentrate in nearshore surface waters and would be susceptible to oil. Similarly, the epipelagic eggs and larvae of other commercial species would be at risk from spilled petroleum. Associated with the above is a need for information on areas of concentration of particular richness of forage fishes and benthos. Many of these biota have commercial potential (e.g., herring, capelin) or are prey of commercial species. Finally, these is a need to assess the potential for impacts on Alaskan corals by an evaluation of their biology and the commercial fishery for corals. The information obtained will be used with oil spill trajectory model results to identify particularly critical areas and time periods and possibly form the basis for tract deletions and the specification of protective stipulations.

Habitats

The seasonal intensity and nature of the use of estuarine habitats in the Yakutat-Fairweather region by water-related birds and, in shelf waters, by cetaceans, is not well known. Casual observations indicate that hundreds of thousands of waterfowl, seabirds, and shorebirds may be present at times in coastal estuaries and Yakutat Bay. The major bird concentration areas and timing of habitat use must be known before informed assessments of vulnerability to oil spills can be made or stipulations to minimize disturbance developed.

Endangered Species

Several endangered whale species have been observed in the lease sale area. Included among these are humpback and gray whales. Numbers of humpback whales forage in the Yakutat-Fairweather continental shelf region in late winter and spring. In addition, most of the eastern Pacific gray whale population is believed to transit through Yakutat coastal waters in spring and autumn enroute to summering and wintering areas. Legislation (Endangered Species Act of 1973) mandates that lease sale decisions and exploration plans ensure that these and other endangered animals are not disturbed or otherwise adversely affected as a consequence of OCS activities.

Hazards

Seismicity: The Kodiak-Alaska Peninsula area is located in a seismically active zone. Hundreds of seismic events have been recorded in this area in the past 75 years. About 30 of these earthquakes were of magnitude greater than 6 on the Richter scale and two exceeded magnitude 8. Earthquakes of such magnitude are potentially disastrous; those of magnitude 7 or higher usually result in widespread and extensive damage. The greatest seismic hazard in this area is associated with potentially damaging earthquakes occurring in the "Shumagin gap" area. This area, 600 km in length and located between the Sanak and Semidi Islands, is considered the most likely site for a great earthquake (magnitude 8.0 or higher) within the currently expected span of oil development in the western Gulf of Alaska. Such an event may cause ground rupture in the vicinity of Trinity Islands, strong ground motion over large areas including the Kodiak Archipelago and shelf, sediment slides, and potentially destructive tsunamis.

Faults: Several shallow faults, some offsetting the seafloor and therefore likely to be active, occur across the shelf. In general, two northeast trending fault zones are known to exist in this area, one off the southeast coast of Kodiak, roughly coinciding with a zone of aftershock activity from the 1964 Prince William Sound earthquake, and the other located near the shelf break. Any wells that cut through a fault zone have an added risk related to movement of the fault.

Sediment Instability: Seismic reflection surveys have revealed no significant slumps or slides on the shelf, although major slides have been found on the continental slope. Geotechnical measurements are needed to identify areas with ground failure potential and to establish the degree of possible risk to structures and platforms placed on the shelf.

Gas Seeps: There is some evidence of gas-charged sediments on the shelf. A sample taken at the Chiniak Trough contained bubble-phase gas, probably biogenic in origin. Samples from other locations (portions of Middle Albatross Bank and Kiliuda Trough) show anomalously high concentrations of gas but not in bubble phase.

Transport

Contaminant input to the marine environment associated with OCS development may be in the form of regulated (e.g., drilling muds) or accidental (e.g., oil spills) discharges. In either case, contaminant dilution, dispersion, formation of plume, and surface trajectories are primarily dependent on prevalent conditions of turbulent mixing, currents, wind fields, and tidal mixing. Oceanographic data acquired and analyzed to date indicate the presence of three circulation patterns over the shelf and slope areas off Kodiak: (1) a swift, seasonally persistent, southwesterly flowing Alaska Stream seaward of the shelf break, produce by global wind forcing; (2) currents over the shelf, particularly the banks, are much less energetic, are noted for inconsistent direction and speed, and are dominated by tidal currents; and (3) a band of moderately strong southwesterly currents along the coastline produced by freshwater runoff. Depending upon the ocnsistency and speed of the mean flow, contaminants would remain for a longer period of time over the banks and other shelf areas but would also experience relatively high dispersion through tidal mixing. There is evidence of eddies northeast and south of Kodiak Island, which might retain contaminants in geographically restricted areas.

A contaminant trajectory model for the Kodiak shelf is under development. Its results will be coupled with an oil spill risk analysis model to determine the probable physical state and the concentration and chemical composition of released contaminants along and at the end of trajectories. These studies will also furnish data that can be utilized to minimize risks to the environmentally sensitive or biologically critical areas during various stages of oil and gas development and will include plans for clean-up operations and mitigating measures in case of an accidental spill offshore.

Commercial Fisheries

The Kodiak Archipelago and environs are noted for exceptionally high commercial harvest for marine finfish and shellfish resources. Kodiak is Alaska's premier fishing port and its future growth and prosperity are inextricably tied to growth in fishing and the fish processing industry. Commercial fishing in this area was traditionally reliant on salmon, supplemented by catches of halibut and herring. However, while salmon remains an important fishery, large catches of shellfish, notably the king crab, Tanner crab, shrimp and Dungeness crab, contribute significantly to the seafood harvest and the regional economy, including the area's seafood processing industry.

Salmon: It is estimated that, on the average, 12 million salmonids return to the Kodiak area annually, and the potential high run is 29 million fish. All five species of the Pacific salmon are caught commercially, with an average catch of about 8 million fish annually. The catch is dominated by pink salmon (which contributes over 80% of the total catch), followed by chum salmon (9%), and sockeye salmon (6%). Coho and king salmon commercial catches are small, although king salmon is a highly valued species and a primary target for sport fishing.

The five salmon species exhibit markedly different life cycles. The timing of spawning, larval development and juvenile outmigration vary with species and regional environmental characteristics, such as the type of substratum and water temperature. Salmonids enroute from offshore waters to the spawning grounds segregate into population units bound for specific spawning streams and into subunits segregated spatially and temporally within specific streams. The return to a spawning stream occurs at about the same time each year and is believed to be a function of genetic makeup and environmental factors such as temperature.

Because of the reliance of salmon on environmental cues to find spawning areas, contamination of the environment or impairment of the habitat may interfere with breeding and early development. Such interference, depending on its extent and duration, could cause the loss of a year class or an entire breeding population.

Shellfish: King crab is the most valued shellfish. Experimental trawl catch data and tagging studies have shown that there may be six relatively distinct population stocks of king crab around Kodiak Archipelago, the distribution of which appears to correspond to bathymetric features. Available data suggest that these stocks vary in population size and migratory behavior. Crabs of one stock are believed to move to particular inshore areas for spawning, fertilization and early development. Following the mating season, adults move back offshore to specific deep water areas. This aspect of the life history has important implications, as depletion or significant reduction of one stock (as a possible result of OCS activities) is not expected to be compensated through juvenile recruitment and migration of adults from other stocks.

Detailed life history information for other shellfish in this area is not available and it is not known if population stocks of any other shellfish are also distinctly separated.

Halibut and other Bottomfish: Kodiak is a major port for halibut fishing, which is managed by the International Pacific Halibut Commission. Halibut catches have declined recently; about 4 million pounds were landed yearly in 1976 and 1977 in the Kodiak area. Even though the present commercial catch is substantial, halibut is not viewed as a fishery with great promise for future development.

A large variety and extensive populations of certain bottomfish exist in waters around Kodiak. There are immediate plans to expand bottomfish fishing and processing capabilities in Kodiak. Initially, the bottomfish fishery will probably be based on commercial catch of large populations of Pacific cod, walleye pollock and arrowtooth flounder. This will mean that additional new areas will be utilized for fishing, and trawling activity will increase markedly over the shelf and slope areas.

Habitats

The most obvious biological features of the coastline and shelf waters of the Kodiak Archipelago are the abundance and richness of biota and high productivity. Certain species of mammals, birds and fish are of great aesthetic significance and important features of local culture and societies. Many regions are well known as areas for fish and shellfish spawning and early development (Alitak and Chiniak Bays), rookeries and hauling grounds of marine mammals (Marmot Island, Chirikof Island, Tugidak Island), sites of major bird colonies (Sitkalidak Strait, Barren Islands), and extensive macrophytic assemblages (Sitkinak Island, Ugak Island). These areas, among others, must be evaluated in terms of potential adverse impacts from oil and gas development. The further criteria of a species' uniqueness in the region, feeding and reproductive strategies, sensitivity to habitat disturbance, and population recovery potential must also be examined to define its value to the regional ecosystem and the consequences of significant population reduction.

Some species of birds and mammals, and especially their young, may be extremely sensitive to noise or other physical habitat disturbance. For, example, low-flying aircraft over Tugidak Island reportedly caused panic in the harbor seal population and resulted in a ten percent mortality of pups. There is meager and insufficient knowledge concerning avoidance behavior of birds and mammals or assessment of impacts at the population level.

Endangered Species

Seven species of whales and possibly two species of birds which occur in this area on a seasonal basis or at irregular intervals have been designated as endangered. Several of these species use the Kodiak shelf and offshore waters for feeding during spring and summer. Other species migrate through the area while in transit to their principal feeding or calving areas. The endangered species and their habitats, including their migratory range, must be protected from adverse impacts due to human activities or industrial development.

SUBARCTIC: LOWER COOK INLET/SHELIKOF STRAIT - Sale #60

Hazards

Geohazards: Prominent geohazards considered to be potential problems in the safe exploration, development, and production of oil and gas in Lower Cook Inlet/Shelikof Strait are seismic and volcanic activity, active faults, unstable bedforms, and severe bottom erosion.

A major concern relative to oil and gas structures and their placement in the lease area is the amount of relative risk due to seismic and volcanic activity associated with various locations. Adequate assessment of these risks requires long-term monitoring of seismic activity on a regional basis and adequate risk analysis.

Risk to platforms and pipelines due to movement of shallow faults requires a thorough mapping of such active faults throughout the lease area. In addition, unstable bedforms may pose risks. Mapping the location and extent of unstable bedforms and defining the degree of stability are necessary preliminaries to safe siting.

Experience of the oil and gas industry in Upper Cook Inlet shows that severe sediment erosion may be a particular concern in maintenance of pipelines in the Inlet. To locate the areas of dynamic sediment movement and determine the degree of erosional problems that might be expected are important if areas of high risk are to be avoided.

Transport

Circulation patterns in the Inlet are fairly well understood and are not considered as items of concern, although they need to be taken into account in issues of habitat protection and commercial fisheries. Trajectory analyses for these areas continue, and models are refined by application of new data.

Trajectory analysis gives a measure of probability of impact on major habitats during different seasons and wind and current regimes. Adequate interpretation of trajectory analysis requires additional information on oil weathering, spreading, and, especially in the case of the lease area for Sale #60, adsorption to and transport by suspended particles and deposition in the sediments.

Commercial Fisheries

Commercial fishing is important to the economy of the lease area. Major commercial species include pink, chum, sockeye, coho and king salmon, king, Tanner, and Dungeness crab, shrimp, herring, halibut, and razor clams. With the exception of halibut, no commercial ground fishing exists in the lease area. There is a potential, however, for the development of ground fishing in the future. Present information indicates that ground fish species are concentrated in the southern portion of Lower Cook Inlet and Shelikof Strait.

A major difference in the commercial fisheries of Lower Cook Inlet and Shelikof Strait is that the major harvest areas for most species are much larger in the latter. Major harvest areas for salmon are scattered throughout the strait and nearshore. Major herring catches occur between Kaguyak and Kukak Bays and between Kupreanof Strait and Uyak Bay. Shrimp are harvested in most bays on the east side of the strait, and between Cape Douglas and Hallo Bay. King, Tanner, and Dungeness crab are harvested throughout the strait. Since the area proposed for Sale #60 includes all of Shelikof Strait three miles offshore, it also includes most of the king and Tanner crab harvest areas.

Leasing of tracts, exploration, and development will have to take into consideration these important fishery areas and fishing activities in order to minimize and/or avoid impacts and to identify any operations that may conflict or interfere with normal fishing procedures.

Habitats

The identification of major biological habitats at risk from OCS oil and gas activities requires a thorough knowledge of the distribution and abundance of populations of birds, mammals, fish, benthos and associated species, trophic relationships, and seasonal activities. Of major concern are those habitats which would be most biologically sensitive to impacts (spawning or breeding areas, nursery and feeding areas) and the timing of their use for these activities.

The vulnerability of these habitats to impact from possible oil spills requires information on transport. The area of the marine system which has shown the greatest observable impacts from oil spills has been the nearshore zone, particularly the intertidal and beach areas. Identification of major habitats for multiple species use in the coastal area is required in addition to some measure for the longevity of spilled oil in such habitats. Habitats that have a potential for retaining spilled oil for long periods of time could then be considered as having a relatively high vulnerability to impact.

SUBARCTIC: EASTERN BERING SEA - First Sale #57

The Bering Sea has been studied by foreign and American scientists, resulting in much information. Information from all sources needs to be collected and synthesized before adequate direction can be given to future research. Informational synthesis, as well as the understanding derived therefrom, is currently the paramount issue for the Bering Sea OCS areas.

Hazards

Geologic hazards: Basic to the entire Eastern Bering Sea are seismic and sediment instability risks. Information is needed on the location and number of active faults, and on the effects of cyclic loading of waves on the stability of the sediments in the shallow Norton Sound. In order to accomplish the former a marked improvement of the Norton Sound seismic network is necessary. This will provide low level seismic detection of fault activity since dynamic bottom conditions prevent sediment accumulation, and, therefore, preclude using exposure at the surface of the seafloor as being indicative of recent fault activity. Geologic hazards in the rest of the Bering Sea, except for parts of St. George Basin, are relatively unknown and acquiring information will require a major effort in this direction.

Sea Ice Hazards: There is considerable risk to oil activities, structures and personnel by ice movement at sea and onto shore areas. Grounding of sea ice was prevalent during the late winter of 1979 in the southern part of Norton Sound. Ice conditions are never the same from one ice year to another. The acquisition of data on ice piling and gouging is difficult, so this is an important concern.

Gas Cratering: Apparently due to decaying peat in Norton Sound, gas cratering has been observed off Nome and the mouth of the Yukon River. The potential of cratering represents a threat to drilling rigs and transport pipelines. Past craters may have been obliterated by ice gouging, which occurs in water depths up to 30 m throughout the northeastern Bering Sea, particularly in close proximity to the delta of the Yukon River.

Natural Seeps: A major gas seep was located about 12 km south of Nome in 1976. Studies have been initiated to determine the kinds and distribution of hydrocarbons in the water column. A question that begs to be answered is: Of what do the current microbial populations near the seep area consist? The answer then needs to be compared with populations in or at the seep area in order to evaluate microbial degradation rates and to determine the microbial community structure that has been exposed to hydrocarbons from the seep. For this, organisms at and near the gas seep area need to be collected and subjected to a tissue analysis to determine the kind and extent of impact the seep hydrocarbons have upon the physiological well-being of functioning tissue and the possible presence or absence of tainting in the tissue of edible species.

Transport

Another major issue being considered is the development of an overall circulation and trajectory model of the Bering Sea. This model not only takes into account the shear turbulence created by the Bering Sea waters moving over this extensive shallow shelf, but also considers the seasonal under-ice currents existing in these lease areas. A complete picture of the Bering Sea circulation and trajectory analysis will only be realized when the nearshore patterns are better understood.

Effects of oil spills associated with ice is an issue of importance in the Eastern Bering Sea. There appears to be great vulnerability of island, estuary, lagoon, and shore habitats in much of the area because of surface currents. It is vital to know the circulation patterns and flushing times of all embayments and estuaries.

Norton Sound is subject to storm surges far above the usual tide levels. Past storms have been known to push water four meters above mean sea level. Associated with storm surges is the phenomenon of bluff erosion. This form of erosion needs to be examined and understood along the entire coastline where bluffs exist.

Commercial Fisheries

In a more specific sense the Eastern Bering Sea is a productive body containing some of the largest fish, crab, and marine mammal stocks in the world. Studies during the summer of 1979 evidenced again the tremendous sockeye salmon industry present here, with a commercial catch well over 15 million fish. Several factors contributing to this productivity may be affected by petroleum pollution. For example, the ice edge ecotone, which has been shown to be biologically important, would be likely to trap spilled pollutants in its leads and at the ice edge itself. Dissolved fractions would be carried into deeper water by the sinking of the surface waters along the ice edge.

Habitats

The Yukon Delta is both a critical habitat for vast numbers of waterfowl and salmon and an unstable, vulnerable foundation for construction by humans. It is underlain by permafrost and has major river flooding with snow melt and ice breakup. Its low elevation will permit the intrusion of contaminants on storm surges as far inland as 15 km or more. The exposed intertidal area may be as large as 500 km^2 and is an important unstudied foraging area for marine and shore birds, as well as waterfowl.

The Pribilof Islands are clearly unique and should be carefully protected. For a limited period, the bulk of the world's population of Red-legged Kittiwakes resides here, as well as the world's entire northern fur seal population. The birds are disturbed by noise and the presence of man or his pets, resulting in significnt losses in eggs or chicks. The seals are subject to cold exposure upon oiling, with possible dermal and mucous membrane damage. Oil contaminated water or food may cause enteric disturbances also. The islands are downstream from the southern Bering Sea lease areas and from Unimak Pass, which is an important route for tankers, thus increasing the vulnerability of the biota of and near the Pribilof Islands.

The world's total population of Black Brant and a major share of its population of Emperor Geese use the north side of the Alaskan Peninsula during migration. This peninsula separates the Bering Sea from the Pacific Ocean. An untimely, catastrophic tanker spill, well blowout, or pipeline rupture here could decimate these populations directly or through habitat destruction. Thousands of other avian species and forage fish use these same nearshore waters.

