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Environmental Assessment of the Alaskan Continental Shelf

Executive Summary

April 1977 — March 1978

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

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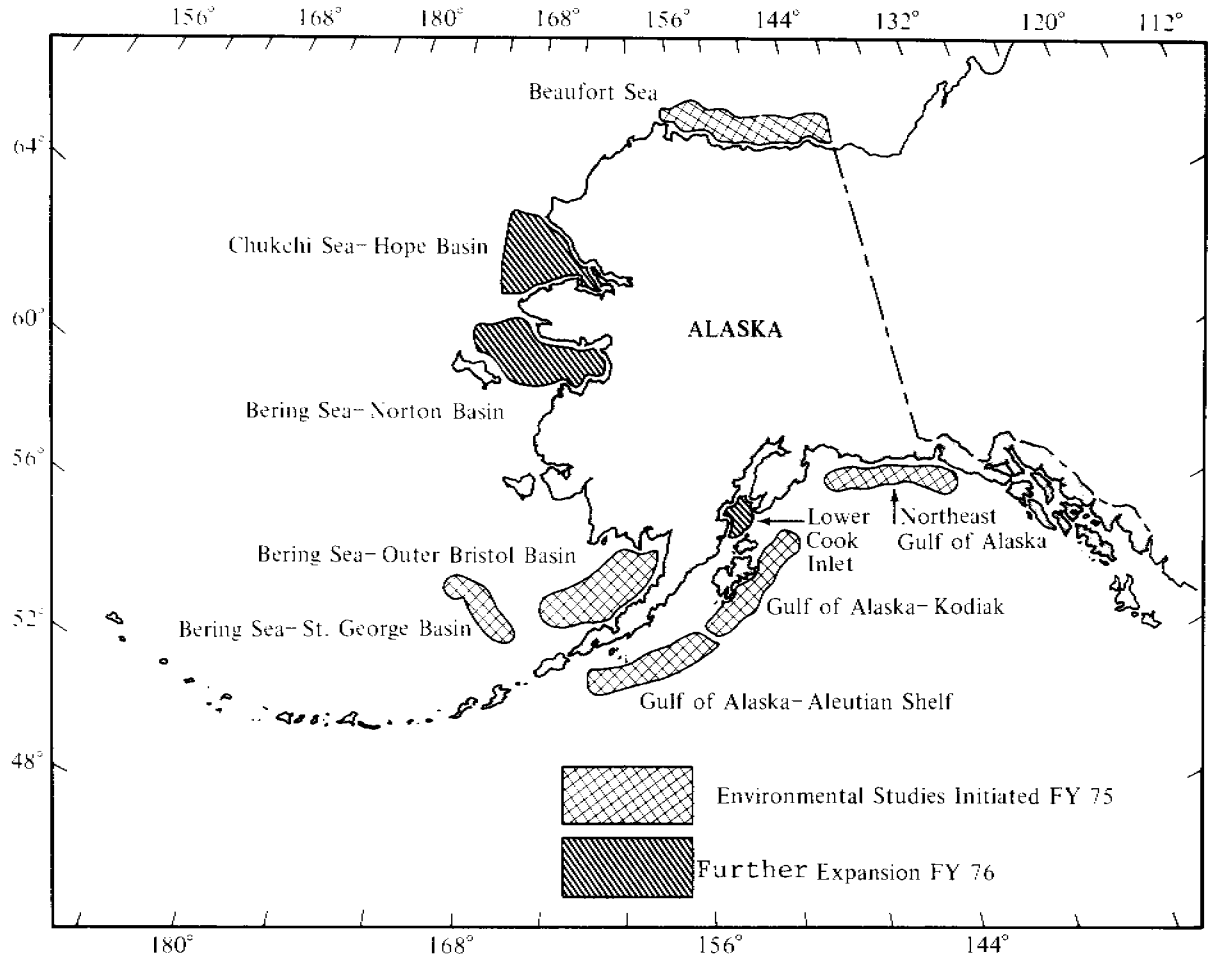

Figure 1. Map of Alaska showing lease areas

ALASKAN MARINE CONCERNS AND KEY ISSUES, 1978

A Message From the Director

The Outer Continental Shelf Environmental Assessment Program (OCSEAP) focuses 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.* The vast geographic area included involves extreme environmental conditions, which are largely responsible for the lack of marine environmental information on the Alaska 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 basic information for the protection of 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 the 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.

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*See Figure 1

In meeting these information needs, especially the one of prediction of effects we find a wide variety of essential biological and physical studies directed toward understanding the processes and relationships in the environment. The environment is complex, and consequently the manner in which these studies relate to one another and to oil and gas development is not quickly or easily recognized.

OCSEAP is systematically developing all four classes of information in each of the nine areas proposed for leasing the Alaskan OCS. This effort is described in OCSEAP's Program Development Plan, the ten Technical Development Plans for FY 79, 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 listing of these serves to illustrate the nature of OCS-related environmental problems confronting the OCSEAP. It also provides a brief overview of the scope of OCSEAP program content and demonstrates the imperative nature of the studies. The key issues listed do not include socio-economic and certain non-petroleum contaminant issues, such as sewage, nor certain engineering design issues which are not assigned to OCSEAP for planning and management, but which we are nevertheless aware to be of considerable significance.

Rudolf J. Engelmann
Director, OCSEAP

KEY CONCERNS & ISSUES

This list is not exhaustive and will no doubt be modified as the studies continue.

1. The arctic marine environment is extensively controlled by the presence, character and behavior of ice. There is a close association between the biota and the ice edges and leads. This has the potential of concentrating the biota in the very places where and at times when spilled oil may be confined. It is possible that the entire Beaufort populations of some species make use of a traditional lead during spring migration.

2. When the ice is far offshore, as in the summer of 1977, ice habitats for seals are limited. An ice remnant in Harrison Bay was seen to attract a large population of western Beaufort Sea seals. If this ice feature is found repeatedly in future years, it should be treated as a critical habitat.

3. Storm surges are a frequent occurrence in the Beaufort Sea and observations of driftwood on islands and beaches suggest that some islands may be entirely awash during such surges. Storm surge heights may exceed two meters, and, since the topographic relief along the Beaufort Sea coast is very low, spilled oil may be distributed quite extensively over islands, lagoons, salt marshes and estuaries during such events.

4. Development must deal with the dynamic nature of the Beaufort coast, which erodes at 1-2 meters per year and in some areas as much as 30 meters per year. Entire spits and islands can disappear and reappear on occasion in single storms. Barrier islands are part of this dynamic system, and their stability and usefulness as habitats may be threatened by demand for gravel. Removal of gravel from river bottoms may also affect critical habitat for the overwintering of fish. Of equal concern to gravel removal in the arctic is the whole subject of freshwater removal in support of operations. Drawdowns of water in fish overwintering pools can suffocate or freeze local populations in winter. Opportunities for overwintering by anadromous fish are now believed to be the overriding limiting factors upon population size in the Arctic.