Although most visible major rookeries, hauling grounds, colonies, and foraging areas have been identified for many species, there are likely to be some major temporary and sub-seasurface essential habitats yet to be discovered for fish, birds, and mammals. Examples are spawning and breeding grounds or overwintering sites under ice, with heavy, temporary concentrations of biota.

The general issue is to determine the vulnerability to oil of finfish, shellfish, all forage species, decomposers, marine birds, and mammals. Further, there is a scarcity of winter data; little is known about the winter whereabouts of juvenile salmonids and forage fishes. Seasonal concentrations would be of great value in determining the timing of oil activities.

Endangered Species

The California grey whales migrate twice through areas in the Bering Sea OCS areas. Roughly 11,000 or 75 percent of these whales, which summer in the Bering Sea, migrate through Unimak Pass during a three-week period. If grey whales are at all vulnerable to activities relating to oil transport by tankers, then their movement through Unimak Pass is a matter of concern. Some evidence in California indicates that grey whales change their migration routes to avoid heavy ship traffic.

Bowhead whales (an endangered species) are known to winter in the eastern Bering Sea and congregate in substantial numbers near St. Lawrence Island. During their migratory phase in fall and spring bowheads may pass through the Norton lease area.

Habitat use, migratory pathways and feeding ecology of both gray and bowhead whales in the eastern Bering Sea are relatively little known. Further studies are needed to ensure that these and other endangered species are adequately protected during oil and gas exploration and development of the OCS.

ARCTIC: BEAUFORT SEA

Introduction

On 24-26 July 1979, a group of scientists involved in NOAA's Outer Continental Shelf Environmental Assessment Program (OCSEAP) met in Fairbanks for the third annual synthesis meeting on the Beaufort Sea. The purpose of the meeting was to consider the current status of environmental information useful in making leasing and post-leasing decisions in the Beaufort Sea, where the present lease schedule calls for a state-Federal government sale in December, 1979. A series of sale stipulations, operating orders and zoning ordinances drafted by the U.S. Department of Interior, the State of Alaska, and the North Slope Borough, provided a focus for discussion.

Brief discussions of these issues and the conclusions reached by the panels of scientific researchers are presented here. Although these recommendations may not all be accepted by the agencies involved, it is important to note the interrelationships and internal consistency among a number of the proposed stipulations.

Despite the participation of federal, state, and municipal agency representatives in the July 1979 Beaufort Synthesis Meeting, the conclusions reported here represent consensus views within OCSEAP and not necessarily those of any other agency. Further details may be obtained from the Arctic Project Office Special Bulletin #25, 9/15/79, Environmental Stipulations Relating to OCS Development of the Beaufort Sea.

Issue I. Limitations to the extent of the Beaufort Sea lease area as the result of extreme ice hazards.

In the development of the offshore oil and gas resources of the Beaufort Sea, the foremost hazards are caused by the presence of ice! To design, install, and operate systems that can successfully extract these resources, the nature of ice hazards must be thoroughly understood and safety features incorporated into the proposed offshore structures and procedures.

There are gradations in the intensity of ice hazards along the coast, particularly those perpendicular to the coast. The magnitude of the hazards also varies with the season and from year to year.

Considering, in addition to the environment, the time necessary to design and construct offshore equipment and structures suitable for arctic operations, the time necessary for transport and installation, and the time required to complete exploratory drilling (which could take two field seasons if restrictions are applied to the length of the drilling season), it is clear that a 5-year sale (one requiring production capability to be proved within 5 years) does not allow enough time for a gradual, safety-conscious development of the proposed lease area, initiating operations at sites where ice conditions are easiest to handle (within the 13 m isobath) and extending cautiously, after experimentation and verification, into the more difficult outer reaches. This more gradual method, which would be possible with a 10-year sale, would also allow for additional research and field studies on techniques for continuing and cleaning up a spill in broken pack ice. If the proposed Beaufort Sea sale is a 5-year sale, drilling sites should be restricted to regions inshore of the grounded ridge zone, presently suggested to be the 13 m isobath. Tracts that cannot be reached by directional drilling from sites inside the 13 m isobath should be deleted from the present sale.

Issue II. Monitoring Potential Ice Hazards

The Beaufort Sea nearshore environment presents hazards to exploration operations because the possibility of rapid motion of apparently stable, heavy ice against structures. During certain phases of drilling, movements sufficient to cause even minor structural damage could have serious results. A short-term warning system to provide sufficient time to seal off a well beforehand would thus enhance the safety of offshore operations.

Collecting information during operations to provide a data base for forecasting ice conditions is desirable, both for safety and for future use in platform design. It must be emphasized that operations in the Arctic will require new monitoring concepts and instrumentation, if adequate data on ice movements and forces are to be acquired.

Issue III. Biologically Sensitive areas within the Beaufort Lease Area

A. Three areas were considered to be the most biologically sensitive.

1. Cross and Pole Islands harbor nesting eider and other ducks from June 1 to August 15 in consistently larger numbers than on other islands of the lease area. These and other nesting birds have proved sensitive to disturbance by human activities and aircraft noise.
2. Stefansson Sound has boulder patches which support a unique marine community of diverse flora and fauna, which is possibly an important energy source for the surrounding marine benthos inhabitants. In lease tract 700, the biomass approximates that of kelp beds in boreal and temperate latitudes and is 200 times greater than the average benthic biomass of all other nearshore and inshore Beaufort Sea regions investigated. The species diversity is the highest of any area in the Beaufort Sea. It is the only known Beaufort Sea habitat of a particular assemblage characteristic to exposed boulders (kelp and other algae, anemones, soft corals, sponges, bryozoans, hydroids).
3. In spring, bowhead whale migration routes follow leads in the ice shear zone offshore of the barrier islands of the Beaufort, whereas during westward migration in the fall, whales sometimes enter Stefansson Sound or lagoons in the area. Gray whales infrequently enter the lease area, but migration routes are unpredictable.

Recommendations for protecting these biologically sensitive areas follow:

1. Aircraft should not be allowed to fly low over or land on Cross or Pole Island, nor other disturbing human activity be permitted.
2. Access to petroleum resources under lease tract 700 should be by oblique drilling from outside the tract.
3. Development in tracts downstream from lease tract 700 should include measures to assure protection of the kelp community from toxic or anoxic sediments, siltation or oil.
4. Exploitation of tracts adjacent to lease tract 700 should be permitted only after lessees conduct site-specific biological surveys and assure that no installations or activities shall affect rocky bottoms supporting kelp, bryozoans, sponges, soft corals, or other sessile, epifaunal or epifloral marine organisms.
5. Seasonal restrictions on drilling activities, rather than spatial, are considered more effective measures for protecting migrating whales.

Issue IV. <u>Siting of Industrial Facilities and Activities</u>

A. Effects of lease activities on free passage of fish and other biota

1. Fish

Most activities or structures would have only local effects with the possible exception of causeways. These may alter nearshore current, temperature, and salinity patterns in areas where fish concentrations are highest, but it is unlikely that small changes in habitat would disrupt fish migrations. Causeways or other structures which block or impede access to lagoon systems or overwintering streams could have an adverse effect on nearshore fish populations. More studies are required to resolve this issue.

2. Invertebrates

   Key bird and fish species in nearshore waters rely on epibenthic organisms for most of their diet. These organisms annually recolonize shallow nearshore waters. Any major obstruction to their movements in restricted areas (e.g., gaps between barrier islands) might result in a lower food supply for vertebrate consumers.

3. Birds

   Although elevated structures have proved hazardous to songbirds and shorebirds in other latitudes, similar structures in the Beaufort do not appear to have caused significant mortality to migrative birds.

4. Mammals

   Mammals in the Beaufort Sea are highly mobile and their movements or migration are not expected to be affected by structures.

It is concluded that despite the location of the Beaufort Sea lease area on the migrational routes for large numbers of birds, fish and mammals of local and international importance, the effects of most lease activities are probably negligible since the disturbances would be similar to naturally-occurring ones. Persistent noise from air or boat traffic, which might affect bird or whale movements, could probably be mitigated by stipulations. The effect of causeways of solid fill is a major concern which must be resolved so that no lasting or harmful effect derives from the location or construction and so that gaps are provided to avoid disruption of movements of organisms.

B. Buffer Zones for protection of fish-bearing streams

A buffer zone of 1500 ft (500 m) is desirable to separate water supplies or fish-producing water bodies from adjacent sewage ponds or oil storage facilities. This requirement may be too restrictive for small lakes and ponds containing only the widely-dispersed ninespine stickleback; however, but not in the case of flowing waters where it is necessary to retain a buffer to prevent discharges of toxic materials into downstream watercourses.

Issue V. Restrictions On Exploratory Drilling to the Period November 1 to March 31

In the event of an oil blowout or other major oil-spilling accident during summer, maximum biological impact is possible, with disastrous consequences to biota (birds, mammals, and important species of anadromous fish).

Summer is a period of intense biological activity, of primary production by ice algae, phytoplankton and macrophytes (to name a few) and of maximum organic detritus input, which supports a sizable fraction of the biota that would be sensitive in the event of a spill. Major spills at this time would therefore have most serious biological consequences.

Winter conditions of the fast zone will tend to help rather than hinder possible cleanup; the oil will have a much higher viscosity in winter, will tend to be semi-solidified by snow on the ice surface, and will tend to accumulate in the uneven under-ice surface if released beneath the ice. Extremely sluggish currents, high salinities, and low temperatures beneath the ice will retard dispersion, inhibit microbial degradation, and allow prolonged contact and dissolution of toxic aromatic fractions. For these and other reasons the winter scenario is considered to be less destructive.

As a consequence of the preceding, it is recommended that exploratory drilling be limited to the period November 1 to March 31 and that extensions beyond this time be restricted to those where prior demonstration by the lessee assures that control and cleanup of a spill could be accomplished before June 1.

The probability of a blowout or major spill is very low, but until industry can demonstrate that improved control capabilities exist, it is estimated that it would take at least 39 days to drill a relief well in order to stop a blowout. The March 31 cutoff date was selected to provide a maximum of 60 days prior to spring breakup to drill a relief well, if necessary, and to clean up the area before summer biological activity begins.

Issue VI. Restrictions on Borrow Removal

Development in the Beaufort Sea area is estimated to require 1 to 3 million cubic meters of gravel and other fill. Sources of fill are not very plentiful.

A. Inland sources

Removal of gravel from river channels and wetlands destroys valuable fish and bird habitat. Removal from upland sites or deep thaw lakes damages smaller and less crucial wildlife. Unless quarrying is done in winter, using ice roads, the access roads themselves will increase the demand for fill.

B. Shoal complexes

Offshore islands are emergent parts of broad, low shoals of gravelly fine sand, several kilometers wide, tens of kilometers long and 5-10 m thick. These are believed to be remnants or roots of former island chains, but their origin is unknown. Quarrying would have considerable negative impact, since the shoals cause grounding of pressure ridges and tend to control the position of the shear zone between shorefast and pack ice. Without the shoals, the shear zone might be displaced shoreward, reducing the area of shorefast ice.

C. Paleovalleys

Large supplies of gravel are available in the Sagavanirktok paleovalley and possibly in other paleovalleys not yet definitely known. Dredging here would destroy marine life in the immediate area, and would also affect marine life downdrift by turbidity and siltation. The impact of offshore dredging would appear to be acceptable on the open shelf, but more significant and possibly destructive in productive nearshore areas such as in and near the boulder patch. Dredging in the paleovalleys would also have no known effects upon erosional depositional processes several kilometers from the dredge site, but could cause accelerated erosion of island or mainland shores within one or two kilometers to the south and west of the excavation site.

D. Barrier islands

Offshore island chains are relict features of Pleistocene sediments that are rapidly disappearing. Most are migrating southward and westward or are being destroyed by wave attack and thermokarst collapse. Removal of sand and gravel would only hasten this process, resulting in loss of bird nesting habitat and shelter for large flocks of birds.

E. Mainland beaches

Only small amounts of gravel are obtainable from mainland beaches andremoval of gravel from these would cause dramatic increases in rate of coastal retreat.

In conclusion, quarrying and dredging should be prohibited on offshore islands, on offshore gravelly-sand shoals, and in a belt two kilometers wide adjoining all island and mainland shores. Because of uncertainties of the effects of turbidity and siltation, dredging should also be prohibited in the more biologically productive area in and near the boulder patch. Paleovalleys of the open shelf are environmentally preferable to mainland sites as sources of sand, gravel and mud fill.

Issue VII. Restrictions On Artificial Islands and Causeways

A. Artificial fill islands during exploration

Numerous sites will be required during the exploratory phase, requiring 1 to 10 x $10^6 m^3$ of fill. Sources of fill are in short supply on the North Slope. Use of temporary drilling structures during exploration may be expected to have the following effects:

1. Each temporary exploratory drilling structure will require excavation and burial of several acres of potential habitat. Most serious impacts would be expected in stream channels and/or lagoonal seabeds.
2. Increased stress will result on borrow sites, which, on land, are already stressed by previous excavations.
3. Artificial habitats will encourage the development of new ecosystems in the vicinity of newly constructed islands.

Available evidence (primarily from the Mackenzie Bay experience in Canada) suggests that artificial gravel islands do not constitute a severe disturbance of the environment if the fill material is taken from an acceptable location (see Issue IV). Some sea bottom habitat may be destroyed where the island is located and sediment plumes may affect adjacent areas. These disturbances are, in most cases, considered to be minor, and habitats created by the island itself may offset such effects. If left to decay naturally, the island probably will soon assume the character and shape of a natural feature.

B. Continuous and non-continuous fill causeways

Effects of year-round access to offshore facilities by causeways could be the following:

1. The large amount of fill required might cause destruction of marine habitats by burial and siltation and by channel modification.

2. Causeways may affect circulation patterns, biological environments, ice movements and the nearshore thermohaline regime, and this would, in turn, cause alteration of nearshore processes of erosion, deposition, ice breakup and freezeup.
3. Causeways may serve as barriers to fish migraton, if appropriate openings are not provided.
4. Erosion and causeway maintenance will alter sediment transport routes and create a continuing need for fill.

   Continuous-fill causeways are undesirable, and adequate breaks should be provided for fish and mammal migration and for water exchange.

Issue VIII. <u>Disposition of Formation Water, Drilling Muds and Solid Wastes</u>

A. Formation water is a necessary part of the oil extraction process. It is generally anoxic, possibly highly saline, and contains variable quantities of dissolved aromatic hydrocarbons, which are known to be toxic to marine organisms at very low concentrations. It is believed that formation water should not be discharged into the poorly flushed nearshore marine environment; there are acceptable alternatives.

B. Drilling muds may introduce heavy metals into the arctic marine environment. This possible source of toxicity should be considered. According to present levels of knowledge, drilling muds should not be discharged into the nearshore Beaufort Sea, but should be brought ashore for proper disposal.

C. Solid wastes, particularly oily ones, are an undesirable additive to nearshore waters or artificial islands. However, clean cuttings constitute a large volume of relatively inoffensive waste which can be incorporated into artificial islands.

Issue IX. Oil Spill Countermeasures and Contingencies.

If a release of pollutants should occur despite safety precautions, it would first be necessary to predict the trajectories of the pollutants in order to bring an effective clean-up plan into operation. There are difficulties in accurately forecasting the movement of the pollutants due to several factors and difficulties in cleanup in the presence of ice.

A. Meteorological and oceanographic aspects

During the open water season in the Beaufort Sea circulation is wind-driven, and currents are difficult to predict on a long term basis. A surface slick from a spill in the summer open water season would reach the shore in less than half a day, given 5 m/s winds from the ENE. Longshore currents would increase the time to reach the beach, but at the same time the size of the slick would increase. Winter currents are very low, about 2 cm/s, and this would minimize the spreading and dispersion of foreign substances introduced into the water column in winter.

B. Ice Aspects

The outer edge of the shorefast ice zone coincides approximately with the 13 m depth contour. Low temperature and the proximity of ice tend to slow the movement of spilled oil, but the ability to predict ice movements, and hence forces on structures or pipes, is not well developed.

C. Clean-up difficulties

A general lack of roads, equipment and work force would slow response to a clean-up operation. Also, there is a lack of clean-up technology for oil mixed with broken pack ice. However, due to the quasi-solid nature of ice, containment could be achieved by over-ice travel. If cleanup were not accomplished during winter, ice motion following breakup would tend to disperse spilled oil over a very much larger area.

D. Biological aspects

The greatest importance is attached to the high level of biological activity in summer (Issues III and IV). The locations of vulnerable populations and the time periods when they are present should be considered in contingency and clean-up plans.

Greater industry commitment should therefore be required in the areas of instrumentation, development, containment, and clean-up technology. Separate clean-up strategies must be developed for winter months and for the fall and spring periods when broken ice is present.

Issue X. Freshwater Supply for Industrial Activities

Freshwater supply requirements (currently about one million gallons) will increase with increasing activity in the Beaufort Sea. Pumping from deep pools in river channels is a very unsatisfactory solution as this results in severe mortality to the fish using these pools as overwintering habitat. Large scale reservoir construction has currently solved this freshwater supply problem, so this issue must be viewed in the context of continuation of evolved policy.

Acceptable proposed approaches include storage reservoirs melting of snow or multi-year sea ice, and use of natural lakes where no overwintering populations of fish with a recognized sport, commercial, or subsistence value are present.

Issue XI. Aircraft and Noise Disturbance

Aircraft, especially helicopters, flying at low levels, have been identified as a primary cause of disturbance to birds and large mammals. In fact, aircraft overflights were identified as a dominant factor in the abandonment of the Howe Island snow geese colony during the summer of 1977. To prevent such effects, fixed-wing aircraft and helicopters should avoid flying over the following areas at altitudes of less than 500 m (1500 ft.):

1. Cross Island, Pole Island, and the Sagavanirktok and Canning River deltas during the bird nesting, brood-rearing and molting period (May 20 - August 1);
2. The area less than 22 km (15 miles) inland between the Kuparuk and Canning rivers during caribou calving (May 15 - June 25).

At present no experimental evidence is available to indicate that bowhead whales are either positively or negatively affected by noises associated with oil and as exploration.

It is recommended, however, that:

- o Noise levels in marine environment be reduced to a minimum.
- o Seismic operations should be discontinued in water depths over 18 feet (about 6m) during period from March 20 to ice breakup, when ringed seals are pupping.
- o Seismic operations should be conducted only along prescribed routes with no deviations, so that whale migration routes and seal colonies will not be affected.

Issue XII. <u>Duration of Lease Period</u>

Several reasons for considering the length of the lease period as an issue include:

1. Consideration of ice hazards resulted in the conclusion that the area outside the 13 m water depth represents considerably higher risks to offshore development than the area shoreward of this boundary. This depth contour is considered to be the inner boundary of the grounded ridge zone and the outer edge of relatively stable shore-fast ice. Nevertheless, even within the 13 m depth zone, major ridging events and significant ice motion are possible throughout the winter and spring. It is unlikely

that research and engineering efforts by industry, to assure safe design and operation in the area outside 13 m, could be completed within the time limitations imposed by a five-year lease (production capability must be shown within 5 years) (see also Issue I).

2. Restriction of the leases to a five-year period would also result in an intense level of activity through the entire period. Impacts of oil and gas exploration would be accelerated. The impacts would include gravel mining, marine habitat destruction and siltation, noise, and general low-level pollution effects. In addition, it is likely that a larger number of gravel islands and wells would be required if the five-year limitaton remained in effect than would be needed if the leases were for longer time periods.
3. The imposition of a five-month drilling window per year limits the effective length of time available for actual drilling to only 25 months during the five-year lease option. This, with other limitations to operations which may be imposed for specific cases (e.g., cessation of some operations during bowhead whale migrations) could increase the costs of exploration while decreasing efficiency. Alternatively, it may force the taking of risks which could be avoided if there were a longer time frame for exploration.
4. A longer lease period would permit the continuation of research in several critical environmental and technological areas. These include studies of bowhead whale migration routes and response to noise, additional studies of the kelp communities of the boulder patches, and improvement of oil spill clean-up technology in ice-infested waters.
5. Scientists working in the Arctic have supported the concept of gradual extension of exploration from shallow

to deeper waters, as experience progresses. The five-year lease sale makes staged exploration considerably difficult. It is, therefore, recommended that the time period for which the leases are valid be extended from five to ten years.

Issue XIII. <u>Long-Term Monitoring and Assessment</u>

Long-term effects of OCS development on the arctic environment should be monitored and assessed. Monitoring strategies must be developed for hydrocarbons or other toxic substances, changes in biological populations and processes, effects of structures on erosional processes and effects of sea ice forces on structures. It is recommended especially that stipulations include requirements for an appropriate system for monitoring ice conditions during operations and for developing methods for using the data for prediction of ice events which might affect operations and endanger safety.

RESEARCH HIGHLIGHTS

The following results from OCSEAP studies in the year ending March 31, 1979, have been briefed from annual highlights and status reports provided by the Juneau and Fairbanks Project Offices. Details concerning any particular item can be obtained from the annual report for that item. Annual reports are arranged according to category and discipline as follows:

VOLUME I	Receptors -- Mammals -- Birds
VOLUME II	Receptors -- Birds
VOLUME III	Receptors -- Fish, Littoral, Benthos
VOLUME IV	Receptors -- Fish, Littoral, Benthos
VOLUME V	Receptors -- Microbiology Contaminant Baselines
VOLUME VI	Effects
VOLUME VII	Transport
VOLUME VIII	Transport
VOLUME IX	Hazards
VOLUME X	Hazards Data Management

The above volumes and other OCSEAP publications are available on request from the Publications Officer, Rx4, OCSEAP/NOAA, Boulder, CO 80303.

MAMMALS

The final report on natural history and ecology of the bearded seal (*Erignathus barbatus*) is a comprehensive ecological characterization of a taxon found in Arctic regions (Eskimo, "oogruk"). A discussion of growth, reproduction, age, and sensitivities to environmental disturbances including noise, pesticides, and heavy metals are included as well as a section on socio-economic values of bearded seal harvesting.

Another partial final report, dealing with all Alaskan marine mammals describes seasonality of prey selection, competitive interactions between species, and two trophic systems in the Beaufort Sea one pelagic and the other benthic-based. Gaps in understanding pointed out include information on arctic cod, pelagic amphipods, mysids and euphausiids. Further efforts will focus on these and other interpretations for defining vulnerability of trophic webs in the arctic regions.

A final report on cetaceans in Prince William Sound was also received, describing seasonal sightings, behavioral patterns, use of habitat and reactions to survey vessels.

Results from field efforts of the past year substantiated a general movement of sea lions from west (Marmot and Sugarloaf Islands) to east (Prince William Sound, Cape St. Elias, Middleton Island, and possibly southeastern Alaska).

BIRDS

A cumulative, synthetic treatment of bird research in the Chirikov Basin of the Bering Sea over a three-year period has been completed. Ledyard Bay, northeast of Cape Lisburne, has been determined to be a candidate for special habitat protection because of the highly productive feeding opportunities it offers to large numbers of seabirds. Selected areas were studied with varying degrees of thoroughness, particularly emphasizing Black-legged Kittiwakes and Common Murres. The studies provide an effective ecological background for further studies on feeding areas and processes, prey species, and spatial differences.

Analysis of data has begun on biological responses of littoral shorebird species to disturbances typically associated with oil and gas development activities. A critical information gap is related to predictions of impact on populations by perturbations due to spilled oil.

Processing of transect data collected over a 3-year period, primarily in the Gulf of Alaska, has now been completed and analysis of that data will begin soon.

One study provides an overview of interconnections between littoral, pelagic and ice habitat use patterns by birds over a 3-month "typical" Arctic summer. It provides a broad perspective delineating critical periods and habitats of most importance to major bird species. A re-census of Glaucous Gulls is recommended because of marked increases noted in 1 to 3 year old immatures in the Beaufort/Chukchi areas since 1976. If these are now swelling the ranks of adult breeding birds there is cause for concern about the effects of this increase of predator-scavenger gulls on other birds.

A "Catalog of Alaskan Seabird Colonies" published by U.S. Fish and Wildlife Service is the result of investigations by another group. Data from more than 100 sources are presented on over 1000 sites for nesting involving about 22.5 million birds. Total population of Alaskan breeding species is estimated at some 40 million birds excluding Southern Hemisphere breeding shearwaters.

Some decreases in type of surface feeding seabirds in 1978 were ascribed to unavailability of some species of fish. On the other hand substantial increases of breeding bird populations have occurred on Middleton Island. These were attributed to possibly additional habitat created by uplift of the island during the 1964 earthquake.

Northern Bering Sea investigations over the past three years report spatial and temporal patterns and limiting factors in biological parameters (production, predation, growth rates, diet species) for a subset of major colonies and aggregations of seabirds in and around the Chirikov Basin. Localities centered on King, Little Diomede and Sledge Islands and Bluff Cliffs involved Black-legged Kittiwakes and Common Murres in a most rigorous investigation.

Another portion of the same report deals with a pilot project using radar imagery to investigate timing and volume of seabird migrations through the Bering Straits.

Initial modeling results from studies on murres in the Pribilof Islands indicated that most of the foraging activity during the breeding season was restricted to an area within 40 km of St. George Island. Simulations project a 30-50% mortality from a moderate spill, and as much as 40% mortality from even a small spill occurring at a critical time and location.

Kittiwakes (95% of the world's population on St. George Island) appear to be sensitive in two areas within 30 km of St. George Island, but their main distribution and sensitivity area is a corridor extending toward the continental shelf break SSE of St. George. Spills of over 1,000 barrels of oil could result in a 10-20% breeding adult mortality in this area even at distances as much as 150 km from the island.

Modeling also indicates that chronic effects of oil development and associated activities may be more damaging to avifaunal populations than short-term effects of an oil spill.

FISH, LITTORAL BENTHOS, etc.

Information focuses on the snow crab (*C. bairdi*) as the dominant taxonomic group on the NEGOA shelf. Highest densities are found in the Copper River Delta, southwest of Kayak Island, which is known to be an area of high productivity. A major snow crab nursery is found in the deeper waters east of Cape Douglas, extending northward to an associated area NNE of Augustine Island. Studies of feeding habits show rather varying, widely distributed feeding clams, hermit crabs, barnacles, and crangonid shrimp.

Meroplankton studies show the larvae of three species of crabs to be most abundant in Kachemak Bay - *Paralithodes camtschatica*, *Chionecetes bairdi*, and *Cancer magister*.

Results of 1976-77 field work have been summarized in a report on finfish surveys in Norton and Kotzebue Sounds. Most numerous species (in descending order) were Pacific sand lance, pond smelt, juvenile pink and chum salmon, saffron cod, starry flounder, and Pacific herring. Based on an index of vulnerability of coastlines to oil, the most vulnerable coastal segments of Norton and Kotzebue Sounds are thought to be the Seward Peninsula between Golovin Bay and Kotzebue Sound and the Yukon River delta. Further Bering Sea studies suggest that demersal finfish and shellfish communities may be characterized by broad-scale, major features such as outer shelf, central shelf, or southern deep-water species groups. Another milestone in investigations of non-salmonid pelagic resources in the Eastern Bering Sea and in the Gulf of Alaska is a three-part report containing reviews on each species, maps of relative abundance, and data appendices.

Some results of studies in the Beaufort/Chukchi systems are:

1. The biotic community in Stefansson Sound "boulder patch" is a unique biological feature dominated by kelp (*laminaria* spp), which puts on its major annual growth spurt between November and January, in total darkness.
2. Of the Arctic salt marshes, those on the Beaufort Sea are more sensitive than those of the Chukchi area.

3. Information was obtained concerning the relevance of metabolic and digestive physiology of nearshore marine invertebrates to tolerances for overwintering conditions and the method by which these organisms secure energy from benthic detritus and terrigenous peat.
4. Seasonal trends indicate peak densities of infaunal and epibenthic invertebrates in the middle of the ice-free period in the 2 to 10 m zone.

Overall plankton abundances and estimates of productivity were lower in 1978 than in 1976-77, possibly due to dirty brash ice in February and March. Investigations of Beaufort Sea benthos are being interpreted in terms of physical and chemical conditions at different depths and locations (such as ice scour, salinity variations, or sediment types). Questions of whether and how energy flows between epontic and benthic communities still remain to be answered.

Trawl surveys of epifaunal invertebrates in Norton Sound, Southeastern Chukchi Sea and Kotzebue Sound show highest biomass values for Norton Sound in an area off Nome extending northwestward toward the Bering Strait. Diversity was generally lowest off the Yukon River delta in the inner Norton Sound and off the northwest coast of the Seward Peninsula. The distribution was more diffuse in the Chukchi-Kotzebue Sound region. Highest values were found at two isolated stations in the Chukchi southeast of Pt. Hope, with highest diversity in Norton Sound between Nome and St. Lawrence Island and at an isolated station southwest of Rocky Point.

A biological sampling over the Kodiak shelf and adjacent slope waters was supplemented by hydrographic measurements and release of seabed drifters. Preliminary analysis indicates that there are season-specific and area-specific distribution patterns. The general area over the Kiliuda Trough, South Albatross Bank, and the Trinity Islands is characterized by large concentrations of ichthyoplankton and fish eggs. Species distribution in this region is clumped and patchy. Food web studies in nearshore Kodiak waters suggest that gammarid amphipods are an important food source for a variety of juvenile and adult fish.

In the Northeastern Gulf of Alaska work to date on shallow water fish communities has indicated composition variation with water depth, bottom topography and substrate, vegetation, and exposure to waves and currents. In contrast to the exposed location at Schooner Rock in Hinchinbrook Entrance, which showed basically similar large fish communities winter and summer, the protected eel grass beds in Constantine Harbor were barren of fish in late winter.

The accuracy of the benthic food web is impacted by the scarcity of information; however, an accurate picture of biomass for the entire benthos will be possible when infauna are counted.

ECOSYSTEMS

Ecological studies of intertidal and shallow subtidal habitats in Lower Cook Inlet show that shallow subtidal communities are well-developed and diverse, with distinctly different communities on the west side of the inlet as compared with the east side. The former appear similar to those of the Beaufort or Bering Seas, while the latter (e.g., Kachemak Bay) are representative of those in southeast Alaska and British Columbia.

Major kelp development in these habitats supports a diverse assemblage of herbivores and predators and probably also exports plant tissue to other habitats from Kennedy Entrance and Kachemak Bay.

Deposit and suspension feeders predominated in mud and sand flats of the Lower Cook Inlet. The relatively higher biomass of the mud flats indicates possible higher sensitivity to oil spill impacts, due to both the high productivity of forage food for shorebirds, diving ducks, fish, and crabs and to the potential for long-term retention of oil in such areas.

An ice edge ecosystem study on primary productivity, nutrient cycling and transfer of organic matter in the Bering Sea area indicates that as the phytoplankton bloom begins, the composition of the phytoplankters, rather than the density, undergoes distinctive changes. The exact dominant species varies at different stations although the basic assemblage remains constant. One controlling mechanism may be a complicated succession of dominant species. Another may be the geographic position of the ice edge at the time of the bloom, affecting the zooplanktonic grazing community present. The planktonic system is "uncoupled" by the sinking of phytoplanktonic cells out of grazing range with the cold dense waters of the ice edge and the contributing of their carbon to the benthos.

Some lagoon ecological studies along the Beaufort coast produced some new findings: an unexpected run of pink salmon, a massive influx of arctic cod into Simpson Lagoon, and evidence of decline in numbers of catchable cisco (least and Arctic) from the Colville River.

A study supporting ecological processes in nearshore under-ice waters has accumulated evidence that terrestrial carbon (about 62% of the total), including "old" carbon in coastal peat, is partly driving the nearshore food webs. Detrital carbon probably enters tissues of benthic crustacea by an elaborate series of steps; scintillation counts clearly indicate that benthic crustacea are stripping living microflora and meiofauna from the detrital material as the crustacea lack enzymes or intestinal flora to attack detrital cellulose and depend on the organisms to liberate peat energy.

Ice algae surveys point to the overriding importance of ice quality in limiting marine primary production in the Beaufort. As ice turbidity (or opaqueness) results in minimal counts of ice algae, light penetration far outweighs the influence of nutrient availability from the thermohaline convection mechanism ("nutrient pump").

MICROBIOLOGY

Numerical taxonomic studies demonstrate that microbial populations in Alaskan OCS areas are taxonomically distinct from previously described marine microorganisms. Alaskan populations were found to exhibit adaptive features such as the ability to grow at low temperatures and a high incidence of pigmentation in areas receiving intense solar radiation. Diversity of microbial populations seems to be a sensitive indicator of pollutant-related as well as natural environmental stress. Diversities were found to be lower in the Beaufort Sea than in the Gulf of Alaska or Cook Inlet, but they were high in the sediments of these regions. Diversities were also lower in areas of low current exchange, such as in gyres or in the area southwest of Augustine Island. A model experiment to determine effects of crude oil on diversity demonstrated that dramatic reduction in diversity resulted.

In Lower Cook Inlet, areas of probable hydrocarbon contamination, identified by high numbers of hydrocarbon-utilizing bacteria and degradation potentials in water and sediment samples, include Kachemak Bay, Upper Cook Inlet near Kalgin Island, and three bays north of Kamishak Bay. In the Beaufort Sea, similar indications of the presence of petroleum hydrocarbons are found in the vicinity of Demarcation Bay, and north of the Kuparuk and Canning Rivers. Low degradation potentials for complex polynuclear aromatics indicate a possible long residence time in sediments should contamination occur. Denitrification studies suggest a potential for markedly increased rates of denitrification if organic compounds are added to sediments. Increased rates could decrease the availability of fixed forms of nitrogen which are required by primary producing plankton and macroorganisms.

Data collected from Cook Inlet demonstrate the presence of two distinct water masses, highly turbid water of low salinity to the north and west, with high levels of microbial activity and low respiration percentages, and, to the south and east, open ocean water with low levels of activity and high respiration percentages. In both Cook Inlet and the Beaufort Sea, highest relative levels of activity in sediments were found near the mouths of large rivers.

The presence of crude oil was shown to decrease the rate of microbial activity, an effect that was more pronounced in water than in sediment samples. The degree of effect of crude oil on relative microbial activity and respiration varied with geographic area, and also with the amount of previous hydrocarbon exposure.

Information obtained on morbidity and mortality of marine mammals indicates that pinnipeds from the Bering Sea lease areas exhibit a higher incidence of pathological conditions than do their counterparts in the Gulf of Alaska. Evidence points to either a less stressful existence in the Gulf than in the pack ice of the Bering or a better adjustment to environment by pinnipeds in the Gulf. Beached carcasses occurred three and one-half times as frequently along the Bering coastline than in the Gulf/Kodiak, which might also be accounted for by the fact that a greater number occur naturally in the Bering as well as that they appear to be more subject to disease and to effects of the environment.

In particular, mortality and morbidity of gray whales seem to be on the increase, while rate of occurrence of walrus carcasses is remaining fairly constant, despite the fact that the walrus population is increasing.

The concentration of adenylates (used in the production of energy in living plants and animals), a measure of the biomass of the benthic community in Beaufort Sea sediments, was found to vary greatly with season, winter levels being much lower than summer.

In situ studies of oil biodegradation in the sediments of Elson Lagoon, Alaska, demonstrated that biodegradation did not appear to be a major factor in reducing higher molecular weight concentrations.

Several diseases of demersal fish and invertebrates have been observed in animals near Kodiak shores (such as epidermal cysts, skin tumors or ulcers, pseudobranchial tumors). Invertebrates sampled in Kalgin and Izhut Bays showed appreciable fungal infections of 3 and 8.7 percent, respectively. Rock sole, in particular, have been shown to develop skin tumors at about one year of age.

CONTAMINANT BASELINES

Studies of suspended sediments were carried out in Lower Cook Inlet and Shelikof Strait. In general, suspended matter distributions follow the circulation pattern.