5. Subsea permafrost is a hazard posed to offshore structures, leading to analogous problems as those ashore. Recent studies have indicated that the nature and distribution of subsea permafrost is highly irregular. Former lake beds, such as Prudhoe Bay, are free of permafrost, while some, but not all, barrier islands are underlain by it. The stability of both natural and artificial islands is affected by possible permafrost bonds to deeper layers, which may not be established in artificial islands, either because of the high salinities produced on freezing or because the permafrost level below the island is too deep.

6. Ice poses a spectrum of threats to development in the Arctic. In the nearshore zone, where leasing is first scheduled, the fast ice is not stable but may move by several meters or even tens of meters during events that compress the ice; even thermal expansion may cause movements up to a meter or more. There is a high density of pressure ridges in the fast ice, and ice-shove (the overriding of beaches by the ice to several tens of meters in distance) occurs regularly in some areas. Several Beaufort Sea barrier islands were overridden by ice surges in late 1977, and the Chukchi shore of the City of Barrow suffered considerable damage from ice-shove in the same period. An understanding of the physical processes of fast ice movement, ridge building, ice-shove and similar phenomena is far from complete, and statistics on the frequency and areas of these hazards are inadequate.

7. Other ice hazards include the gouging of the ocean floor by the keels of pressure ridges and ice islands, digging furrows up to 6 meters deep. Hundreds of criss-crossing gouge tracks per kilometer have been recorded, and in some areas the entire sediments get completely reworked every 30 years or so to a depth of 30 cm. The pressure ridges and keels which produce these gouges may be up to 50 meters thick and can exert large forces and threats to structures.

8. The "extreme event" has not been established or quantified for any of the threats the arctic environment poses to development. The number of years of observation is too few to have observed the "100-year" storm or extreme, and the understanding of physical processes is still too meager to calculate that extreme from other data. Extremes are still unspecified, for example, on fast-ice movement, pressure ridge depth and stresses, gouge depth and location, and the forces exerted by the intrusion of floebergs into shallow waters.

9. Changes in circulation in the Beaufort nearshore and lagoon regions are expected to be produced by causeways and other structures. The inshore and barrier island lagoon areas are especially important to fishes (migration, growth) and birds (staging, molting, rearing). One may expect changes in salinity and nutrient supply, both minerals and detritus, and possibly in barrier island building and migration when circulaton is changed. These changes would primarily affect nearshore fish species that are an integral part of the food web.

10. Oil spill cleanup in the Arctic, as convincingly demonstrated by several Canadian papers, is virtually impossible for most areas and for most of the year. There is some hope for effective summer cleanup if not too much ice is present, and some limited hope for tackling spills under fast ice. There is no available method for cleaning up spills in the zone of moving pack ice, which covers most of the Arctic continental shelf. It has been shown that oil can be burned when it moves to the surface of the ice, but the effects of this on the biota are unknown, as are the effects of dispersants.

11. Although experience with offshore oil development in the northern part of Cook Inlet has shown that environmental hazards short of major earthquakes can normally be dealt with, it is clear that Cook Inlet structures and pipelines must cope with high tidal currents, high rates of sediment movement, active faults and seismic activity, and the existence of ice during the winter months.

12. Mt. Augustine, a volcanic island in Lower Cook Inlet, presents a potentially serious hazard to the western tracts in the lease area. These include ashfalls, acid rains, noxious fumes, bombs, and especially large glowing clouds which would travel across the sea and a basal glowing avalanche which would travel along the seafloor. In 1883 an eruption produced waves 30 feet high across the Inlet in English Bay. Augustine has an average period of only 30 years between eruptions and so is very likely to affect the safety and integrity of oil and gas structures in the Lower Cook area.

13. The trajectories taken by oil from spills and routine operations are determined by both the ocean currents and the winds. Neither of these are defined in the critical nearshore areas, especially where irregular and elevated shorelines exist. In the case of Lower Cook Inlet, the trajectories used in tract selection for the past sale are highly suspect. Considerably more data from more observation points, and study time to analyze and model water and air flows are needed before trajectory models (for extensive stretches of Alaskan coast) can be established with any confidence.

14. Historical earthquake recurrence rates off Kodiak exhibit considerably higher frequencies than in either NEGOA or Cook Inlet. Several major nearsurface faults have been identified, which may be active since they trend across young sediments. A major earthquake is expected in the "Shumagin gap" within the lifetime of any productive field that may be developed. Faults with vertical offsets (movements) as much as 20 meters have been observed in NEGOA. Extensive areas with submarine slumps and slides, and with sediments of very low shear strength have been found in NEGOA. In summary, the Pacific Alaskan lease areas pose serious geohazards to petroleum production.

15. The Kodiak lease area is known to be extremely productive in terms of commercial utilization and is probably equally important to non-commercial species. Unfortunately, nearshore circulation and biological data are not yet adequate to fully explain this productivity or to predict movement of pollutants. Trophic relationships on which higher forms depend are not yet defined.

16. Gas cratering, apparently due to gas from decaying peat in Norton Sound, has been observed off Nome and the mouth of the Yukon. The potential of cratering represents a threat to rigs and 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 close to the Yukon delta.

17. Norton Sound is subject to storm surges far above usual tide levels. The storm of November 1974 pushed water four meters above average sea level, and had waves three or four meters high. Bluff erosion up to 45 m was attributed to this storm. Debris from surges has been found at 4.75 m above mean sea level in the eastern flank of the Sound.

18. The Yukon delta is both a critical habitat for vast numbers of waterfowl and salmon, and an unstable, vulnerable foundation for man to build on. It is underlain by permafrost, has major flooding in the spring, and even has the potential for major relocation of the main channel. Its low elevation will permit the intrusion of contaminants on storm surges as far inland as 15 km.

19. The eastern Bering Sea is a productive ocean region containing some of the largest fish, crab, and marine mammal stocks in the world. Several factors contributing to this productivity may be affected by petroleum pollution. For example, the ice front edge, which has been shown to be biologically important, would be likely to concentrate and trap spilled pollutants in its many leads and irregularities. Dissolved fractions would be carried into deeper water by the sinking of the surface waters along the ice edge.

20. The Pribilof Islands are clearly a critical habitat that must be carefully protected. Here for a limited period is the bulk of the world's population of Red-legged Kittiwakes, a very large total population of birds, as well as the world's entire northern fur seal population. The birds are disturbed by noise with significant resultant egg loss. The seals are subject to cold exposure upon oiling, with other possible effects of oil on them and their young. The islands are downstream from the St. George lease area and from Unimak Pass (through the

Aleutians), which will eventually bear major tanker traffic. There are only a few sites that could be used for staging and loading in the development of the St. George Basin. Our concerns are whether the island populations can withstand any intrusion. Sufficient definition of oil transport in the water upstream from the Pribilofs is needed to be able to specify tracts and transportation corridors that represent threats.

21. The world's whole population of Black Brant and most of the world's population of Emperor Geese use the north side of the Alaskan Peninsula during migration. This peninsula separates the Bering Sea and Pacific Ocean and is the mainland extension of the Aleutian Islands. An untimely, catastrophic spill here could destroy these populations directly or through habitat destruction. Thousands of other birds use these same estuaries.