Chemical analysis shows that 80-95% of suspended material from Lower Cook is mineral aluminosilicate from coastal rivers, the remainder being biogenic. C:N ratios indicate that organic material of marine origin predominates in the eastern portion of Lower Cook Inlet throughout the year. Organic material of terrestrial origin predominates in the western part of the inlet during winter and early spring, when primary production is low.

Some trace metals (Mn, Cu, and Zn) are enriched in the organic phase of the suspended matter from the surface waters of Kachemak Bay. Since organically bound trace elements are more available to biological organisms, these trace metals could have more impact in Kachemak Bay than in other regions of Lower Cook Inlet.

Significant quantities of aromatic hydrocarbons, detected in the water column in upper Cook Inlet, included benzene, toluene, and xylene. Improved procedures and equipment will permit more complete analysis of these in the future. A thermogenic gas source was also evidenced in upper Cook Inlet by analysis for low molecular weight aliphatic hydrocarbons. Depletion of methane was determined to be a good indicator of water entering Cook Inlet from the Western Gulf of Alaska.

Petroleum contaminants in waters and biota of Alaskan OCS areas are generally of very low concentration in the vicinity of production platforms. This appears to be a reflection of the high degree of turbulent mixing that Cook Inlet's tidal currents produce. Petroleum pollution is shown to be mostly in the water column at Homer's inner bay mudflats as it enters the system of the filter feeder rather than the deposit feeder. The latter is mostly associated with pollution in sediments and hence fossil hydrocarbons from coal are shown to be assimilated by deposit feeders as detrital sediments.

Cadmium has been quantitatively determined to accumulate and concentrate in biota tissue to up to 103 times normal, but problems in measurement developed due to difficulties in purging the digestive tracts of the organisms.

Analyses were made for total carbon, organic carbon, and aliphatic and aromatic hydrocarbon content for sediment samples from four proposed lease areas: Beaufort Sea, Norton Sound, Kodiak and Cook Inlet. These showed relatively little if any pollution in the environment. Alkanes in sediments showed a bimodal distribution, typical of a mixture of marine and terrestrial hydrocarbons. Kodiak shelf sediments showed more marine and less terrestrial input.

Data from samples of trace heavy metals in Alaskan Shelf and estuarine areas have been analyzed. They indicate some regional trends related to differing mineralogy. Variations with depth have not been noted down to 20-25 cm. Amounts of "available" metals, associated with organic phases, are very small.

Circulation patterns lead to deposition in Shelikof Strait of considerable organic matter produced in Kachemak and Kamishak Bays. A slight decrease of vanadium in surface waters was thought to be related to the influx of glacial meltwater in August 1978. Higher dissolved manganese values were found in samples from nepheloid layers in Shelikof Strait.

Prudhoe Bay crude oil was weathered under varying conditions of light and agitation. The weathering resulted in almost complete disappearance of light (C_8-C_{10}) saturated compounds and of most monoaromatics under all conditions. Severe agitation and exposure to light caused 72% of the heavier (up to C_{26}) saturates and 49% of the aromatics to disappear.

EFFECTS

Experimental data obtained to measure metabolic rates in sea otters, whose fur remained oiled for 8 days before washing, suggested that any contact with oil at any time of year would profoundly influence the health of these animals; death might follow due to pneumonia or hypothermia. Rehabilitation is costly and has a low rate of success.

Aerial surveys of sea otters have determined that their poopulation has increased from a low of an estimated 5080 in 1974 to dense populations in areas which previously did not support otters, e.g., in the Valdez-Port Gravina area, sites where they may come in direct contact with oil pollution.

Toxicity of water-soluble fractions of petroleum to shrimp and other marine organisms has been tested, showing that immature invertebrate life stages are more sensitive to oil than adults. Very short-term exposure (2 hours) caused sublethal behavioral effects, such as loss of ability to swim, which could lead to death from predation.

Experiments conducted to establish whether or not mobile marine organisms would avoid oil-contamination showed no efforts by sole to avoid contaminated sediments nor by Dungeness crabs to avoid the surface of such sediments, though they did not bury themselves in it unless alarmed.

Water-soluble fractions of oil at concentrations less than 100 ppb were found to inhibit defensive behavior of green sea urchins within 5 to 15 minutes of exposure. The process was reversible but recovery in clean seawater required several days.

Species differences affected the amount by petroleum hydrocarbons taken into the tissues, the presence or absence of oil-related biological changes, and the manner in which fish reacted under laboratory conditions. Rock sole absorbed three times more parent aromatics than other species and proved highly susceptible to disease; English sole developed reduced hemoglobin and lipid vacuolization not detected in others.

Preliminary data suggest that differences in sensitivity of outmigrant salmonid smolts in seawater was about twice their sensitivity in fresh water. Results show that temperature and salinity are environmental variables that affect oil toxicity and effects in various ways, depending on species and oil components.

Sediment properties were determined to be important factors in rates of hydrocarbon release into the water. Preliminary data on chum salmon showed no abnormalities or changes in growth rates as compared with controls. The extent of biotransformation of naphthalene and types of metabolites remaining in liver tissues of some flatfish were influenced by the mode and length of time of exposure. Lowering of temperature of the environment resulted in increased concentrations and residence times of naphthalene and metabolites in tissues of flounder.

Higher molecular weight compounds of 4 and 5 rings might also be enriched in weathered oil. Preliminary experiments in the field indicated that oil effects on animals (such as lug worms) were severe; feeding rates were greatly reduced, and many animals died.

TRANSPORT

The acquisition of data for a long-term Eulerian time series for currents at selected locations in the Beaufort Sea have shown an energetic current regime extending landward to at least the 100 m isobath, with a series of eastward or westward pulses along isobath contours. The magnitude of these currents is typically 20 cm/sec, occasionally exceeding 65 cm/sec, and lasting from a day to several weeks. The net displacement is between 100 and 250 km westward.

Mesoscale oceanographic processes in the Gulf of Alaska have been the subject of other investigations. Lower Cook Inlet is strongly influenced by three energy sources - the Alaskan Stream, meteorological events, and freshwater entering from the upper inlet during the summer.

The significance of oceanographic data to offshore petroleum development is the possibility of long retention time for inadvertent spills. Mixing in the water column is also of interest. This is enhanced over shoals in the presence of tides due to turbulent energy imparted to the water column by currents. The greater density of energy possible over a shoal may result in significantly less stratification. This was true for Portlock and North Albatross Banks; between those two banks lies Chiniak Trough where tongue-like intrusions of higher salinity indicated shoreward intrusion of deep water up the trough. It has also been shown that the Alaskan Stream's baroclinic transport does not vary from season to season, so if changes in currents on the shelf and in Cook Inlet are correlated with the Alaskan Stream, they respond to changes in its position, not in its strength or total transport.

OCSEAP now has a method for synthesizing meteorological and oceanographic data to obtain time series of currents for calculation of oil trajectories. It combines the calculated current with a random current derived from statistics of current meter records. A local wind field is input to the model. As an oceanographic study device, the model, in principle, gives a more accurate picture of baroclinic currents than previous methods. Improvements will be made with use.

Nearshore meteorological studies have produced wind patterns in Cook Inlet and Shelikof Strait which were not based on Putnins patterns, used in previous trajectory analysis. The present data base should provide information needed to increase spatial resolution in wind fields and capabilities of prediction of winds in the area.

Further meteorological studies relate to a theoretical model for sea breeze modification of geostrophic winds on the North Slope. Examination of several case studies shows favorable comparisons with the model.

A circulation model for Bristol Bay and Norton Sound has been reformulated to include possibilities of an ice-covered sea in calculation of trajectories. Some satisfactory verification has been obtained.

Oceanographic studies in the Arctic barrier island-lagoon system show that breakup and river runoff are events affecting water quality. During the first ten days in June a nearly instantaneous drop in salinities under the sea ice from 40 $^{o}/oo$ to 0 $^{o}/oo$ is coupled with a temperature rise to $0^{o}C$. This flushes out the cold saline lagoon waters of winter. About a month later saline oceanic water returns through inter-island channels to mix with the warmer brackish lagoon waters. Still to be determined are the linkage between oceanographic circulation beyond the barrier islands and in the lagoons, the year-to-year variability in water mass behavior in Simpson Lagoon, and stream gauging on other rivers besides the Kuparuk River.

Steps are underway to develop an environmental geographic-based data management information system, to include possibilities for prediction of undersea permafrost. Some problems relating to reliability still need to be resolved.

Research on dynamics of coastal sedimentation produced core samples from the Colville prodelta which indicate that a wide variety of fluctuating hydrodynamic conditions points to a complex history for the Colville River. Other core samples from Simpson Lagoon suggest that it evolved from a coastal freshwater lake system. LANDSAT images show that large turbid plumes are generated by wave turbulence across shoals at river mouths, not by erosion or stream transport.

Extensive modeling of wind-driven currents in the Beaufort Sea has been completed, utilizing both 2- and 3-dimensional numerical models. Interpretation of results must take into account that while it is safe to assume that, on the open ocean, petroleum would be carried with the surface element, this is not valid in nearshore areas.

A two-dimensional model, used to test scenarios involving causeways, showed that if the entrance between Lay and Egg Islands is left open, as well as a 1 km gap between Milne Point and Pingok Island, the resulting reduction in water volume will be less than 20%. Further, the time for water in the Lagoon to respond to a 180^{0} change in wind direction was shown by the model to be about 2 hours. Finally, the landward side of Simpson Lagoon was found to contain warmer and less saline water than the seaward side - the result of influence of coastal streams and rivers.

An effort to describe the underside relief of sea ice in order to provide an estimate of the pool potential of spilled petroleum showed mesoscale relief under late winter ice on the order of 5-50 cm, as a variation of snow cover. This research also found a strong correlation between sea ice crystal C-axis orientation and reflected radar system polarization. This orientation can also be highly correlated with oceanic currents.

Solution of some problems associated with oil spill scenarios have been attempted concerning 1) motion of Beaufort Sea pack ice and 2) examination of mechanisms for major "break-out" events for ice motion from Chukchi through Bering Strait. The results are summarized by figures showing the most likely 12-month free drift ice trajectories for ice originating at Cross Island on October 1 and June 1. They both predict transport of ice past Pt. Barrow on a WNW track.

Some studies on transport and behavior of oil spilled under sea ice show that: 1) it appears safe to assume that currents on the order of 25 cm/sec would be necessary to transport oil which has already attained equilibrium thickness; 2) current velocities of 15-25 cm/sec are sufficient to trigger the flushing mechanism to remove oil from the upstream side of obstacles; 3) there will be a tendency for oil to collect in low pressure regions, due to the Venturi effect; and 4) major ridges should not be a primary consideration in oil spill spreading.

HAZARDS

In the eastern Gulf of Alaska, except for one earthquake (M=7.7) north of Icy Bay in February 1979, seismic data indicate little change in activity in that area since September 1974 when the regional network was established. Relatively high rates of activity persist near Icy Bay and northeast of Kalgin Island, but magnitudes are generally less than 4-4.5.

Since the rupture zone of the February 1979 earthquake did not extend throughout the entire seismic gap, another quake of equal or larger magnitude is anticipated within the next decade or two. Such an earthquake could trigger effects which would be extremely hazardous to offshore and coastal structures.

Seismic and volcanic risk studies in the western Gulf of Alaska continue, the seismic network operating with high reliability and providing continuous and accurate recordings. On the Kodiak shelf the greatest hazard is associated with the probability of a great earthquake in the Shumagin Gap, an area lying roughly between the Semidi Islands and Unimak Island. Although this is outside the Kodiak lease area, ground motion and aftershocks from a great earthquake pose greater hazards than from smaller earthquakes within the lease area.

The earthquake hazard in Cook Inlet was probably lessened by the 1964 quake because the area lies within a previously filled gap. The greatest potential volcanic hazard to OCS development there is from glowing avalanche and cloud activity attending eruptions.

Recent field studies in the Lower Cook Inlet lease area could detect no recent faulting despite high seismic activity. Surficial sediments show no evidence of slope failure nor liquefaction of sand under dynamic load conditions. The only potential hazards in Lower Cook may be areas of large sand waves, although tests show no appreciable motion of these over a four-year period; sand erosion around seafloor structures may occur, however. No significant slope instability has been observed on the Kodiak shelf, even on the steep walls of Sitkinak Trough.

Geologists have identified a seismic gap in the area of the Shumagin Islands and the southwestern end of the Alaska peninsula. Results from geodetic and geologic studies indicate that the Shumagin Islands region has experienced significant vertical movements in the past and can be expected to do so again.

Interpretations of recently acquired strong ground motion data and re-evaluation of earlier data indicate that peak horizontal accelerations in the eastern Aleutian arc are generally higher by a factor of 2-4 than in the western continental U.S. This may be caused by differences in seismic source properties or in attenuation and propagation properties of the two regions. Higher stress drops in the Shumagin Islands are at least partly responsible for higher levels of shaking.

A coastal processes study shows evidence of Holocene faulting in the Yukon-Kuskokwim delta region, coupled with high potential for liquefaction of most of the Holocene fluvial and deltaic sediments. These constitute serious geologic constraints both in the selection of transportation corridors and in the design of offshore structures. The risk from explosive volcanism is probably slight, with the possible exception of the area around St. Michael where flows have been found which appear to be younger than any of the other volcanic activity in the region.

Surface and near surface faults are prominent along the north margin of Norton Sound, but recent activity is difficult to determine because strong current scour may be obscuring geologic relationships. Determination of the magnitude and recency of fault activity will depend on the results of seismicity studies being conducted. Based on two years data collection from the regional seismic network, it is already apparent that the seismic activity in Norton Sound is higher than previously thought, which may mean that at least some of the faults are active.

Seismicity studies in the Beaufort Sea, Norton and Kotzebue Sounds, and Northeast Alaska areas have led to conclusions that the area from the Brooks Range north along the Beaufort Sea coast is aseismic excepting the coastal area east of 147^{o}W. Estimates of magnitude are in the vicinity of 6 and the local seismic network on th Seward Peninsula has observed four local quakes of magnitudes ranging from 5.2-6.5; a large number have registered in the 1-4.5 range.

A variety of seafloor geologic features and processes are found within Norton Sound which may pose hazards to OCS oil and gas development. These include faulting, gas-charged sediments, sediment liquefaction, current scour, and movement of large sand waves. Ice gouging is also extensive on the Norton Basin seafloor, but gouge depths appear to be limited to one meter or less.

Two types of gas-charging sediments are present in Norton Sound, which may create potentially unstable surficial sediment conditions and, in the case of one, the possibility of uncontrolled gas escape if penetrated during drilling operations. The first type, giving rise to this possible blowout hazard, is thermogenic gas which rises to the sediment surface from an accumulation about 100 m below the surface and 9 km in diameter, centered about 40 km south of Nome. Six meter-long vibracorer samples collected in 1978 above the suspected gas pocket showed positive signs of gas saturation, consistent with this interpretation. The apparent weakness of the sediment, judging from lower shear strength and a vibracorer penetration rate three times greater than at other sites without suspected gas charging, may cause severe foundation instability problems. The other type of gas-charging is associated with the decomposition of shallow buried organic matter. The gas periodically escapes through a thin (1-2 m) overlaying layer of mud, apparently during storms, creating shallow collapse craters. The upper several meters of sediment has reduced shear strength because of the gas and organic content, and may be hazardous to offshore facilities because of rapid collapse.

Use of seismic records to analyze characteristics of subsea permafrost has yielded results showing good agreement with drill hole data along a transect connecting the west ARCO dock and Reindeer Island and extending seaward, showing a deep trough in depth to permafrost near Reindeer Island (where it surfaces) and lending support to the theory that coastal rivers once flowed across what is now seafloor, causing melting of permafrost to some depth.

Boreholes have been used for analysis and interpretation of offshore permafrost and are informative for a history of the Beaufort and Chukchi Sea coasts, as an aid in predicting locations of offshore permafrost.

Beaufort Seacoast permafrost studies using techniques involving low-energy wave trains are limited in that refracted signals are not expected to give reliable data from below 40 meters under the water surface. This method involves refraction of some signals from ice-bonded permafrost; thus it enables production of maps showing places where permafrost is within 40 m of the surface as well as the high variability of depth to bonded materials. Other studies confirmed the great variation found in depth to ice-bonded permafrost, and additional data supported the concept of large depth-to-permafrost values in paleovalleys. Ice-bonded permafrost beneath Prudhoe Bay is believed to be as deep as 50-80 m, although a boundary to hard materials was found at a depth of 25 m below the sea surface in close agreement with a zone of fast sound transmission as determined by seismic techniques.

A potential permafrost hazard exists in the region which may be difficult to predict because of its irregular distribution. Permafrost appears to exist in most areas except along large rivers, deep lakes, and rapidly prograding shorelines. Flooding is a potential hazard along the rivers and the coast, particularly during breakup. Other potential hazards include erosion and sedimentation along rivers, sub-ice channels, and the shoreline, and ice-related effects such as rapidly moving pack ice and ice gouging.

Techniques have been developed for measuring various strength properties of sea ice in situ. Tentative results are: simple uniaxial compression tests indicate higher strength at lower salinity for high loading rates; ice strength is increased about 30% by mere confinement along the axis perpendicular to the applied forces and increased about 50% by addition of lateral pressure.

Ice morphology studies in the Beaufort Sea emphasized processes associated with ocean swell propagation into newly formed ice. The most complex oil and ice interactions would probably follow an October or November spill when wave interaction with newly-formed ice is likely.

In the initial formation of ice there is an upward transport of salt, forming a highly saline layer on the ice surface. When the ice warms in spring, the surface salt liquefies and drains through the ice, causing brine channels and void spaces in the upper part of the ice. If oil should be released beneath growing winter ice, it would become entrained in thin lenses within the ice. In spring, this oil would flow to the surface through newly opened brine channels and be distributed within the brine channel feeder systems, on the ice surface and in horizontal layers in the upper part of the ice. These layers probably form from interaction of brine drainage with the percolation of melt water from surface snow down into the ice and the rise of oil from below. Finally, in summer, oil on the surface leads to melt pond formation; the solar energy is adsorbed by the oil on the surface, causing the melt pond to melt through the ice, releasing the oil again into the ocean.

Using data from drift buoys, investigators have concluded that drift of the ice cover in the Chukchi Sea generally northward and westward during March-October 1978 precluded the oil spilled on or in the ice at this time from being transported into the Bering Sea.

Studies of nearshore ice by laser and radar techniques show relatively small long-term displacements ($\leq$ 3 m), perpendicular to the shore and related to thermal effects.

Larger displacements measured farther offshore by radar indicated systematic increases up to 12 m and a standard deviation of 6 m. No systematic relationship was found between pack ice motions and local winds. It was determined that fast ice stability could not be depended upon at depths greater than 13 m and shore ice pile-up and ride-up could occur at any time of year but are most common in fall and spring.

Environmental geology studies indicate that the most important land forming process in the Beaufort area appears to be loss of ground ice. In these studies, measurements of actual rates of change in physical features, taken from aerial photography and other remote-sensing sources were identified from field observations.

A main theme for other studies is sediment dynamics and seafloor stability with the result that ice piling, for instance, is approached from the point of view of its impact on the sea bed. More important results of this research show that there is a negative correlation between snow depth and sea ice thickness and that sea floor morphology changes more drastically from year to year than previously thought, indicating underestimation of original depth of sonar-observed gouges.

Analysis of sea bed materials indicated widespread occurrence of over-consolidated clays overlaying coarser materials in many locations. Evidence tends to support the conclusion that the overconsolidation has been caused by successive freeze-thaw cycles, either by direct contact with bottom fast ice or by lowering of temperatures through contact with super-saline solutions created during freezing of ice above.

Holes drilled north of Reindeer Island encountered soft sediments of only a few tenths of a meter followed by hard clay. Below 10 m, ice-bonded gravelly sand was encountered and penetrated to 2 m. Again this is in agreement with seismic data and lends support to a suggestion concerning the role played by overconsolidated clays and ancient streams in the depth to present-day subsea permafrost. Holes drilled on off-shore islands showed, in general, a complex variation of properties with depth--particularly the degree of ice bondedness.

A survey of beach morphology, sediment and vegetation characteristics, physical processes, and seasonal effects related to the potential longevity of spilled oil in the coastal zone of Kotzebue Sound showed that fifty-seven percent of the coastline from Cape Prince of Wales to Point Hope consists of protected tidal flats and salt marshes, considered highly vulnerable to spill oil (9-10 on an index scale of 10). Large areas of estuarine tidal flats are found behind barrier islands along the coast of Seward Peninsula, and in Eschscholtz Bay and Hotham Inlet. These environments can retain oil for more than 10 years, usually have high biological sensitivity, and would present extreme clean-up difficulties.

Pure gravel beaches and sheltered rocky headlands comprise about five percent of the coastline and are classified as slightly less vulnerable (7-8) than the protected tidal flats and marshes. These areas occur mostly on the Baldwin Peninsula and downdrift of rock headlands, and would retain oil for a period of several years due to rapid penetration and burial. Another 26 percent of the coastline is classified as sand and gravel beaches and impermeable exposed mud tidal flats, assigned a vulnerability of 5-6. Both would retain oil for about a year. The mud tidal flats do not permit deep penetration of oil but also are not cleaned rapidly by natural processes because of low wave energy. Sand and gravel beaches are highly prone to oil burial, but not as deep as on pure gravel beaches. Almost the entire northern shore of Norton Sound falls into categories 5-6.

Low risk areas (1-4) include the sandy barrier islands on the southern sound shoreline (11% of the shoreline), and the rocky headlands of Cape Thompson (2%). The fine sands prevent oil penetration, and both environments are washed well naturally by strong wave activity.

Seasonality of these processes is extreme and is not fully understood. Further studies during the winter months and <u>in situ</u> monitoring of river influx, wind and waves, oceanic and tidal currents, and ice must be carried out before predictive models of their effects can be fully developed.

New results indicate that there may be significant reworking of sediments near the outer edge of the sub-ice delta front platform by wave or current activity, as evidenced by an unusual paucity of fine sediments (clays) and offshore increase in percentage of sand. The seasonality of processes on the delta are somewhat better understood now, and three dominant annual periods can be identified: 1) an ice-dominated regimen beginning with freezing along the coast in late fall, 2) a river-dminated regimen beginning with breakup in early May, and 3) a storm-dominated regimen beginning with the onset of frequent southwesterly winds, waves, and major storms in late summer and early fall. In an effort to gain an improved understanding of the effects of sea ice on processes in the delta region, some new information on rates and patterns of ice movement had been obtained, showing that there are previously unrecognized complications in the kinds of ice-related hazards present in Norton Sound. The complete results of these studies and all related work performed for OCSEAP by this unit will be given in the final report at the end of the year.

Liquefaction by wave-induced or seismically-induced dynamic loading is a potential hazard in areas of fine-grained sand and coarse-grained silt, particularly along the Yukon prodelta. Liquefaction to a depth of 1-2 m may contribute to the formation of gas craters and surficial slumps, and enhance erosion in prodelta sediment.

Large, shallow depressions (25-150 m in diameter, up to 1 m deep) are found along the southwest margin of the Yukon prodelta and in north-central Norton Sound. The depressions are usually associated with increased bottom steepness and higher bottom current speeds. They indicate areas where artificial structures that disrupt current flow may cause extensive erosion and create potentially hazardous undercutting of the structures. Strong bottom currents in sandy areas also create migrating fields of mobile bedforms. Sand waves 1 to 2 m high with wavelengths of 10 to 20 or 150 to 200 m occupy the crests of large sand ridges west of Port Clarence. Local changes in bedform type and trend, seen in comparisons of 1976 and 1977 data, substantiate recent bedform activity and indicate a potential hazard to offshore structures from large-scale sand movement.

Results from studies of bottom and near-bottom sediment dynamics in Lower Cook Inlet indicate that tidal currents during fair weather and low-to-moderate tidal stages are strong enough to transport bottom sediment within the region of large sand waves.

Instead of becoming higher as the coastline retreats, bluffs along the beach appear to maintain a low height of 1-3 meters. As coastline retreat has thus apparently not started at the islands, it appears that vertical subsidence of the entire coastal plain is occurring. Results of these studies postulate that loss of ground ice is occurring with the horizontal retreat of the coastline. Also stream channels do not seem to be created or rapidly enlarged by mechanical erosion of bank and bed materials, but rather by loss of ice.

Two types of islands make up the Barrier Island chain. One of these is tundra covered, frozen material left behind as the coastline has retreated due to loss of ground ice. The other is non-frozen gravel materials, derived from destruction of tundra islands or coastal promontories. The umbrella slope of the islands is due to two alternating longshore currents. The islands are not true barrier islands as their materials are not derived from streams on the coastal plain and transported hundreds of kilometers by totally dominant longshore currents.

The existence of a formation known as "Flaxman's" has been a useful source for determining geomorphic sequence. Ancient coastal rivers are thought to have cut through this formation when the sealevel was lower. Presence of ice-rafted boulders and other supportive data, indicate their deposition there between 60,000 and 30,000 years ago.

Although not extensive, the river deltas are considered probably the most important landforms in the ecosystem, since they are sources of detritus which is picked up and transported through the system during the ice-free season.

FUTURE PLANS

The area north of the 66°N parallel includes two OCSEAP study areas, the Beaufort Sea and the Chukchi Sea. The great interest shown by the petroleum industry in offshore sales in the Beaufort Sea will result in a sale in December 1979 by the state of Alaska and BLM. Information gaps that must be filled prior to the lease sale pertain to geohazards, sea ice hazards, and the behavior of oil spilled in the arctic environment. Two synthesis efforts already undertaken have addressed the above concerns as paramount. Biota have been studied primarily from a natural history standpoint and the extreme variability of biological populations from year to year has been verified; critical habitats have been located. However, many of the physical and mechanical properties of this ice impacted area cannot be resolved prior to the sale. Continued research will be necessary in the disciplines of sea ice, subsea permafrost and other geohazards. In addition, biological effects work should be conducted to provide more information for predicting biological impact.

The Chukchi Sea lease area is on the current lease schedule but with a sale date of February 1985. Consequently, the research effort in this area is being limited to investigations of permafrost and of physical and biological associations between the Beaufort and Bering Seas. Past work has investigated the transport of ice and water masses and the possible movement of oil from one lease area to another. Studies of the migration of birds and mammals and some food studies from plankton to fish have been accomplished. Future work should include a continuation of earlier preliminary geohazard studies.

The Bering Sea is represented by four lease areas in the OCSEA program. Industry interest in these areas has always been high and the current lease schedule includes all four: the Norton Basin in the northeastern Bering Sea is scheduled for a September 1982 sale; the St. George Basin has a sale date of December 1982; the North Aleutian Shelf has a sale date of October 1983; and the Navarin Basin has a sale date of December 1984.

In the Norton Basin OCSEAP and earlier surveys have identified seafloor hazards including ice gouging, scouring, gas charged sediments, and faulting. Most critical habitats are now identified. However, biological studies have been accomplished in a natural history fashion with little information being developed along the ice front and during the winter season. The morphology, strength and dynamics of the sea ice are poorly understood, as are the dynamics of other physical and biological phenomena in the area. A substantial program to study the Norton Basin will be required in FY 80 and FY 81 to obtain information necessary for assessment.

Although some work on the geohazards of the St. George Basin has been completed by OCSEAP, additional geohazards studies must be carried out, including geotechnical work and continued seismic monitoring. Topical studies in pollutant transport will take place during FY 80 and FY 81, and literature search and topical studies in the biological sciences will also be conducted.

No information is available on the geohazards in the North Aleutian Shelf, therefore, a concentrated effort there in geohazard studies will begin in FY 80. This will include geological and geotechnical reconnaissance studies as well as earthquake monitoring. Literature surveys on pollutant transport will begin in FY 80, and topical studies will be carried out in FY 81. Broad ranging biological studies will be initiated in FY 81.

The Navarin Basin is a promising petroleum source and, because of the escalating energy problems, will be the subject of extensive exploration activity. It is a large basin 450 km x 250 km, is free of ice only a few months each year and is far from Alaskan seaports. These factors and a general lack of environmental information necessitate a long lead time in which to conduct scientific studies if sufficient data are to be made available at key decision points. Therefore, reconnaissance geohazard surveys are to begin in FY 80, and the initiation of sea-ice morphology and dynamics, pollutant transport, and biological studies in FY 81.

The southern Bering Sea is characterized by generally high biological productivity and unique habitats for biota. The lease area has been heavily utilized in the past by foreign and domestic exploiters of biological resources. The area is under constant biological pressure and changes in some populations have been recorded in the last few years. Additional stress exerted by oil and gas development may cause population changes of an unprecedented nature. Because of the biological importance of the region and the relatively long lead time required to obtain physical oceanographic information, studies are required through the development phase. Of paramount concern is the development and verification of a workable transport model for the area. In addition, the study of certain geohazards and the synthesis of ecosystem data will be needed by FY 1981.

At or below the 60°N parallel are four lease areas. Sales have occurred in two the areas (Northeast Gulf of Alaska and Lower Cook Inlet) and each of these is included for a second time in the current schedule, which also includes the Kodiak. The fourth (the south Aleutian shelf area) is not on the current schedule.

Exploration in the NEGOA (Sale #39) has not been successful up to the present time. With the addition of sale #55 for June 1980, a substantial portion of the proposed lease area is outside the areas previously studied by the OCSEA program. This westward expansion between Yakutat Bay and Cape Fairweather represents additional data gaps in geohazards, transport and biology. Additional field work began in FY 79 in these disciplines and the synthesis of available data is in progress.

Proceeding westward, Lower Cook Inlet is scheduled for its second sale (#60) in March of 1981 and the current synthesis will be of great usefulness. Shelikof Strait area will be included in this sale. Lower Cook Inlet and Shelikof Strait have long been known for high biological productivity and are important for commercial and sport fisheries. The renewable resources of these areas have considerable value to the State and Nation. The areas are physically characterized by strong tidal currents, complex circulation, and vulcanism and other geohazards including seismicity, faulting and bottom instability. It is anticipated that additional field work will be necessary in transport, geohazards and biological effects to supplement the current synthesis.

The Kodiak lease area just south and west of Lower Cook Inlet and Shelikof Strait is included in the proposed lease sale #46 for December 1980. A synthesis of all current OCSEAP and non-OSCEAP generated information has just been completed. The renewable resources of the Kodiak area are extremely important to the economy of Alaska. Fish, crabs and clams have served as both commercial and recreational resources for many years. Also, Kodiak is very important as a breeding and nursery area for marine and anadromous species. Although a modest field program will be conducted in 1979, it is anticipated that a continuing program will be required during any exploration and development and beyond. The major issues to be considered include contaminant transport, geohazards (especially seismology), commercial fisheries, and habitat of marine mammals and birds.

The Aleutian lease area is not currently on the sale schedule. The OCSEA program there has generally been very limited due to the predominant needs of other lease areas and a general lack of industry interest. This area is seismically active and this has been investigated in a generalized way with a natural history approach to the biological forms present. Probably the most important biological factor is that the area experiences an annual migration of species from other lease areas and beyond. These species include fish, birds, and marine mam-mals. Future work in this lease area will depend upon leasing schedule revisions. The latest lease schedule is shown in Figure 2.

Requested funding for FY 80 is given for each lease area in the table which follows. At the present time (as of November 1979) the FY 81 budget is unknown. Amounts under FY 80 represent OCSEAP's request from BLM for studies needed in FY 80 and tentatively agreed upon.

BUDGET SUMMARY

ALASKA

(dollars in thousands)

	FY 80
Beaufort Sea	3,585
Chukchi Sea	406
Kodiak	1,575
Gulf of Alaska	1,184
Lower Cook Inlet	1,757
Norton Basin	2,503
St. George Basin	227
North Aleutian Shelf	809
Navarin Basin	
South Aleutian Shelf (included above)	
Non-site-specific	355
Total	$12,427

Plans are to continue studies providing the information needed for assessment and for protection of the environment compatible with oil and gas exploration and development. The studies will proceed as rapidly as possible with available funds, recognizing that 4-6 years minimum time is required to obtain environmental data in each lease area when adequate funding is provided. With constant level funding ($20 million from BLM and $6 million from NOAA) plus an inflation factor, OCSEAP believes that adequate data and techniques will be available to satisfy requirements of assessment at various decision points in the current lease schedule.

Some tracts have been removed from consideration for sale because of hazards identified in the OCSEAP program, (e.g. faults, unstable bottoms). Also, tracts and, allegedly, entire lease areas have been removed from sale consideration because there was insufficient environmental information to guarantee that development could proceed safely. OCSEAP is working hard to obtain missing information. In order to meet the 4-6 year study minimum for lease areas opening after 1981, there must be adequate funding on a stable, continuing basis in all lease areas and adequate lead time to modify program emphasis in response to future changes in the lease schedule. Decreasing funds will not permit the attainment of adequate environmental information in time for decisions. After the lease sales in each area, environmental studies should be intensified in the specific sites under consideration for development (including potential pipeline corridors and onshore facility sites).

MANAGEMENT

General

Overall managing, fiscal, and coordinating responsibilities rest with the OCSEA Program Office in Boulder, Colorado. Two project offices have been established in Alaska, one in Juneau to coordinate research in the Gulf of Alaska and the Bering Sea, and the other in Fairbanks to coordinate research in the Chukchi and Beaufort Seas. These two project offices direct the research efforts of more than 150 scientists (principal investigators). They also maintain the orderly flow of data required to produce products needed by BLM and to manage the contracts designed to fulfill program requirements. To accomplish this, the contracted studies are monitored or "tracked" by scientific personnel of the Project Offices. The Project Offices also provide and coordinate logistics needs, such as ships, aircraft, housing, and supplies.

NOAA manages the data flow from the Alaskan program by providing data formats and reporting, archiving, and analyzing of the data. A continuing effort is maintained to improve data quality in terms of data handling and analysis and in instrument quality, calibration, and standardization aspects.

The products and deliverables of the program are defined in cooperation with the BLM to be applicable to its needs for prediction, assessment, stipulation setting and regulation. Included are models for predicting oil transport, charts of geological hazards, tables for distribution of biological parameters and biota, probability distributions for hazards, and data sources and banks for future reference and analyses.

Funds for the 1979 Alaskan program are provided principally by BLM, augmented by NOAA ship-time contributions. These funds are distributed by lease area in accordance with the lease schedule and deficiencies in environmental information. The planning recognizes that information needs in a lease area do not end with the lease sale, and that even after development proceeds, a continuing study and monitoring effort will be essential.

Planning

In accordance with the Program Development Plan (PDP) approved by BLM in December 1976, preparation of the Technical Development Plans (TDPs) for FY 1980 began in October 1978. These plans logically follow previous research, using the recognized workshop output from investigators, suggestions from the Users' Panel, and the BLM requirements described in its Alaska Regional Plan.

Management Support

Support for OCSEA Program management was provided under contract by Science Applications, Inc., whose Boulder office is staffed with a complementary mix of disciplinary scientists. SAI's major task involved the preparation for publication of lease area synthesis reports based on investigator reports, synthesis meetings, and other available environmental data. The first of these reports, the Kodiak Interim Synthesis Report, was published in January, 1979. The second, the Lower Cook Inlet Interim Synthesis Report, is in press. Reports on other lease areas are under review and in preparation. Annual updates of these summaries are planned.