22. Lagrangian drifters released in the NEGOA lease area have shown a strong tendency to enter Prince William Sound. A better understanding of the factors influencing Prince William Sound inflow and outflow will be required to predict the path of pollutants from both NEGOA development and from tanker traffic in the area. Prince William Sound is an especially rich habitat for a wide variety of important biota ranging from whales and salmon to profuse benthic life. There is evidence of a genetically isolated population of killer whales in the Sound, which makes them more vulnerable to insult than if they intermixed with other populations elsewhere. Hinchinbrook Entrance and Montague Strait are important concentrating or foraging areas for marine mammals.

23. Although probably most visible major rookeries, hauling grounds, colonies, and feeding areas have been identified for many species, there are likely some major temporary and sub-seasurface critical 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. For instance, 20,000 Steller sea lions were unexpectedly observed in Puale Bay in March 1978. It is presumed that this may be an indication of some unknown migration pattern.

24. Recent evidence, plus re-evaluation of older material, challenges the generally accepted assumption that winter represents a season of biological standstill in arctic marine systems. Overwintering sites must be identified and protected, because there may well be the limiting factors in population size and even survival.

25. An area inside Narwhal Island, covering 18 x 7 km and known as Stefansson Sound, has been delineated by OCSEAP divers and singled out for further attention because of the existence of boulders on the seafloor, especially clear water, and the resulting unique assemblage of flora and fauna. To the extent that the macro-algae growing in this "boulder patch" are perennial species, it would require years for this community to re-establish itself following disturbance. The true significance of this unique habitat to the community remains to be determined.

26. Bowheads remain an endangered species. Spring counts in 1978 estimated a population of only 2,264 in the Beaufort. The reactions of bowheads to human activities in the nearshore remain a key concern, especially if they use nearshore areas in the fall period.

27. It is unknown what effects man's activities and noise will have on use of breeding and calving areas. There is a real possibility that whale (Beluga) calves could not survive in colder waters if driven from present "warm" water calving areas in the Mackenzie or elsewhere.

28. The California gray whales migrate twice through six Alaskan lease areas each year. About 11,000 or 75% of the gray whales which summer in Bering Sea migrate through the Unimak Pass area in a three-week period. If gray whales are vulnerable to man's activities in the nearshore environs, then the movement of whales through Unimak Pass is of considerable concern. Preliminary evidence in California indicates that gray whales change their migration routes when confronted with heavy boat traffic.

29. One investigation observed a 10% mortality of harbor seal pups on Tugidak Island as a result of disturbance by low-flying aircraft. This island, 20 miles southwest of Kodiak Island and downstream from the lease area, has the largest known concentration of seals, at least 13,000.

Bird investigators have reported similar observations of disturbance, particularly for cliff-nesting species, with loss of eggs. It is not clear whether mortality will continue to increase with more frequent disturbances, or if tolerance might be induced.

30. For birds and mammals of Alaska little is known of avoidance or attractance behavior in the presence of oil. Avoidance of extensive areas could displace animals from their optimum habitat and food supply. Insufficient information exists to assess these effects on population dynamics and the use of alternative food sources. Fur pelts and feathers lose their insulating qualities when oiled, and subsequent washing of sea otter pelts increases their metabolic rate and decreases their resistance to disease. Experimental animals have developed pneumonia.

31. We have no definitive knowledge of the effects of oil on large mammals including the bowhead whale. It is reasoned, and observed in controlled studies on seals, that nasal and eye effects occur, but effects on the mammal populations are totally unknown.

32. We are continually aware that oil and gas development may have a surprise side-effect on some species with a cascading disastrous effect on others. As an illustration, it has been hypothesized that if starfish are quite sensitive to hydrocarbons, eelgrass communities may suffer, since starfish control the sea urchin population which grazes the eelgrass beds--important nurseries of the sea. A comprehensive understanding of the interrelationships among species and processes is needed to determine the reality of a multitude of such hypotheses.

33. For most species, especially for non-commercial fish, there is inadequate information on population dynamics, recruitment and prey to permit an assessment of short and long-term effects of episodic insults from oil and gas activities.

34. The significant decline in ringed seal population in 1976, as compared with 1970, and reduced pregnancies through 1976 are still unexplained, but pregnancy rates rose in 1977 to more typical values. The ringed seal and polar bear populations are moving southward and westward. It is speculated that the population reduction is related to severe ice conditions and decreased availability of food. Since pinniped densities

have recently been found to be lower in the vicinity of human habitation, regardless of whether seal hunting is practiced from the village, there is tangible concern over the reactions of seals to seismic activities offshore.

35. We also recognize the urgent need for studies of the sensitivity to contaminants of arctic forage fish and other important trophic elements such as euphausiids, mysids and amphipods. Should the fry or eggs be especially sensitive, there could be serious consequences to mammal and bird populations, even from modest contamination. There are few data on arctic organisms and extrapolation of results to the arctic outdoors from laboratory studies on subarctic species is not feasible. Since rates of reproduction and growth are slow in the arctic and because overwintering organisms may already be at the limits of physiological tolerance for stress, organisms may be more vulnerable to insult. Some populations for fish and mammals will recover very slowly from any resultant damage. Thus damage must be carefully avoided or minimized.

36. The need for effects studies on arctic forage species is accented by the observations that the population of murres at Cape Thompson is down 50% compared to 1959-61, and there was virtually complete reproductive failure of Black-legged Kittiwakes in 1976 followed by only partial recovery in 1977. It is speculated that the reason was a shortage of forage fish. The drastic reproductive failure was observed in subarctic Norton Sound as well. Although many species are known to fluctuate widely in numbers from year to year, there is insufficient knowledge of the population dynamics of many Alaskan species to determine if such a failure is unusual, or is a threat to the species. The near doubling of the Least Auklet population in ten years is also unexplained; we do not even know if this is a typical variability. These examples emphasize our inadequate understanding of arctic systems and consequently our inability to predict reactions to development and recoveries.

37. Northern sea lion numbers in the eastern Aleutian Islands appear to be at about one-half of their 1950 to early 1960 levels. On the breeding rookeries in the study area, the decline approaches 65%. Eighty percent

of these are in the Fox Island group, and large numbers remain there through the autumn. The population drop may or may not be within the range of "natural" variability. We do not know the natural variability, its reasons, or the population dynamics of the species, so we are unable to assess the effects which man's activities are having or that OCS development may have.

38. We are likewise concerned with the probable large increase in population of predators (e.g., foxes and gulls) that overwinter successfully with man's oil and gas developments. Increase in these predators will affect bird populations to a greater degree as development occurs.

39. Drilling muds and cuttings are believed to have only local effects in subarctic areas, and the ecosystem can quickly recover by immigration. In the arctic, however, the lagoon areas are quite shallow and circulation is restricted by bottomfast and other ice. A major concern is whether the release of muds and cuttings, particularly during the presence of ice, will produce damage over large areas, especially to overwintering populations already stressed by high salinity and low temperature.