MEETINGS

Workshops

A number of workshops were sponsored during the period. These meetings varied greatly in format and purpose but were of two general types: the disciplinary workshops, such as bird studies and physical oceanography, brought the PI's together with staff scientists to discuss the content of the ongoing research and preliminary results, to arrange coordination and data exchange, and to solicit PI comments on future research and program management; planning workshops, such as Field Effects Workshops and the Oil Weathering Workshop discussed the scientific program content of future integrated research efforts. The following meetings were held:

Fish, Benthos, & Nutrient Review	17-21 Apr 78
Barrier Island-Lagoon Workshop & Review	24-26 Apr 78
Physical Oceanography Workshop	2-4 May 78
User's Panel Meeting	16-18 May 78
Coordination Panel Meeting	7-8 Jun 78
Data Management Planning & Review	10-14 Jul 78
Response & Recovery Working Group	26-27 Jul 78
Ice & Permafrost Review	1-4 Aug 78
Oil Weathering Workshop	29-31 Aug 78
Data Management & Synthesis Meeting	7-8 Sep 78
Bird Species Account Meeting	18-19 Sep 78
Physical Oceanography/Meteorology Workshop	17-19 Oct 78
Bird & Mammal Workshop	17-19 Oct 78
FY 79 Program Replanning Meeting	30 Oct - 2 Nov 78
Field Effects Workshop	15-17 Nov 78
Bird Synthesis Meeting	20-21 Nov 78
Lower Cook Inlet Planning Meeting	14-15 Dec 78

(Continued on next page)

Data Management Working Group	10-11 Jan 79
Response & Recovery Working Group	10-11 Jan 79
BLM-OCSEAP TDP Meeting	12-15 Feb 79
Bering Synthesis Planning Meeting	13-15 Mar 79
Seismology & Earthquake Engineering Workshop	26-29 Mar 79
Bering Sea - Norton Sound Cruise Planning Mtg	27-28 Mar 79
Barrier Island-Lagoon Workshop & Review	23-26 Apr 79

Summaries of some of the meetings follow.

BERING SEA SYNTHESIS MEETINGS

The synthesis of current environmental information on the Bering Sea is being accomplished through a series of meetings held throughout FY79 and into FY80. The first meeting of the Bering Sea Studies Advisory Committee was held in Seattle on December 13, 1978. Discussions at the meeting focused on defining the desired outcome of these synthesis efforts and on Bering Sea research needs.

Dr. Leland Hepworth, the Lease Area Coordinator, convened the first Bering Sea Planning Meeting in Seattle on March 13, 1979. Dr. Donald Hood, acting in the role of Synthesis Coordinator, outlined the preparation of a two volume synthesis publication. Volume I is planned to contain 12 disciplinary synthesis chapters and several interdisciplinary discussions. It will be written by scientists who were in attendance at the meeting. Volume II will contain the application of basic information to the development of offshore energy resources and will delineate the anticipated impacts of this development.

A third meeting was held in Juneau on July 9-11 to review the drafts of these chapters, to discuss graphics needs and to coordinate the synthesis effort. Additional meetings of the disciplinary experts and OCSEAP and BLM personnel will occur as needed through FY79 and FY80 to guide this endeavor to completion prior to the BLM tract selection in the Norton Sound in February 1980.

FIELD HYDROCARBON EFFECTS WORKSHOP Nov. 15-17, 1978

A group of approximately 30 scientists, including chemists, field and experimental biologists, ecologists, physiologists, and microbiologists, was convened in San Diego to produce an experimental design for an OCSEAP field effects studies program. The meeting was chaired by Dr. Lois Killewich, OCSEAP staff biochemist. The goal of the effects program was defined to be providing decision-makers with the capability of predicting the impact to and the recovery potential of littoral and shallow subtidal Alaskan ecosystems which may be exposed to an acute oil pollution incident such as a blowout resulting from outer continental shelf oil and gas development.

More specific objectives for the study were outlined as:

(1) to identify and quantify the population, community, or ecosystem level effects to representative intertidal and shallow subtidal ecosystems resulting from an acute pollution incident;

(2) to measure the degree and rate of recovery of the affected areas and associated organisms;

(3) to determine whether petroleum effects on individual organisms occur in the representative ecosystems and are documented in laboratory studies; and

(4) to use the information collected under objectives 1, 2, and 3 to develop a set of rules allowing extrapolation to other, similar environments, and thus predict what would occur in the event of an acute oil pollution incident.

It was recommended that detailed, quantitative hydrocarbon component analysis of sediment, water, and biota accompany the biological measurements. In addition, recommendations were made for studying the geochemical fate of oil in both microcosms and the field, (for example, sedimentation and persistence of oil fractions as a function of sediment type and grain size).

LOWER COOK INLET BIOLOGICAL MEETING November 21, 1978

A meeting was held in Anchorage, and was attended by OCSEAP and BLM staff members and all OCSEAP biological investigators who are involved in writing final reports in FY79 on work conducted in Lower Cook Inlet. Chairman for the meeting was Paul Becker, Lower Cook Inlet Lease Area Coordinator.

In order to identify the potential for impact from OCS oil and gas exploration and development, the principal investigators were encouraged to address three basic items in their final reports. They were: 1) identification of important species and habitats and critical time periods; 2) identification of risks to important species and habitats from drilling platforms, potential shore-based facilities, pipelines, tanker routes, and physical disturbances from aircraft and boat traffic; and 3) identification of the relative sensitivities of those important species and life history stages which occur within important habitats identified as being at risk.

The results of this meeting and the final reports have been incorporated into the Interim Synthesis Report on Lower Cook Inlet which was published in October 1979.

KODIAK SYNTHESIS MEETING May 14-17, 1979

The second Kodiak Lease Area Synthesis meeting was held in Kodiak. Dr. M. J. Hameedi, OCSEAP Lease Area Coordinator, served as organizer and chairman. The meeting was attended by principal investigators, representatives of OCSEAP management, SAI, BLM and industry personnel, and local residents. Primary emphasis was placed on discussions concerning scenarios of oil and gas development, environmental impacts of proposed activities and evaluation of currently available environmental data in terms of their usefulness to the governmental decision-making process. The meeting also provided an opportunity for data and information exchange among principal investigators. The outcome of the meeting will be the revision of the Interim Kodiak Synthesis Report of January 1979 to include new data and a more extensive synthesis chapter containing material for the draft Environmental Impact Statement for Sale 46.

FISH, BENTHOS, PLANKTON, NUTRIENT AND MODELING STUDIES REVIEW MEETING April 17-20, 1978

The first review of OCSEAP hydrobiological studies was held at Santa Cruz, California. Approximately 50 people attended, including principal investigators, management personnel from NOAA, BLM, USGS, and outside reviewers from academia, government and industry. The meeting covered hydrobiological studies that have been conducted since the inception of the OCSEA Program in the nine lease areas, and had three main objectives.

1. To provide input from an evaluation of the program's effectiveness in meeting informational needs relative to marine biology in the Alaskan OCS leasing processes.
2. To identify data gaps and research needs for incorporation into future planning.
3. To provide a forum for information exchange at the PI level.

Dr. David Nyquist, OCSEAP staff biologist, was chairman for the meeting. A panel of nine outside reviewers was engaged to provide an independent evaluation of the OCSEAP hydrobiological studies in the Arctic and subarctic (based on presentations, discussions and handouts at the meeting as well as background reading materials received prior to the meeting). The outcome of this process was a compilation of the reviewers' suggestions for modifications of research units and research management directions.

OIL WEATHERING WORKSHOP

August 27-31, 1978 Boulder, Colorado

On August 27-32, 1978 a workshop was sponsored by OCSEAP to plan a research project to determine the physical/chemical/biological weatherings and fate of oil spilled in Alaskan coastal waters. Dr. John Calder of OCSEAP served as workshop chairman.

The major goals identified by the workshop were:

1. To construct a mass balance of oil following a spill, that will account for all of the oil, whether it resides in air, water, or sediment as biota.
2. To determine the major alteration pathways of oil, such as evaporation, biodegradation, sinking, etc.
3. To determine a time-course for these alteration events, so that it can be predicted at any time after a spill where the oil should be.

These objectives were felt to constitute the first step in understanding the true environmental impact of oil spills in Alaska. The second step will be the addition of a biological component to look at short- and long-term effects of oil and its components and products on individual organisms and ecosystems. A third step will include examination of the effects of countermeasures and clean-up operations on oil weathering and effects.

SEISMOLOGY AND EARTHQUAKE ENGINEERING WORKSHOP
March 26-29, 1979 Boulder, Colorado

An OCSEAP-sponsored Alaskan Outer Continental Shelf Seismology and Earthquake Engineering Workshop was held on March 26-29 in Boulder. The meeting was organized by Dr. Joseph Kravitz of OCSEAP and chaired by Carl Kisslinger, director of the University of Colorado's Cooperative Institute for Research in the Environmental Sciences. Its purpose was to review OCSEAP's seismology program to date and provide a well-formulated set of recommendations to OCSEAP management on future program directions. Participants included OCSEAP principal investigators, representatives from NOAA, BLM, and USGS, and specialists from oil companies, consulting firms, and universities. The meeting was divided into three disciplinary working groups on seismology, geology, and engineering. Each group was responsible for producing a written document stating the information products needed from OCSEAP by decision makers and other users, data required to generate those products, and specific field and laboratory techniques that should be used.

Four recommendations were proposed:

1. An improved knowledge of the regional seismotectonic framework is needed, combining properly designed geological and seismological studies, to enable the program to produce reasonable estimates of the level of earthquake activity to be expected in a given area;

2. The program should improve and expand its network of strong motion accelerometers, including the use of offshore instruments where appropriate, to determine the energy attenuation and level of ground motion associated with major earthquakes on the Alaskan continental shelf;
3. A well-coordinated program to collect marine geotechnical data, including <u>in situ</u> measurements and some deep geotechnical drilling, should be integrated with geologic mapping surveys to determine the response of sedimentary units to earthquake shaking and the potential for earthquake-triggered ground failure;
4. A continuous effort must be maintained to synthesize this interdisciplinary seismological, geological, and geotechnical data for a complete assessment of earthquake hazards and to display and interpret the results in a form useful to decision makers and planners.

OCEANOGRAPHY/METEOROLOGY WORKSHOP 17-19 October 1978

A physical oceanography/meteorology workshop was held at Orcas Island, Washington on October 17-19, 1978. Attendance included OCSEAP oceanography and meteorology investigators, OCSEAP and BLM staff members and a USGS representative. The workshop chairman was Roy Overstreet, OCSEAP Staff Scientist.

The objectives of the workshop were (1) to review the first draft of an integrated oceanography/meteorology project report for NEGOA, (2) to provide a forum for the presentation and discussion of investigators' recent findings and (3) to do initial planning of the oceanography/meteorology synthesis effort for the western Gulf of Alaska.

The document under review in Obejctive (1) has subsequently been incorporated in the Transport secton of the Draft NEGOA Synthesis Report, and is presently being revised and expanded into a definitive report of oceanographic processes in NEGOA. Objective (2) provided an opportunity for open discussion of scientific findings, information gaps and future program directions. One highlight of this discussion was a consensus opinion that OCSEAP modeling studies in the Gulf of Alaska have progressed to the point that it is highly desirable to transfer the technology to USGS for more efficient use in oil spill risk analysis. This activity is currently underway. The western Gulf of Alaska oceanography/meteorology synthesis identified in Objective (3) is in progress.

Data and Information Management Summary

1 April 78 - 31 March 79

The objectives of the OCSEAP data management program are two-fold: 1) to establish a data base of quality checked environmental information that has been collected by OCSEAP, and 2) to provide data services (data, data products, data analyses and visual data displays) to all interested users of such a data base. Investigator reports, synthesis reports, photographs and remote sensing imagery and the voucher specimen archives are also parts of this data base of environmental information.

The validation of data and the generation of analysis products are tasks that are shared between NODC, the Data Projects Group at the University of Rhode Island, the Alaskan Data Support Facility, NIH (microbiology), and NGSDC (geological data), as well as management. The following data and information management summary incorporates the efforts and accomplishments of all of these components.

A. Progress Report on Continuing Projects

1. Data Catalogs and Inventories

Distribution of 300 copies of the revised Part I (lease area plots of data collection station locations) and Part II (tabulated list of data submissions by lease area and file type) of the OCSEAP Data Catalog was completed during August and Septemer 1978. Distribution included OCSEAP, NOAA and BLM personnel, OCSEAP investigators, User Panel members and all individuals or institutions requesting copies. Information was included for each digital data set received through May 1978 by NODC, NGSDC and NIH. With Program Office assistance, broad environmental regions were established to incorporate nearly all OCSEAP-related observations in one of the nine lease areas.

After modification and update of 24 of the OCSEAP data file types and the creation of two new file types for zooplankton and bird data, Part III of the Data Catalog, which contains data formats, was distributed in January 1979.

Initial efforts are underway to identify specific graphic products that can be readily provided or derived from current OCSEAP file types (Part IV of the Catalog), providing data have been submitted in the proper format and supported by adequate documentation. A draft version of this part of the Catalog is planned for October, 1979.

An inventory has been completed for all parameters submitted to date for some of the master file types. This information, when completed for all master tapes, together with similar planned data submission inventories for FY79/80 data, will be used to support Project Office evaluations of PI contract compliance and format usage of 'core' parameters for future format modifications.

Twenty copies of the OCSEAP Data Tracking System, sorted by either research unit number, discipline or Project Office, and a similar number of File Type Summaries have been distributed each quarter to OCSEAP and BLM personnel. Updates and changes to the tracking system over the past year amounted to over 1500 new data records and nearly 10,000 individual parameter modifications.

2. Taxonomic Code Developments

A revised, updated version of the NODC taxonomic code was distributed to OCSEAP management and investigators in June 1978. A continuing obstacle in the standardization of taxonomic codes has been the unofficial and intermittent use of different taxonomic codes (Alaskan codes) by some investigators. Corrections must be completed on a data set by data set basis; the Alaskan Data Support Facility assisted in this effort by checking certain file types and interfacing with investigators known to have used earlier unofficial lists of codes. This office also maintains an up-to-date file of both Alaskan and NODC codes, supplied by NODC, to assist in checking and preliminary processing of selected OCSEAP data files and to provide species information such as summaries and prey-predator lists to investigators and BLM personnel.

3. Data Product Developments

The major new product development efforts for the past year concerned products to support the OCSEAP Interim Synthesis Reports and data synthesis activities for Science Applications, Inc. (SAI)

Existing NODC programs were adapted to OCSEAP data for such products as seasonal location and abundance of specific marine mammal and bird species, seasonal distributions of fish and benthos, graphic summaries of mammals by behavior groups, ice and water movement plots, hydrocarbon and primary productivity contour charts and bottom temperature summaries. Standard products were provided, such as dynamic height anomaly contours, current vectors, rotary plots, and temperature/salinity profiles.

Work is currently underway to adopt portions of the SAI bio-statistics computer package to OCSEAP file types. Initial efforts using file type 032 (benthic organisms) will include graphic presentations such as dendrograms, kite diagrams and other statistical plots.

The improved land mass file (World Data Base II) received through NGSDC was adapted to NODC's computer system and is now being used in all products for OCSEAP management and investigator requests.

Although no BLM requests for OCSEAP data have been directed to the Data Centers the past year, the Alaskan Data Support Facility has been working with BLM-Anchorage personnel throughout the year in developing prey-predator matrices for selected OCSEAP data and has assisted in other matters concerning OCSEAP data and inventories. This facility has also provided taxonomic sorting services for various investigators.

The Data Projects Group (URI) working with investigators and Juneau Project Office personnel, has developed a suite of products based on bird census data. These products, which are being generated in a production mode now, include a data summary table, digital density plots, density histograms, graduated symbol plots, contour plots, star diagram plots, statistical analyses, a transect catalog, a sightings effort table, and sightings effort plots.

Also established during the last half of this year by the Data Projects Group was an Interactive Data Entry and Analysis (IDEA) distributed processing network for OCSEAP. This project allows investigators to enter their data at intelligent terminals located at field sites. The data are quality checked by programs provided and then are immediately available to the investigator and others for analysis products. The use of this facility is presently directed towards several file types of bird data.

4. Voucher Specimen Archive

Procedures for submission of materials to the Voucher Specimen Archive, which is maintained for OCSEAP by the California Academy of Science, have been prepared to document the kinds of specimens and required handling prior to archival. A cross-check of taxonomic information in the digital data base is being undertaken.

B. Synthesis Products

1. Synthesis Reports

The first in a series of Interim Synthesis Reports was published and distributed. This report on the OCS area of Kodiak Island replaces the Annual Technical Summary Report previously published by OCSEAP. The subarctic Synthesis Reports are compilations by SAI of all relevant OCSEAP and non-OCSEAP environmental information pertaining to a particular lease area, organized by discipline. The material is arranged according to OCSEAP tasks and subtasks. Special emphasis is placed on graphical and tabular presentations of data. Each Synthesis Report will include (when available) a chapter on industry information such as probable locations of shore-based facilities and pipelines, types of drilling equipment that are to be expected in the area, etc. A final chapter integrates the disciplinary, industry and effects information and gives an assessment of critical habitats and species and key issues concerning the development of the individual lease areas. These two chapters are written by the lease area coordinators. Updates of the Synthesis Reports will occur periodically as new information is received by OCSEAP or as BLM needs dictate.

In addition, the Beaufort/Chukchi Interim Synthesis Report was prepared by the OCSEAP Arctic Project Office, and distributed in August 1978. It, too, is a disciplinary summarization of environmental information and addresses key issues relevant to OCS development. It will be updated following a Synthesis Meeting in July 1979.

An extensive review procedure for these reports has been initiated, involving principal investigators, lead scientists, lease area coordinators and the OCSEAP Information Synthesizer.

2. Map Products

The maps that are used in the Interim Synthesis Reports have been standardized with respect to scale, projection (Universal Transverse Mercator), and area covered. This projection has been chosen to assure compatibility with BLM protraction diagrams. A series of maps of different resolution have been prepared by SAI ranging from an All-Alaska map, regional maps (Arctic, Bering, and Gulf of Alaska), lease areas, plus areas of special interest (Kachemak Bay). Principal Investigators have received copies of these maps for use in their data analysis and data display. Thus, graphics from principal investigator reports are immediately compatible with the format used in the Synthesis Reports. Overlays of bathymetry, lease blocks and latitude-longitude grids are available. A compendium of the SAI-OCSEAP map graphics is being prepared for general distribution in the near future.