40. Long-term accumulation of hydrocarbon in tissue is not yet quantified for most species. Evidence is that accumulation in tissues of deposit-feeding organisms does occur. Feeding of contaminated food to salmonids results in damaged eye lenses, as does external exposure, and results in the accumulation of hydrocarbons in muscle and organs. The significance of this accumulation is not known.

41. The effects of long-term exposure to oil at low concentrations ("chronic") are far from being adequately studied to permit predictability. Changes in growth rate, homing ability, migration time, disease resistance, predation, and reproductive success have been observed in laboratory studies. These require further study and verification by field experiments, since the effects observed on individuals in the laboratory cannot be extrapolated to populations in natural conditions. However, field verification will be very difficult to accomplish.

MANAGEMENT

General

Overall management, fiscal, and coordination 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). These project offices maintain an 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 formats and reporting, archiving, and analyzing 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 1978 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 (TDP's) for FY 1979 began in October 1977. These plans logically follow previous research, the recognized workshop outputs from investigators, suggestions from the User's Panel, and the BLM requirements described in their Alaska Regional Plan.

Workshops

A number of workshops were sponsored during the period. These meetings were greatly varied in format and purpose but were of three general types: the disciplinary workshops, such as chemistry, bird studies, or physical oceanography, brought together the PI's 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 the Oil in Ice meeting and the Barrier Island-Lagoon study meeting, discussed the scientific program content of future integrated research efforts; the second type was the review meeting, which exposed the ongoing disciplinary programs to review by top management and outside scientists. The review meetings were a new effort during this period and were intended to expose the Alaska OCS research program to the scrutiny of the outside scientific community. Summaries of comments from these reviews have been prepared and the many suggestions made were considered in the FY 79 program. These meetings were held:

First Barrier Island-Lagoon Study Workshop	6-8 April 77
Oil in Ice Planning Meeting	9 June 77
Data Management Workshop	31 Aug.-1 Sept. 77
Chemistry Review Meeting	15-16 Sept. 77
Bird and Mammal Review Meeting	25-28 Oct. 77
Physical Oceanography - Meteorology Review Meeting	9-11 Nov. 77
Effects Review	29 Nov.-2 Dec. 77
Second Barrier Island-Lagoon Study Workshop	6-8 Dec. 77
Geology Review Meeting	30 Jan.-3 Feb. 78
Kodiak Field Planning Meeting	30 Jan.-3 Feb. 78
Fish, Benthos, etc. Review	17-21 April 78
Third Barrier Island-Lagoon Workshop and Review	24-26 April 78

Synthesis

Two synthesis meetings were conducted which integrated disciplinary data for the particular lease areas in order to meet BLM decision-making needs and to provide inputs for future research. These meetings, attended by principal investigators, BLM personnel, OCSEAP management, and other scientists, concentrated on identification of key species, important processes, and interactions in terms of possible impingement from oil and gas development. Such meetings provide a primary mechanism for arranging interdisciplinary interpretation of observed data. Draft reports summarizing results of proceedings were distributed to participants for their comments and corrections.

The two synthesis meetings held were:

Lower Cook Inlet	17-19 Jan. 78
Beaufort - Chukchi	23-27 Jan. 78

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 tasks involved

the initial preparation for publication of three synthesis reports, which were based on meetings held the previous winter. SAI has now undertaken the preparation for each lease area, of an integrated and comprehensive summary of all available information in terms of the PDP tasks and subtasks. These summaries will be updated annually.

OCSEAP PUBLICATIONS

Annual Reports for year ending March 1976	(14 vols.)
Quarterly Reports, April-June 1976	(2 vols.)
Quarterly Reports, July-Sept. 1976	(4 vols.)
Quarterly Reports, Oct.-Dec. 1976	(4 vols.)
Quarterly Reports, Apr.-June 1977	(2 vols.)
Quarterly Reports, July-Sept. 1977	(3 vols.)
Quarterly Reports, Oct.-Dec. 1977	(2 vols.)
Annual Reports for year ending March 1977	(18 vols.)
Annual Report Summary for year ending March 1976	(1 vol.)
Annual Report Summary for year ending March 1977	(1 vol.)
Executive Summary for year ending March 1977	(1 vol.)
1977 Synthesis Report for Lower Cook Inlet	(1 vol.)
1977 Synthesis Report for Northeast Gulf of Alaska	(1 vol.)
1977 Synthesis Report for Kodiak	(1 vol.)
1978 Synthesis Report for Beaufort	(1 vol.)
Climatic Atlas	(3 vols.)
Vol. 1 Gulf of Alaska	
Vol. 2 Bering Sea	
Vol. 3 Beaufort/Chukchi Seas	
FY77 & FY78 Work Statements	(3 vols.'78)
(Descriptions of research units involved in studies of the Alaskan Outer Continental Shelf)	(1 vol. '77)
FY78 Technical Development Plans	(10 vols.)
(Detailed descriptions of plans for FY78 research in each of the 9 Alaskan lease areas plus one for general studies)	
Research Management	(1 vol.)
(Description of OCSEAP's management program)	
Final Reports of Principal Investigators	(3 vols.'78)
(Biological Sciences)	

DATA MANAGEMENT SUMMARY

The objectives of the OCSEAP data management program are two-fold: 1) to establish a data base of the 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. To develop the capability and flexibility of meeting the needs of many different users, emphasis has been placed on the development of a digital data base because of its flexibility for many different types of outputs. Investigator reports, raw data records and photographs are, of course, a part of the data base of environmental information.

During this past year a number of important steps were accomplished in the OCSEAP data management effort. A large amount of environmental data was received by the data center and the first edition of an OCSEAP data catalog was issued. A new taxonomic code of biological species was developed to provide a common base of taxonomy for the whole of the United States, an on-line computerized data inventory system was established, and many user data needs were serviced by the data center. These accomplishments are further described in detail below.

Data Flow

Rather than deal in discrete observations that have been catalogued and archived, typically the flow of data received is assessed in terms of data sets, a data set representing the data collected by an investigator on a particular ship's cruise or the total data collected by that investigator in a three-month data collection period. Table 1 summarizes the data received during the year.

Table 1. Data, Data Reports and Data Inventories Received from April 1977 to March 1978

	Total	Apr-Jun 77	Jul-Sep 77	Oct-Dec 77	Jan-Mar 78
A. Digital Data Sets					
Biological	274	12	25	118	129
Physical	78	9	47	11	11
Chemical	21	0	5	0	16
Geological	2	0	0	2	0
Non-OCSEAP Format+	11	4	3	2	2
	396	25	80	133	158
B. Seismic & Earthquake Data	8	2	2	2	2
C. Data Reports	136	58	39	32	6
D. Data Inventories	184	49	38	63	34

Table 2 gives a somewhat more detailed breakdown of the types of digital data received. Each of the 34 digital file types is identified and the number of data sets received from each of the nine lease areas is shown.