3. Lantern Slides

In an effort to make the OCSEAP graphics as readily usable by BLM as possible, 3½ x 4¼ slides of all maps and pictorial graphics from the Synthesis Reports are being supplied to BLM. Through the use of these slides, which are prepared by SAI, scale and size can be readily modified. The slide collection will be updated as the Interim Synthesis Reports are revised.

4. Data and Information Synthesis and Management Brochure

An information brochure was compiled by OCSEAP personnel to aid potential users of OCSEAP information. Included is a compendium of OCSEAP data and information products and their sources. The functions of the Information Synthesis and Management group are also enumerated. This report will be distributed to BLM and other users after the current revision process is completed.

5. OCSEAP Bibliography

The compilation of a comprehensive bibliography of all OCSEAP publications and all publications resulting from OCSEAP funding was begun. It will be arranged alphabetically by author and will be sorted by research unit number, geographic area, and discipline. Publication and distribution are anticipated in early 1980.

C. Product Requests

Table 1

Selected Examples of Data Requests Completed in the Last Year

Date Completed	Requestor	Description
4/78	Arneson, ADF&G (RU 003)	Plots of selected bird species distribution on UTM map projection in Lower Cook.
4/78	Robertson, Corps of Engineers	Inventory of OCSEAP offshore data for NEGOA, Lower Cook and Kodiak areas.
4/78-3/79	RUs 083, 108, 239, 337, 467	Tape copies of validated File Type 033 data
5/78	Nat'l Park Service, Fairbanks	Inventory of offshore environmental data for Glacier Bay area.
6/78	SAI, Boulder (RU 468)	Data Synthesis product applications - . Location of walrus hauling-out areas . Seasonal presence of Mallard and Pintail ducks and shearwaters . Seasonal distribution of selected ground fish and benthic species with catches exceeding 100 and 1000 lbs/hour, respectively . Dynamic height contour plots . Primary productivity contour plots
6/78	Harrison, U. Alaska	Annotated bottom temperature plots for Chukchi Sea
6/78	Vigdorchik, INSTAAR	Magnetic tape of grain size data for Bering Sea surveys
8/78	Pease, PMEL (RU 541)	Magnetic tape copies of selected IMS CTD surveys for NEGOA
8/78	Lowry, ADF&G	Formatted listing of RU 5/502 benthic data for Bering/Chukchi Seas for selected species
8/78	Thibodeaux, L.S.U.	STD/CTD data listing for Beaufort Sea stations
8/78	NMFS, Kodiak	Current meter data for summer months in St. George area of Bering Sea
9/78	Pelto, JPO	Listing and magnetic tape of all Nansen/STD data for area east of NEGOA

Date Completed	Requestor	Description
10/78	Frost (RU 230)	Predator/Prey list, copy of program listing and tax. code conversions of Arctic mammals
10/78	Roberts (RU 289)	Pressure data at Middleton Island
10/78-3/79	Hunt (RU 83)	Bird sighting data summary tables, digital density plots, density contour plots, star diagram data presentations and statistical analyses
10/78	Carey, Oregon St. (RU 006)	Tape copies of Beaufort Sea OCSEAP data for CTDs, zooplankton, phytoplankton, primary productivity, ice drift and benthic data for all lease areas
11/78	Hall, USFWS (RU 481)	Formatted listing of OCSEAP mammal sighting data for the Gulf of Alaska
11/78	SAI, Boulder (RU 468)	OCSEAP lease area maps and earthquake seismic charts
12/78	Lowry, ADF&G	Bottom temperatures within 3 days/5 miles of selected trawl locations in the Bering and Chukchi Seas (200 sta.)
12/78	Ingraham, NMFS	Tape copy of selected OCSEAP STD/CTD data (29 cruises)
12/78	Tobias, ADF&G	Temperature and salinity data for Hotham Inlet, Alaska
12/78	Ludwig, PMEL	Formatted listing of selected OCSEAP CTD data sets
12/78	Wakefield, House Approp. Sub-Comm.	OCSEAP catalogs and data management information
12/78	Wormuth, Texas A&M	Listing of selected OCSEAP zooplankton collected by RU 425
12/78	Crane, Anchorage (RU 497)	Tape copy of RU 417 intertidal data to review for taxonomic code problems
1/79	SAI, Boulder (RU 468)	Walrus behavior summary plots for Bering and Chukchi Seas

Date Completed	Requestor	Description
1/79	Petersen, U. of RI (RU 527)	Copy of land mass file on magnetic tape with coastline and map plotting subroutines
1/79	Walter (PMEL)	Copy of meteorological logs from offshore platforms operated by the oil industry in Lower Cook Inlet and Harrison Bay
2/79	Royer, IMS (RU 289)	Tape copy and listing of USCG station data for Gulf of Alaska - continuing request
2/79	Farentinos, Program Office	Walrus behavior plots incorporating data from both mammal sighting formats
2/79	Wesnousky, Lamont-Doherty	Hypocenter data listings for selected lease areas
2/79	Walter (PMEL)	Copy of oil rig meteorological data from Lower Cook Inlet
3/79	SAI, Boulder (RU 468)	Dynamic height contour plots and temperature/salinity/density profiles for Hinchinbrook Entrance

D. Data Processing

Rather than deal in discrete observations that have been catalogued and archived, the flow of data received is assessed in terms of data sets. A data set represents the data collected by an investigator on a particular cruise or during a field operation. The following tables summarize the data received and checked during the year:

Table 2

NODC's Handling of Data Sets

Digital Data	Total Received This Year[1]	Total Received To Date	Final Processed To Date	In Hold[3] To Date	Currently In Processing
Biological	414	1157	736	331	90
Physical	97	305	243	41	21
Chemical	6	38	1	20	17
Geological	1	7	3	3	1
Non-OCSEAP Format[2]	4	N/A	N/A	N/A	N/A
TOTAL	522	1507	983 (65%)	395 (26%)	129 (9%)

1. Through March 15, 1979.
2. Non-OCSEAP formats are those data sets received that are not in NODC formats and include surface pressure, microbiological and certain fish specimen data.
3. Data sets in hold are in need of additional attention for a variety of reasons, such as tapes not readable and a resubmission is requested, conversion to proper format and logic is required, taxonomic code or format conversions are necessary, or additional interaction with the investigator is warranted.

Table 3

Distribution of Data Sets Received by Lease Area and Type

Type of Data	Total Data Sets	Lease Area Codes 1	2	3	4	5	6	7	8	9
Fish Pathology	6	0	0	1	5	0	4	0	0	0
Current Meter (Eulerian)	105	26	0	15	14	1	10	0	4	3
Pressure Gauge	19	8	0	0	7	0	4	0	0	1
Trace Metals in Water	11	5	3	5	2	0	3	0	2	0
STD	87	40	19	34	26	5	22	8	14	4
Fish Resource Assessment	183	27	11	50	49	2	29	28	37	1
Zooplankton	49	13	24	13	10	2	9	2	1	1
Marine Mammal Specimen	41	10	4	10	2	6	1	11	0	3
Marine Mammal Sighting II	34	0	0	0	11	4	15	18	4	6
Marine Mammal Sighting I	211	56	16	62	29	1	21	11	36	6
Phytoplankton Species	58	10	5	10	10	3	5	0	8	0
Primary Productivity I	162	19	10	18	13	4	7	0	33	0
Intertidal Data	26	3	10	5	2	8	1	1	4	3
Benthic Organisms	32	9	3	10	2	9	4	1	0	1
Bird Sighting I (air/ship)	203	59	31	78	35	77	22	15	27	25
Bird Sighting II (land)	8	0	0	0	2	2	0	2	0	2
Marine Bird Colony	58	3	0	0	46	0	0	6	0	3
Feeding Flock (birds)	8	1	0	7	1	0	1	0	3	0
Bird Habitat	33	6	20	6	1	0	12	0	8	0
Hydrocarbons I	11	5	5	5	2	0	2	1	2	1
Hydrocarbons II	1	0	0	0	0	1	0	0	0	0
Lagrangian Current Measurements	87	8	0	3	7	38	3	0	0	8
Herring Spawning	44	0	0	0	6	0	33	10	16	2
Trace Elements	15	7	4	6	7	1	5	1	2	1
Marine Invertebrate Pathology	1	0	0	0	0	0	0	1	0	1
Beach Profiles	1	1	0	0	0	0	0	0	0	0
Grain Size Analysis	7	3	0	0	2	1	2	1	0	1
Wind Data	7	3	0	0	0	4	0	0	0	0

NOTE: Many data sets have stations in more than one lease area.

Lease Area Codes

1 - NEGOA
2 - Lower Cook
3 - Kodiak
4 - St. George
5 - Beaufort
6 - Bristol
7 - Norton
8 - Aleutians
9 - Chukchi

Table 4

Alaskan Data Support Facility

	Data Sets Sponsored	Required	Total
Data Sets Received	128	174	302
Data Sets Processed	64	128	192
Forwarded to NODC	93	139	232

In Hold: 152

The data referred to in Table 4 is of the following file types: Benthic Organisms, Marine Mammal Specimen, Fish Resource Assessment, Bird Habitat, Intertidal Data, and Bird Sighting I. The data sets are separated into two categories; those that are sponsored (funded directly through contract) and those whose processing has been required to enable product generation.

Table 5

University of Rhode Island Data Support Facility

	Data Sets Received To Date	Number Received 4/1/78-3/31/79	In Routine Processing	Processing Complete
Marine Bird Sighting (air/ship)	190	27	55	135
Migratory Bird Seawatch	14	14	14	0

FIELD ACTIVITIES AND LOGISTICS
1 April 1978 - 31 March 1979

General

Detailed planning and coordination of field activities and logistics support continued to be primarily accomplished by the Juneau and Fairbanks Project Offices. The Boulder Program Office monitored overall logistics responsiveness to research needs, provided direction and assistance as necessary, and maintained liaison with other organizations providing logistics support.

Logistics support consisted primarily of obtaining and scheduling suitable vessel and aircraft platforms from which to conduct the planned research, arranging for adequate shore facilities to support the mobile vessel and air operations, and arranging for living accommodations and laboratory space for field parties working in remote regions.

Field activities remained at a high level through FY 78 but were substantially reduced in FY 79 due to budget reductions and a decision to concentrate on synthesis of existing data to better define future program needs. Field work was greatest in the Beaufort Sea, Kodiak, Lower Cook Inlet, and Bering Sea areas.

Funding for direct logistics support was slightly over $4 M in FY 78, dropping to just under $3 M in FY 79, averaging about $3.5 M during this fourth year of the program. Additionally, NOAA ship time provided in support of the program amounted to approximately $4.5 M.

Subarctic Operations

Major support for operations in the subarctic continued to be provided aboard NOAA vessels and NOAA-operated helicopters. The NOAA ships DISCOVERER, SURVEYOR, and MILLER FREEMAN were used for a combined total of 447 days at sea. A leased Bell 206B helicopter was operated off the SURVEYOR during half of her field season, flying a total of 348 hours in support of six cruises and three independent missions. Two UHIH helicopters, on loan from the U.S. Army, were operated as independent NOAA field units for a total of 560 flight hours in support of various projects in the subarctic.

Additional vessel and aircraft support was contracted to meet the remaining field work requirements. Substantial periods of time were obtained on the U.S.G.S. vessel SEASOUNDER (approx. 85 days), the University of Alaska vessel ACONA (49 days), the Oregon State University vessel WECOMA (31 days), the University of Washington vessel COMMANDO (approx. 120 days), and the Alaska Department of Fish and Game vessel YANKEE CLIPPER (approx. 100 days).

The primary staging base for vessel operations continued to be the U.S. Coast Guard Support Center at Kodiak. Pier space, fuel, warehouse storage, repair assistance, and general support were provided through an interagency support agreement negotiated between the Coast Guard Support Center and the NOAA, National Ocean Survey, Pacific Marine Center.

Arctic Operations

In the Arctic, the Naval Arctic Research Laboratory at Barrow continued to provide the major portion of logistics support under the terms of an interagency support agreement between the Office of Naval Research and the NOAA Environmental Research Laboratories. This support included housing and subsistence, lab space, fixed-wing aircraft, small vessels, and field camp installations and removals. A contract with a commercial service company provided housing and subsistence, lab space, and general support at Deadhorse (Prudhoe Bay area).

Vessel operations carried out during the summer of 1978 included a 31 day cruise aboard the U.S.C.G. Cutter NORTHWIND, approximately 100 days funded for the U.S.G.S. vessel KARLUK, and 31 days and 22 days, respectively contracted aboard the NARL vessels ALUMIAK and NATCHIK.

In Oct-Nov, 1978 and Feb-Mar, 1979 a special winter studies project was conducted in the Prudhoe Bay area to fill the data gap during this most inhospitable season in the Arctic. This marked a significant shift in the logistics support base away from Barrow to Deadhorse.

Primary aircraft support for arctic field operations was provided by the two NOAA-operated UHIH helicopters. Between the two, a total of 590 hours were flown in support of various research projects.

Additional fixed-wing aircraft and helicopter time was chartered from the NARL or commercial sources to supplement the NOAA helicopters as necessary.

Cruise Summaries and Schedules

Summaries of major vessel cruises and helicopter missions are shown on pages 85-96.

Schedules of major vessel cruises and helicopter missions are shown on pages 97-99.

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NO. OF STATIONS
SURVEYOR (NOAA)	Mar 23-Apr 2	J. Larrance, R.U. 425 H. Feder, R.U. 05	Lower Cook Inlet	Zooplankton Bentnic Biology	CTDs	21
					Chlorophyll Measurements	21
					Primary Productivity	3
					Nutrient Samples	21
					Phytoplankton Samples	21
					Secchi Disk	15
					Solar Radiation	72 hrs
					Otter Trawls	30
					Van Veen Grabs	30
					MARINE MAMMAL OBSERVATIONS	
DISCOVERER (NOAA)	Mar 28-Apr 20	J. Dunn, R.U. 551	Kodiak Island Shelf	Zooplankton Ichthyoplankton Meroplankton	Neuston Tows	89
					CTDs	89
					Bongo Net Tows	89
					Tucker Trawls	70
					IKMT Trawls	19
					Epi-benthic Sled	5
					Sea Bed Drifters	16
					24-hour Diel Stations	2
					MARINE MAMMAL OBSERVATIONS	
SURVEYOR (NOAA)	Apr 6-Apr 20	K. Pitcher, R.U. 229 D. Calkins, R.U. 243 B. Fay, R.U. 194	Kodiak Island Lower Cook Inlet	Marine Mammals	Harbor Seal Collections	18
					Sea Lion Collections	6
					Beluga Transects	
					Pathology & Parasitology Examinations	24
					Beached Mammal Surveys	300mi
ACONA (U of A)	Apr 21-May 8	T. Royer, R.U. 289 D. Burrell, R.U. 162	Prince William Sound Resurrection Bay	Physical Oceanography Heavy Trace Metals	STDs	88
					Current Meter Deployments (MSB, GAG-WA, HEB)	3
					Current Meter Recoveries (MSA,NEA)	2
					Nansen Casts	5
					Horizontal Plankton Tows	7
					Vertical Plankton Tows	3
					Otter Trawls	3
					Benthos Cores	6
					MARINE MAMMAL OBSERVATIONS	

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NO. OF STATIONS
UH-IH N57RF	Apr 21-May 3	Juneau Project Office	Lower Cook Inlet	Cottonwood Bay Field Camp	Install Field Camp	
					Buildings	3
					Generators	3
					Support boxes	5
					Fuel drums	100
					Mooring bouys	2
UH-IH N57RF	Apr 25-Apr 26	M. Reynolds, R.U. 367	Lower Cook Inlet	Meteorological	Install towers	2
DISCOVERER (NOAA)	Apr 24-May 17	R. Feely, R.U. 152 J. Cline, R.U. 153 D. Burrell, R.U. 162 D. Shaw, R.U. 275 I. Kaplan, R.U. 480 R. Atlas, R.U. 29/30 R. Morita, R.U. 190 D. Robertson, R.U. 506	Kodiak Island/ Shelikof Strait Lower Cook Inlet	Hydrocarbons Trace Metals Suspended Sediments Microbiology	Rosette/Niskin Water Samples	3
					CTDs	35
					Nephelometer Measurements	8
					Sterile Bag Surface Water Samples	68
					Van Veen/Shipek Grabs	31
					Epi-benthic Sled Tows	14
					48-hr Time Series Stations	2
					24-hr Time Series Station	1
					Gravity/Haps Cores	5
					Gas Harpoon	3
					Phleger Cores	2
					Vertical Plankton Tows	2
					Neuston Tows	35
					1KMT Tows	18
					MARINE MAMMAL OBSERVATIONS	

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NO. OF STATIONS
MILLER FREEMAN (NOAA)	May 1-May 17	J. Larrance, R.U. 425	Lower Cook Inlet	Zooplankton Benthic Biology	CTD Plant Pigments Primary Productivity Suspended POC & PON LMW Hydrocarbons Phytoplankton Nutrients Secchi Disk UW Quantum Meter Sediment Traps Solar Radiation Van Veen Grabs Pipe Dredges Otter Trawls MARINE MAMMAL OBSERVATIONS	21 33 7 3 3 13 31 18 5 3 6 189 36 14
SURVEYOR (NOAA)	Apr 27-May 18	G. Hunt, R.U. 83 J. Burns, R.U. 230 B. Fay, R.U. 194 G. Divoky, R.U. 196 J. Burns, R.U. 232 J. Burns, R.U. 248	Pribilof Islands Bering Sea	Bird Observations Mammal Observations and Collections	Bird Transects CTDs XBTs Pathology & Parasitology Examinations Bird Collections Mammal Collections and Observations Otter Trawls	674 39 6 22 28 21 27
UH-IH N57RF	May 5-May 13	K. Pitcher, R.U. 229	Kodiak Island	Marine Mammal	Resupply Field Camp	
DISCOVERER (NOAA)	May 21-Jun 12	J. Schumacher, R.U. 138 J. Hayes, R.U. 138 D. Hansen, R.U. 217	Lower Cook Inlet Kodiak Island Alaska Peninsula	Physical Oceanograhy	CTDs (WGOA Grid) Drift Cord Deployments Nimbus Drift Buoy Deployments MARINE MAMMAL OBSERVATIONS	195 1000 cards 5