Table 2. Types of Data Received*

File Type	Format Name	Total this Year*	Lease Areas: NEGOA	Lower Cook	Kodiak	St. George	Beaufort	Bristol Bay	Norton	Aleutians	Chukchi
013	Fish Pathology	1	-	-	1	-	-	-	-	-	-
015	Current Meters	6	5	-	-	1		-	-	-	-
017	Pressure Gages	5	1	-	-	4	-	2	-	-	-
021	Trace Metals	4	2	1	3	1	-	1	-	1	-
022	STD/CTD	29	12	4	14	7	1	7	3	3	2
023	Fish Resource	33	10	-	12	23	1	23	18	4	17
024	Zooplankton	15	10	10	2	3	1	2	-	2	-
025	Marine Mammal Specimen	18	14	3	6	-	-	-	-	-	-
026	Marine Mammal Sighting II	1	-	-	-	1	-	1	-	1	-
027	Maine Mammal Sighting I	51	45	29	29	12	1	13	-	1	1
028	Phytoplankton	3	-	-	-	2	1	2	-	-	-
029	Primary Productivity	3	-	-	-	2	1	2	-	-	-
030	Intertidal Data	7	6	-	7	-	-	-	-	-	-
032	Benthic Organisms	14	2	2	7	2	4	2	1	2	1
033	Marine Bird Census (Ship/Aircraft)	88	5	4	10	3	67	3	6	1	23
034	Marine Bird Land Census	3	-	-	-	-	1	-	2	-	2
035	Marine Bird Colony	31	-	-	-	26	-	-	6	-	6
036	Marine Bird - Ship Followers	-	-	-	-	-	-	-	-	-	-
037	Feeding Flock	8	-	-	7	3	-	-	-	4	-
038	Migratory Bird Sea Watch	-	-	-	-	-	-	-	-	-	-
040	Marine Bird Habitat	7	4	7	7	4	-	7	-	-	-
043	Hydrocarbon I	2	1	2	2	-	-	-	-	-	-
044	Hydrocarbon II	-	-	-	-	-	-	-	-	-	-
056	Langrangian Current Measurements	33	9	-	-	-	21	3	-	-	-
057	Herring Spawning	0	-	-	-	-	-	-	-	-	-
061	Trace Elements	15	8	3	2	5	1	5	-	-	1
063	Maine Invertebrate Pathology	1	-	-	-	-	-	-	1	-	1
072	Beach Profiles	1	1	-	-	-	-	-	-	-	-
073	Grain Size Analysis	1	1	-	-	-	-	-	-	-	-
100	Intertidal/Subtidal	5	3	-	-	-	1	-	1	-	-
101	Wind Data	-	-	-	-	-	-	-	-	-	-
	Other	11	6	4	5	3	1	3	1	7	1
	Total	396									

*NOTE: Total Data sets for all lease areas will exceed total data sets received because many data sets have stations in more than one lease area.

Data Inventories, Catalogs and Tracking System

The first edition of Part I of the Data Catalog was completed and distributed to over 150 individuals. The first edition included all station locations for digital data received by the Data Centers through April 1977 for biological, physical, chemical, and geological data. The second edition, planned for distribution in July 1978, should include all the above plus epicenter data locations received by NGSDC for OCSEAP studies.

Also, Parts II and III of the Data Catalog are being completed. Part II will consist of an inventory of data sets sorted by lease area and identified by investigator, agency, platform information, and number of stations in each data set. It is planned for distribution with the Part I revision.

Part III will describe each file type with a list of parameters and codes and the format layout. An index of parameters by relevant file types will be included. Distribution of Part III is planned for June 1978.

Other inventory activities included the documentation and distribution of instructions for access to the OCSEAP inventory file (DIP). Copies were forwarded to OCSEAP Offices and EDS liaison offices.

Updated versions of the OCSEAP Data Tracking System and the related File Type Summary have been distributed to BLM, OCSEAP and EDS personnel on a quarterly basis. During the past year approximately 1500 new records and over 10,000 updates to existing records were entered in the system.

Lists of late data sets, late data inventories, and other management products derived from the tracking system have been supplied to the Project and Program Offices. A revised phone and address list sorted by RU and investigator name (also from the tracking system) was completed in January 1978 and distributed to OCSEAP data management personnel.

An updated version of the Alaskan Environmental Data Base Directory (EDBD) was completed during the first quarter of the past year. A complete copy, consisting of five volumes, was forwarded to BLM-Anchorage.

Data Requests

A total of 54 requests for data, data products and OCSEAP data reports have been received by the data centers. Requests for data formats, products from the Data Tracking System and copies of the Data Catalog and NODC Taxonomic Codes are excluded.

During the past year, requests for OCSEAP data have been made primarily by investigators and OCSEAP Offices (as shown below) in contrast to the previous year when the majority of requests were for archived data.

Table 3. Summary of Data Requests

Requestor	Data Type	Total	Apr-Jun 77	Jul-Sep 77	Oct-Dec 77	Jan-Mar 78
BLM	OCSEAP	5	1	1	3	0
	Archives	0	0	0	0	0
OCSEAP Offices	OCSEAP	16	4	4	2	6
	Archives	1	0	0	1	0
OCSEAP PIs	OCSEAP	16	1	6	7	2
	Archives	5	4	0	1	0
Non-OCSEAP Requestors	OCSEAP	11	1	3	4	3
	Archives	NA	NA	NA	NA	NA
TOTALS		54	11	14	18	11

Some of the more relevant requests for OCSEAP and related data are listed below.

Table 4. Examples of Data Requests - April 77-March 78

Requestor	Description
U. Alaska (Geo. Inst.)	XBT/MBT data for Norton and Chukchi areas
U. Alaska (IMS)	US Coast Guard ocean station data (continuing request)
OCSEAP/BLM	Sample earthquake plot products
Juneau Project Office	Plots of temperature, salinity and density for a selected cruise
SAI (California)	Tape copies of selected OCSEAP data files (file types 029, 032 and 073)

Requestor	Description
U. Alaska (IMS)	Tape copy of selected STD data files
AEIDC	Listing and plots of OCSEAP stations with ichthyoplankton and mesoplankton species within 200 miles of Alaskan coast
U. Alaska (IMS)	Listing and plots of selected stations and file types for Kodiak lease area
U. Alaska (Geo. Inst.)	Annotated plots of bottom temperature data from selected OCSEAP cruises in the Beaufort and Chukchi Seas
BLM (Anchorage)	Listing and plots of OCSEAP data containing selected coral species in Alaskan waters
Juneau Project Office	Inventories and data descriptions for OCSEAP hazard, transport, biological and chemical data in Lower Cook Inlet
BLM (Anchorage)	Listing and tape copy of monthly inventories of species currently identified in Beaufort Sea by OCSEAP investigators; prey/predator species itemized for available mammal data
INSTAAR	Geophysical data products for Beaufort and Chukchi areas
Juneau Project Office	Listing of available geological data for Lower Cook Inlet
Research Mgmt. Assoc.	Tape copy of 1975-76 intertidal data (RU78) and NODC/Alaska taxonomic code on tape
OCSEAP Program Office	Selected marine bird population estimates for Pribilof and Middleton Islands (request not yet completed)
Alaska Fish and Game	Seasonal marine bird species plots for Lower Cook area (to be completed in March)
OCSEAP Program Office/SAI-Boulder	Products for "Program Product List" - includes selected plots for physical, chemical, geological, geophysical, and biological data in OCSEAP data files. Products are to be generated for each lease area and for seasonal or monthly presentations where data are adequate. Some products have been completed - others are still being developed

Data Product Development

In addition to requests for specific products, efforts are underway to develop a family of products from the different OCSEAP file types. A status report of all product development concerning OCSEAP data was forwarded to the Program Office in May 1977. Further discussions concerning product development were conducted during the OCSEAP data management meeting at Lake Quinault, Washington in June 1977.

The direction that OCSEAP product development will take within EDS has been determined essentially from the 'Data Product Compendium' generated by the Program Office. Time-series displays, vertical and horizontal arrays and contour plots, vector and rotary plots and three-dimensional displays are all being considered as part of this family of products. Progress in some areas depends on the availability of adequate, correct data to test software packages and output presentations. For other areas, products have been developed but must be modified repeatedly for correct interpretation of data parameters unique to OCSEAP and other non-standard data types.

A sample 'product brochure' is being assembled by the Data Centers to display examples of each type of OCSEAP product (on normal page size where possible). Copies of these brochures will be made available to the OCSEAP Offices and EDS Liaison Offices.

Taxonomic Code Developments

The revised and updated NODC taxonomic code was distributed in March 1977. Requests for additional codes continue to be received and serviced by NODC with Dr. Mueller of the University of Alaska acting as consultant. This new taxonomic code provides a systematic classification of biological species found throughout the United States and provides a basis for comparisons among various parts of the country. Computer programs are now available to match equivalent new codes to the earlier Alaskan codes and to list scientific and common names for each code (where this information is available).

An inventory of unique species for each data set is now incorporated into NODC data checking procedures. Copies will be forwarded to the Project Offices along with a list of data errors, logic errors, and other parameter inventory information.

Several taxonomic code newsletters (Nomenclature Code News Notes) have been distributed during the past year. These newsletters document changes to be made in the new code list, explain proper uses of the codes and include the bibliographic reference list used to construct the hierarchy of the taxonomic file.

FIELD ACTIVITIES AND LOGISTICS
1 April 1977 - 31 March 1978

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 continued at a high level through 1977 with logistics support greatest in the Beaufort Sea, Kodiak, Lower Cook Inlet, and Northeast Gulf of Alaska areas. Funding for direct logistics support remained over $4,000,000 during this third year of the program, with an additional $5,000,000+ of NOAA ship time allocated.

Subarctic Operations

Major support for operations in the subarctic was furnished aboard three NOAA vessels and three NOAA-operated helicopters. The NOAA ships DISCOVERER, SURVEYOR, and MILLER FREEMAN were again allocated to the program for a combined total of 540 days at sea. Approximately 525 of those sea days were used in the subarctic on a variety of projects.

A leased Bell 206B helicopter was operated from onboard the SURVEYOR during half of her field season, flying a total of 345 hours in support of seven cruises and one independent mission. Two UH1H helicopters, on loan from the U.S. Army, were operated as independent NOAA field units, flying a total of 407 hours on eleven different projects in the subarctic.

Additional vessel time was contracted to meet the remaining field work requirements. The University of Alaska vessel ACONA was retained for 70 days at sea. Approximately 140 and 110 days at sea were obtained aboard the USGS vessels SEA SOUNDER and S.P. LEE, respectively.

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).

Ice conditions in the Beaufort Sea were very mild in the summer and fall of 1977. The pack ice receded over 100 miles offshore and freeze-up didn't occur until early November.

Major vessel operations carried out in 1977 included a 37-day cruise aboard the U.S. Coast Guard Cutter GLACIER in the Beaufort and Chukchi Seas, 15 days aboard the NOAA ship SURVEYOR in the Chukchi Sea, and approximately 30 days by the USGS vessel S.P. LEE in the Beaufort and Chukchi Seas. The NARL vessel, ALUMIAK, and the USGS vessel, KARLUK, were also used for work in the Beaufort Sea for approximately 22 days and 60 days, respectively.

Primary helicopter time was provided by the two NOAA-operated UH1H's. Between the two, a total of 688 hours were flown on OCSEAP Arctic projects. Supplemental helicopter charters totaled 122 hours of flying time.

Fixed-wing aircraft support consisted of approximately 160 hours of multi-engine time and 245 hours of single-engine time.

Cruise Schedules and Summaries

Schedules of major vessel cruises and helicopter flying missions are shown in Figure 2.

Summaries of major vessel cruises and major helicopter flying missions are presented in Tables 5 and 6.

TABLE 5. SUMMARY OF MAJOR VESSEL CRUISES, APRIL 1, 1977 - MARCH 31, 1978

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVFSTIGATION	SPECIFIC OPERATIONS	NUMBER OF STATIONS
SURVEYOR (NOAA)	MARCH 15 - APRIL 6	ALEXANDER, IMS COONEY, IMS BURNS, ADF&G DIVOKY, PT. REYES FAY, U OF A	BERING SEA (ICE-EDGE)	ZOOPLANKTON PHYTOPLANKTON MARINE BIRDS MARINE MAMMALS	DIVING OPERATIONS CTD BONGO NET TOWS OTTER TRAWLS SIPRE CORES HYDROACOUSTIC & LIGHTMETER PROFILING NEUSTON NET TOWS TUCKER TRAWLS VERTICAL NET TOWS MAMMAL OBSERVATIONS & COLLECTIONS MAMMALS TAGGED BIRD OBSERVATIONS & COLLECTIONS	2 13 15 14 2 10 8 0 4 31 1 14
DISCOVERER (NOAA)	MARCH 13 - APRIL 1	SCHUMACHER,PMEL HAYES, PMEL FEELY, PMEL CLINE, PMEL CARLSON, USGS	ICY BAY KODIAK ISLAND	PHYSICAL OCEANOGRAPHY	CURRENT METER ARRAY RECOVERIES (62J, WGC-2E, K-1, K-2, K-3, K-5, SLS-16, SLS-17, SLS-19, SLS-20, SLS-21) CURRENT METER ARRAY DEPLOYMENT(62K, WGC-2F, WIST I, WIST II, SLS-22, SLS-23, SLS-24) NISKIN WATER SAMPLES NEPHELOMETER MEASUREMENTS CTD GRAVITY CORES SHIPEK GRABS MAMMAL OBSERVATIONS	11 7 8 8 66 9 23

TABLE 5 (CONTINUED)