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NO. OF STATIONS
SURVEYOR (NOAA)	May 22-Jun 15	B. Fay, R.U. 194 J. Burns, R.U. 230 G. Divoky, R.U. 196 J. Burns, R.U. 232 J. Burns, R.U. 248	Bering Sea Alaska Peninsula	Marine Mammals Marine Birds Geology	Pathology & Parasitology Examinations Beached Mammal Surveys Otter Trawls Mammal Collections Mammals Tagged Bird Transects Bird Collections CTDs XBTs	50 115mi 30 50 13 313 121 30 27
MILLER FREEMAN (NOAA)	May 19-Jun 4	R. Feely, R.U. 152 J. Schumacher, R.U. 138 S. Hayes, R.U. 138	Lower Cook Inlet Kodiak Island Alaska Peninsula	Physical Oceanography	CTDs Current Meter Deployments (K-6B thru K-13B, C-1B thru C-13B) Sediment Trap Deployments	171 21 3
UH-IH N57RF	May 27-May 31	B. Fay, R.U. 194	Bering Sea-Alaska Peninsula	Marine Mammal	Beached Marine Mammal Surveys	700mi
UH-IH N57RF	June 1-June 23	J. Davies, R.U. 16	Alaska Peninsula	Geology-Seismic Network	Seismic stations serviced Geology Surveys Tide Guage Serviced	13 5 6
UH-IH N57RF	June 12	H. Braham, R.U. 67	Ugamak Island	Marine Mammal	Installed Field Camp people gear	 2 5,000lbs.
MILLER FREEMAN (NOAA)	Jun 6-Jun 16	R. Feely, R.U. 152 J. Larrance, R.U. 425 H. Feder, R.U. 05	Lower Cook Inlet	Zooplankton Suspended Sediments Benthic Biology	CTDs Chlorophyll Measurements Primary Productivity Nutrient Samples Phytoplankton Samples Secchi Disk Solar Radiation Beam Trawls Otter Trawls Van Veen Grabs Sediment Trap Recoveries Sediment Trap Deploym MARINE MAMMAL OBSERVATIONS	49 49 8 45 7 21 144 hrs 1 19 11 3 3

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NO. OF STATIONS
DISCOVERER (NOAA)	July 10-Aug 17	J. Schumacher, RU 549 L. Coachman, R.U. 141 L. Coachman, R.U. 541 R. Muench, R.U. 550 G. Hunt, R.U. 83	Bering Sea Norton Sound Pribilof Islands	Physical Oceanography Marine Birds	OBS Recoveries	8
					Current Meter Deployments (FX-2A, BC-4G, FX-3A, BC-21B, BC-20B, NC-24B, LD 1 thru LD-5)	12
					Current Meter - Recoveries (BC-3D, BC-20A, BC-21A, NC-24A, NC-17B, NC-23A)	6
					Nimbus Drift Buoy Deployments	3
					CTDs	140
					XBTs	107
					IKMTs	26
					Bird Transects	289
					Nutrient Samples	74
					Marine Mammal Observations	
DISCOVERER (NOAA)	Aug 25 - Sept 6	J. Cline, R.U. 153 R. Feely, R.U. 152 D. Shaw, R.U. 275 D. Burrell, R.U. 162 I. Kaplan, R.U. 480 D. Robertson, R.U. 506	Lower Cook Inlet	Hydrocarbons Trace Metals Suspended Sediments	Rosette/Niskin Water Samples	27
					CTDs	27
					Nephelometer Measurements	27
					Van Veen Grabs	27
					48-hr Time Series Station	1
					Gravity Cores	11
					Haps Cores	8
					Vertical Plankton Tows	
					Box Cores	6
					Marine Mammal Observations	

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NO. OF STATIONS
MILLER FREEMAN (NOAA)	June 19 - July 9	J. Dunn, R.U. 551 H. Feder, R.U. 005 C. Lensink, R.U. 341	Kodiak Island (Food Web Study)	Zooplankton Ichthyoplankton Meroplankton Marine Birds	Neuston Tows	89
					CTDs	89
					Bongo Net Tows	89
					Tucker Trawls	79
					IKMT Trawls	40
					Epi-Benthic Sled	2
					Sea Bed Drifters	16
					24-hour Diel Stations	2
					Bird Transects	59
					Bird Collections	7
					Marine Mammal Observations	
					Agassiz Trawls	2
					Bottom Trawls	14
					Pipe Dredges	14
MILLER FREEMAN (NOAA)	July 12-23	J. Larrance, R.U. 425 N. Feder, R.U. 05 D. Hansen, R.U. 217	Lower Cook Inlet	Zooplankton Benthic Biology Physical Oceanography	CTDs	7
					Chlorophyll Measurements	7
					Primary Productivity	7
					Nutrient Samples	7
					Phytoplankton Samples	7
					Secchi Disc	7
					Solar Radiation	168 hrs.
					Sediment Trap Deployments	3
					Sediment Trap Recoveries	3
					Agassiz Trawls	16
					Otter Trawls	16
					Van Veen Grabs	16
					Pipe Dredges	16
					Nimbus Drift Buoy Deployment	5
					Marine Mammal Observations	

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NO. OF STATIONS
SURVEYOR (NOAA)	June 19 - July 4	K. Pitcher, R.U. 229 D. Calkins, R.U. 243 F. Fay, R.U. 194 C. Lensink, R.U. 341	Kodiak Island Alaska Peninsula	Marine Mammals Marine Birds	Harbor Seal Collections Sea Lion Collections Sea Otter Aerial Transects Pathology and Parasitology Examinations Harbor Seal Tracking Surveys Establish Field Camp Remove Field Camp Marine Bird Surveys	54 14 14 68 2 1 9 colonys
SURVEYOR (NOAA)	Aug 13-21	J. Larrance, R.U. 425 H. Feder, R.U. 005 F. Fay, R.U. 194	Lower Cook Inlet	Zooplankton Benthic Biology Marine Mammals	Sediment Trap Deployments Sediment Trap Recoveries CTDs Chlorophyll Measurements Primary Productivity Nutrient Samples Phytoplankton Samples Secchi Disc Solar Radiation Agassiz Trawls Otter Trawls Van Veen Grabs Beached Mammal Surveys Marine Mammal Observations	3 3 7 7 7 7 7 7 96 hrs. 6 12 12 30 hrs.

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NO. OF STATIONS
SURVEYOR (NOAA)	Aug 25 - Sept 10	K. Pitcher, R.U. 229 D. Calkins, R.U. 243 F. Fay, R.U. 194	Kodiak Island Alaska Peninsula	Marine Mammals Marine Birds	Harbor Seal Coll t-ions	27
					Sea Lion Collections	5
					Sea Otter Aerial Transects	22
					Pathology and Parasitology Examinations	32
					Harbor Seal Tracking Surveys	
					Remove Field Camp	1
					Marine Bird Surveys	8 colonys (43 transect
Helicopter Bell UH-1H N56RF	June 18 - July 14	M. O. Hayes, R.U. 59	Kodiak	Coastal Geomorphology	Sediment Samples	300
					Beach Profiles	65
					Beach Sketches	65
					Hours of Tape Notes	128
					Aerial and Ground Photos	5000
					Flight Hours	98.8 hours
Helicopter Bell UH-1H N57RF	June 24 - July 17 Aug 31-Sept 7	H. Pulpan, R.U. 251 J. Kienle, R.U. 251	Kodiak Alaska Peninsula	Geology	Seismic Stations Serviced	25
					Flight Hours	77.5 hours
Helicopter Bell UH-1H N56RF	July 20-30	W. Dupre, R.U. 208	Bering Sea Yukon River Delta	Coastal Geology	Short Cores	63
					Grab Samples	25
					textural analysis	20
					possible radiocarbon	16
					pollen analysis	9
					vegetation	40
					Beach Profiles	25
					Flight Hours	38.6 hours

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NO. OF STATIONS
Helicopter Bell UH-1H N57RF	Aug 20 - Sept 12	K. Jacob, R.U. 016 J. Davies, R.U. 016	Alaska Peninsula Shumagin Islands	Geology	Seimic Stations Serviced Flight Hours including the June work	 29 158.7 hours
Helicopter Bell UH-1H N57RF	Aug 10-15	M. O. Hayes, R.U. 059	Beaufort Sea	Coastal Geomor- phology	Sediment Samples Beach Profiles Beach Sketches Hours of Tape Notes Beach Descriptions Aerial and Ground Photo's Flight Hours included in with the June work	100 28 28 2 35 400
Helicopter Bell 206B N49734	July 10-20	G. Kooyman, R.U. 71	Prince William Sound - NEGOA	Marine Mammals	Sea Otter Surveys Sea Otters Tagged Field Camp Establi- shed and Removed Flight Hours	1363 miles 3 1 36.4 hours
Helicopter Bell 206B N49734	Sept 13-15	J. Kienle, R.U. 251	Lower Cook Inlet	Glaciology Geology	Field Camp Removal Glaciologic Studies Seismic Stations Serviced Flight Hours	1 4 1 14.1 hours

Ship	Cruise Period	Principal Investigator	Work Area	Nature of Investigation	Specific Operations	Number of Stations
DISCOVERER (NOAA)	Sept 10 - Sept 29	J. Schumacher, R.U. 549 L. Coachman, R.U. 141 L. Coachman, R.U. 541 G. Hunt, R.U. 83	Bering Sea Norton Sound Pribilof Islands	Physical Oceanography Marine Birds	Current Meter Array Recoveries CTD's Wire Drags for Arrays Bird Transect XBT's Midwater Trawls Nutrient Samples Marine Mammal Observations	11 106 3 306 198 11 40 260 hrs.
DISCOVERER (NOAA)	Oct 3 - Oct 30	J. Schumacher, R.U. 138 R. Feely, R.U. 152	Kodiak Islands Lower Cook Inlet Shelikof Straits	Physical Oceanography	Current Meter Array Recoveries CTD's Drift Cards Marine Mammal Observations	21 184 2000
COMMANDO (CHARTER)	Oct 31 - Nov 16	H. Feder, R.U. 5 P. Jackson, R.U. 552 D. Rogers, R.U. 553	Inshore Kodiak Island (Food Web Study)	Zooplankton Ichthyoplankton Meroplankton	Trawl Hauls Net Tows	188 99
WECOMA (CHARTER)	Oct 26 - Nov 13	M. Hayes, R.U. 551	Kodiak Island (Food Web Study)	Zooplankton Ichthyoplankton Physical Oceanography	Net Tows Trawl Hauls CTD's Seabed Drifters	297 100 97 768

Ship	Cruise Period	Principal Investigator	Work Area	Nature of Investigation	Specific Operations	Number o Stations
SURVEYOR (NOAA)	Feb 2 - Feb 21	Royer, R.U. 289	Gulf of Alaska Prince William Sound	Physical Oceanography Marine Mammals	XBT's CTD's Salinities Marine Mammal Observation	3 139 62
ACONA (Charter)	Feb 12 - Feb 17	Royer, R.U. 289	Prince William Sound	Physical Oceanography	Current Meter Array Recoveries Current Meter Array Deployment STD's Shipek Grabs	2 1 34 6
MILLER FREEMAN (NOAA)	Feb 13 - March 9	Feder, R.U. 005 Dunn, Hayes, R.U. 551	Kodiak Island (Food Web Study)	Zooplankton Icthyoplankton Physical Oceanography	Otter Trawls Bottom Trawls CTD's Neuston Tows Bongo Tows Tucker Trawls Pipe Dredges Seabed Drifters	8 14 104 91 89 37 8 13
SURVEYOR (NOAA)	Feb 26 - March 17	Martin, R.U. 087 Reynolds, R.U. 367 Schumacher, R.U. 549	Bering Sea	Meteorology Physical Oceanography Sea Ice Studies Marine Mammals	Airsonde Balloon Flights Parasail Flights CTD's Meteorogical observations NASA C-130 Aircraft Overflight Scuba Dives Radar/Color Targets Deployed Wave Rider Bouy Deployed Strainmeter Deployments Accelerometer Deployments CW Probe Deployment	23 3 41 every 1/2 1 3 11 16 22 28 1

Ship	Cruise Period	Principal Investigator	Work Area	Nature of Investigation	Specific Operations	Number of Stations
SUVEYOR cont.					Ice Cores Helicopter Flight Time Marine Mammal Observations	22 36.8 hrs.
COMMANDO (Charter)	March 3 - March 18	Feder, R.U. 005 Jackson, R.U. 552 Rogers, R.U. 553	Inshore Kodiak Island (Food Web Study)	Zooplankton Ichthyoplankton Meroplankton	Beach Seine Trammal Net Trawl Try Net Tows Tow Net Otter Trawl	52 15 23 27 6


NOAA FLEET SAILING SCHEDULE
(JANUARY – JUNE)
PERIOD 1978 ACTUAL OPERATIONAL DATES
U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
APPROVED
APPROVED
NOAA FLEET SAILING SCHEDULE
(JULY – DECEMBER)
PERIOD 1978
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
APPROVED
APPROVED
SHIP
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
DAS
MILLER FREEMAN
PMC SEATTLE
LCI
LARRANCE FEDER
KODIAK
HAYES
LCI
LARRANCE FEDER
KODIAK FOOD WEB
DUNN FEDER SENSINK
LCI
LARRANCE FEDER
PMC SEATTLE
DISCOVERER
PMC SEATTLE
LCI-AK PENINSULA
SCHUMACHER HAYES
KODIAK
KODIAK FOOD WEB STUDY
DUNN SANGER
L C I
CLINE
LCI-AK PEN-KODIAK
SCHUMACHER HAYES
PMC SEATTLE
BERING-NORTON
SCHUMACHER COACHMAN
NOS
PRIBILOF ISLANDS
HUNT
LCI
SHAW, BURRELL FEELY, CLINE
NORTON
SCHUMACHER COACHMAN
PRIBILOF ISLANDS
HUNT
LCI-AK. PEN.-KODIAK
SCHUMACHER
PMC SEATTLE
SURVEYOR
PMC SEATTLE
BRISTOL BAY
SCHUMACHER REYNOLDS COACHMAN
LCI-AKPEN-KODIAK
SCHUMACHER HAYES, REYNOLDS
KODIAK
L C I
NGOA
FAY PITCHER
LCI KODIAK
CALKINS
BERING SEA
BURNS, FAY DIVOKY
BERING SEA
BURNS, FAY SCHUMACHER DIVOKY, COACHMAN
NGOA
PITCHER, FAY CALKINS
PMC SEATTLE
LCI
LARRANCE FAY FEDER
KODIAK
K-NGOA
CALKINS FAY
PMC SEATTLE
HELO N49734 BELL 206B
SEA AIRMOTIVE
GAY AIRWAYS
ON SURVEYOR
ON SURVEYOR
ON SURVEYOR
PRINCE WILLIAM SOUND
KOOYMAN
ON SURVEYOR
ON SURVEYOR
SEA AIRMOTIVE
GAY AIRWAYS
UH-1H HELO N57RF
BERING
CHARNELL
BARROW
AAGAARD
LISBURNE TO DEADHORSE
BURNS
LCI CAMP
LCI CAMPS
JUNEAU
TUGIDAK
PITCHER
ANCHORAGE TO COLD BAY
FAY
COLD BAY/SAND POINT
JACOB, DAVIES
AK. PEN.
PULPAN KIENLE
LCI CAMPS
JUNEAU
COLD BAY/SAND POINT
JACOB, DAVIES
NARL
AAGAARD
NARL-DEADHORSE
BURNS
UH-1H HELO N56RF
NOME
AAGAARD
NOME, LISBURNE
MARTIN
KOTZEBUE, LISBURNE DEADHORSE
WEEKS, KOVACS
DEADHORSE
OSTERKAMP
DEADHORSE
BARNES
DEADHORSE
WEEKS, KOVACS
KODIAK
M.O. HAYES
ST. MARY'S
DUPRÉ
DEADHORSE
MISC. PROJ.
KOTZEBUE
WINTER-WORK
HORNER, AGA, DUNTON, SCHELL, MATHEWS
CHARTER ACONA
GOA-PWS
ROYER
GOA-PWS
ROYER - BURRELL
GOA-PWS
ROYER
GOA-PWS
ROYER
CHARTER
KODIAK FOOD WEB

NOAA FORM 77-67B
(5-75)

NOAA FLEET SAILING SCHEDULE

(JANUARY – JUNE)

PERIOD 1979

SHIP	JANUARY	FEBRUARY	MARCH	APR
MILLER FREEMAN	(NMFS)	KODIAK FOOD WEB DUNN, FEDER; KODIAK	KODIAK FOOD WEB DUNN, FEDER; (NMFS)	
DISCOVERER	EPOCS (ERL)	CRUISE; CALCOFI	CRUISE (NMFS)	
SURVEYOR	PMC SEATTLE	T; T/G SEA...; GOA/PWS ROYER; KODIAK	BERING - ICE EDGE MARTIN; KODIAK; NEGOA CO	
BELL 206B		ON SURVEYOR	ON SURVEYOR	
UHIH HELO N57RF		SCC AAGAARD	DEADHORSE DUTTON, HORNER; DEADHORSE; DEADHORSE HORNER, SCHELL	
UHIH HELO N56RF		DEADHORSE LGL; DEADHORSE - BARROW BURNS	DEADHORSE MATHEWS; DEADHORSE ROGERS, MORAY, HOPKINS; SCC	
CHARTER U. of AK. ACONA		GOA ROYER		

☆ U.S. GOVERNMENT PRINTING OFFICE: 1980-0-677-138/11