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NUMBER OF STATIONS
MILLER FREEMAN (NOAA)	MARCH 28 - APRIL 9	SCHUMACHER, PMEL ROYER, IMS	WESTERN GULF OF ALASKA	PHYSICAL OCEANOGRAPHY	CURRENT METER ARRAY RECOVERY (IMS 9) CTD MAMMAL OBSERVATIONS	1 67
DISCOVERER (NOAA)	APRIL 4 - APRIL 23	FEELY, PMEL CLINE, PMEL MORITA, OSU ATLAS, U OF LOUISVILLE	LOWER COOK INLET SHELIDOF STRAIT KAYAK ISLAND	PHYSICAL OCEANOGRAPHY MICROBIOLOGY	PLEGER GRAVITY CORER GAS HARPOON CORER VAN VEEN GRAB CTD NISKIN WATER SAMPLES NEPHELOMETER NISKIN BUTTERFLY SAMPLER	1 6 6 56 50 56 27
MILLER FREEMAN (NOAA)	APRIL 13 - APRIL 27	WALDRON, NWAFC	BERING SEA (GOLDEN TRIANGLE)	ZOOPLANKTON	BONGO NET TOWS NEUSTRON (SURFACE) TOWS TUCKER TRAWL EPIBENTHIC SLED CTD XBT MAMMAL OBSERVATIONS	41 43 1 2 30 36
SURVEYOR (NOAA)	APRIL 14 - MAY 3	ALEXANDER, IMS COONEY, IMS BURNS, ADF&G DIVOKY, PT. REYES FAY, U OF A	BERING SEA (ICE-EDGE) (2)	ZOOPLANKTON PHYTOPLANKTON MARINE BIRDS MARINE MAMMALS	CTD/ROSETTE BONGO NET TOWS OTTER TRAWLS SIPRE CORES HYDROACOUSTIC & LIGHTMETER PROFILING NEUSTON NET TOWS TUCKER TRAWLS VERTICAL NET TOWS MAMMAL OBSERVATIONS & COLLECTIONS MAMMALS TAGGED BIRD OBSERVATIONS & COLLECTIONS DIVING OPERATIONS	15 19 17 1 6 2 0 5 15 80 32 1

TABLE 5 (CONTINUED)

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NUMBER OF STATIONS
DISCOVERER (NOAA)	APRIL 26 - MAY 16	SCHUMACHER, PMEL COACHMAN, U OF W BRAHAM, NWAFC	BERING SEA WESTERN GULF OF ALASKA	PHYSICAL OCEANOGRAPHY	CURRENT METER ARRAY RECOVERIES WGC-3C, WGC-1E, BC-13C, BC-17A, BC-2D, BC-9B, BC-4D)	7
					CURRENT METER ARRAY DEPLOYMENTS (WGC-3D, WGC-1F, BC-13D, BC-17G, BC-16A, BC-2E, BC-15C, BC-19A, BC-18A, BC-9C, BC-4E)	11
					CTD/ROSETTE	149
MILLER FREEMAN (NOAA)	MAY 1 - MAY 17	WALDRON, NWAFC	BERING SEA (GOLDEN TRIANGLE)	ZOOPLANKTON	NEUSTON (SURFACE) TOWS	90
					BONGO NET TOWS	66
					EPIBENTHIC SLED	1
					TUCKER TRAWL	1
					CTD	32
					XBT	48
					MAMMAL OBSERVATIONS	
DISCOVERER (NOAA)	MAY 20 - JUNE 11	ALEXANDER, IMS COONEY, IMS BURNS, ADF&G DIVOKY, PT. REYES FAY, U OF A SHAW, IMS BRAHAM, NWAFC	BERING SEA (ICE-EDGE) (3)	ZOOPLANKTON PHYTOPLANKTON MARINE BIRDS MARINE MAMMALS	HYDROCASTS	23
					DIVING OPERATIONS	
					CTD/ROSETTE	41
					BONGO NET TOWS	14
					OTTER TRAWLS	36
					SIPRE CORES	5
					HYDROACOUSTIC & LIGHTMETER PROFILING	3
					NEUSTON NET TOWS	23
					TUCKER TRAWLS	15
					VERTICAL NET TOWS	20
					MAMMAL OBSERVATIONS & COLLECTIONS	16
					MAMMALS TAGGED	0
					BIRD OBSERVATIONS & COLLECTIONS	109

TABLE 5 (CONTINUED)

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NUMBER OF STATIONS
MILLER FREEMAN	MAY 23 - JUNE 16	FEELY, PMEL HAYS, PMEL SCHUMACHER, PMEL	BRISTOL BAY NEGOA ICY BAY	?	?	?
SURVEYOR (NOAA)	JUNE 6 - JUNE 18	DAVIES, LAMONT DOHERTY	ALASKA PENINSULA	GEOLOGY	SEISMIC STATION SERVICING BATHYMETRY	4
SURVEYOR (NOAA)	JUNE 22 - JULY 13	PULPAN, U OF AK GEOPHYSICAL	WESTERN GULF OF ALASKA	GEOLOGY	SEISMIC STATION SERVICING	3
		FAY, U OF AK	ST. LAWRENCE	MARINE MAMMALS	ESTABLISH FIELD CAMPS	5
		BRAHAM, NWAFC	ST. MATTHEW	MARINE BIRDS	.5M RING HORIZONTAL NET TOWS (BOSTON WHALER)	7
		LENSINK, USF&WS BURNS, ADF&G CONNEY, IMS HUNT, U OF CALIF. (IRVINE)	NORTON/CHUKCHI PRIBILOFS	ZOOPLANKTON	TUCKER TRAWLS OTTER TRAWLS 1-M VERTICAL NET TOWS BONGO NET TOWS BIRD TRANSECT (10 MINUTE) MAMMAL OBSERVATIONS	19 17 59 3 350
ACONA (IMS)	JUNE 22 - JUNE 27	SHAW, IMS	LOWER COOK INLET	HYDROCARBONS	SURFACE WATER SAMPLES SEDIMENT SAMPLES	9 8
ACONA	JUNE 28 - JULY 17	CLINE, PMEL FEELY, PMEL	LOWER COOK INLET SHELIKOF STRAIT	HYDROCARBONS SUSPENDED SEDIMENTS	CTD ROSETTE NEPHELOMETER HYDROCASTS	96 96 96
ACONA (IMS)	JULY 25 - JULY 30	BURRELL, IMS	YUKUTAT BAY	HEAVY TRACE METALS	HYDROCAST BOTTOM CORE	5 5
ACONA	AUGUST 8 - AUGUST 15	ROYER, U OF AK	KODIAK (KISS)	PHYSICAL OCEANOGRAPHY	CTD's	20

(4)

TABLE 5 (CONTINUED)

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NUMBER OF STATIONS
SURVEYOR (NOAA)	JULY 20 - AUGUST 8	COACHMAN, U OF W HUNT, U OF CA (IRVINE) SCHUMACHER, PMEL CHARNELL, PMEL BRAHAM, NWAFC	BERING SEA (B-BOP) PRIBILOFS	PHYSICAL OCEANOGRAPHY MARINE BIRDS MARINE MAMMALS	CTD's XBT's CTD's OF OPPORTUNITY MAMMAL OBSERVATIONS BIRD TRANSECTS (10 MINUTES)	106 46 40 354
SURVEYOR (NOAA)	AUG. 11 - SEPT. 2	SCHUMACHER, PMEL COACHMAN, U OF W	BERING SEA NORTON/CHUKCHI(NCOP)	PHYSICAL OCEANOGRAPHY	CTD's XBT's CURRENT METER ARRAY RECOVERIES (NC1-4, NC6-10, NC14, NC16, NC17, NC20, NC21) NUTRIENT WATER SAMPLES TRITIUM 1-LITER WATER SAMPLES MAMMAL OBSERVATIONS HYDROGRAPHY	113 65 14 50 4
SURVEYOR (NOAA)	SEPT. 5 - SEPT. 19	SCHUMACHER, PMEL HAYES, PMEL LENSINK, USF&WS	KODIAK ISLAND(WGOA) GULF OF ALASKA (NEGOA)	PHYSICAL OCEANOGRAPHY MARINE BIRDS	CTD's CURRENT METER ARRAY RECOVERIES (WGC-2F, SLS-22, SLS-23, 62L) BIRD TRANSECTS (10 MINUTE) MAMMAL OBSERVATIONS	[redacted] [redacted] 164

TABLE 5 (CONTINUED)

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NUMBER OF STATIONS
DISCOVERER (NOAA)	SEPT. 6 - SEPT. 29	SCHUMACHER, PMEL COACHMAN, U OF W	BERING SEA (B-BOB)	PHYSICAL OCEANOGRAPHY	CTD's CURRENT METER ARRAY RECOVERIES (WGC3D, WGC1F, BC13D, BC15C, BC2E, BC16A, NC18A, BC19A, BC18A, BC9C, BC4E) CURRENT METER ARRAY DEPLOYMENTS (BC3D, BC2F, BC4F, BC21A, BC20A, NC24A, NC17B, NC23A, NC12B) MAMMAL OBSERVATIONS	172 11 9
DISCOVERER (NOAA)	OCT. 3 - OCT. 12	SCHUMACHER, PMEL HAYES, PMEL FEELY, PMEL CLINE, PMEL	LOWER COOK INLET	PHYSICAL OCEANOGRAPHY SUSPENDED SEDIMENTS TRACE METALS	CTD/HYDROCASTS NEPHELOMETER PROFILES SHIPEK GRADS GRAVITY CORES CURRENT METER ARRAY DEPLOYMENTS (C1-C11)	173 10 2 1 11
MILLER FREEMAN (NOAA)	OCT. 11 - OCT. 27	SCHUMACHER, PMEL HAYES, PMEL	KODIAK ISLAND/ SHELIKOF STRAIT	PHYSICAL OCEANOGRAPHY	CTD's DEPLOYMENT (K5A-K13A) MAMMAL OBSERVATIONS	36 8
DISCOVERER (NOAA)	OCT. 13 - OCT. 21	SCHUMACHER, PMEL HAYES, PMEL	KODIAK ISLAND	PHYSICAL OCEANOGRAPHY	CTD's XBT's MAMMAL OBSERVATIONS	96 23
SURVEYOR (NOAA)	OCT. 17 - NOV. 2	PITCHER, ADF&G CALKINS, ADF&G SHULTS, IMS	PRINCE WILLIAM SD. ICY BAY	MARINE MAMMALS	HARBOR SEAL COLLECTIONS SEA LION COLLECTIONS AERIAL SURVEYS (BELL 206) PATHOLOGY AND PARASITOLOGY ANALYSIS	9 spec. 4 spec. 10 spec. 13 spec.

TABLE 5 (CONTINUED)

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NUMBER OF STATIONS
DISCOVERER (NOAA)	OCT. 25 - NOV. 5	SCHUMACHER, PMEL HAYES, PMEL	ALASKA PENINSULA KODIAK ISLAND	PHYSICAL OCEANOGRAPHY	CTD's XBT's CURRENT METER ARRAY DEPLOYMENT MI-A,MI-B, MI-C, MI-D) MAMMAL OBSERVATIONS	102 24 4
MILLER FREEMAN (NOAA)	OCT. 30 - NOV. 20	WALDRON, NWAFC LENSINK, USF&WS	KODIAK ISLAND SHELF	NEARSHORE ZOOPLANKTON NEARSHORE ICHTHYOPLANKTON MARINE BIRDS	CTD's XBT's TUCKER TRAWLS SAMEOTO NEUSTON TOWS BONGO NET TOWS ISACCS-KIDD MIDWATER TRAWLS EPI-BENTHIC SLED TOWS MARINE BIRD TRANSECTS BOTTOM CURRENT DRIFTERS MAMMAL OBSERVATIONS	45 32 77 77 62 1 6 151 24
SURVEYOR (NOAA)	NOV. 3 - NOV. 20	ATLAS, U OF L MORITA, OSU FEDER, IMS SHAW, IMS BURRELL, IMS KAPLAN, IMS	LOWER COOK INLET	MICROBIOLOGY BENTHIC INVERTEBRATES BENTHIC FISH TRACE METALS HYDROCARBONS PHYSICAL OCEANOGRAPHY	CTD/HYDROCASTS BEAM TRAWLS OTTER TRAWLS PIPE DREDGES VAN VEEN GRABS SHIPEK GRABS HAPS CORES SURFACE WATER SAMPLES MAMMAL OBSERVATIONS	62 1 12 5 14 6 8 47

TABLE 5 (CONTINUED)

SHIP	CRUISE PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NUMBER OF STATIONS
ACONA	NOV. 10 - NOV. 17	ROYER, IMS	PRINCE WILLIAM SD. GULF OF ALASKA RESURRECTION BAY	PHYSICAL OCEANOGRAPHY	STD's TRANSMISSIOMETRY CASTS CURRENT METER ARRAY DEPLOYMENTS (HINCHINBROOK, MONTEGUE)	31 31 2
DISCOVERER (NOAA)	NOV. 8 - NOV. 21	ROYER, IMS	KODIAK ISLAND LOWER COOK INLET	PHYSICAL OCEANOGRAPHY	CTD's MAMMAL OBSERVATIONS	94
ACONA	NOV. 28 - DEC. 2	SHAW, IMS BURRELL, IMS FEDER, IMS	RESURRECTION BAY	TRACE METALS HYDROCARBONS BENTHIC BIOLOGY	STD's NANSEN CASTS VAN VEEN GRABS BENTHIC TRAWLS PLANKTON TOWS	5 2 15 16 18
SURVEYOR (NOAA)	FEB. 13 - MARCH 1	SCHUMACHER, PMEL COACHMAN, PMEL REYNOLDS, PMEL	BRISTOL BAY	PHYSICAL OCEANOGRAPHY METEOROLOGY	CTD's (B-BOP GRID) XBT's ICE OBSERVATIONS AIRSONDE RELEASES MAMMAL OBSERVATIONS	63 12 14 hours 7
ACONA	FEB. 16 - FEB. 25	ROYER, IMS	PRINCE WILLIAM SD. NEGOA	PHYSICAL OCEANOGRAPHY	CTD's	48
DISCOVERER (NOAA)	FEB. 28 - MARCH 24	SCHUMACHER, PMEL HAYES, PMEL	LOWER COOK INLET KODIAK ISLAND ALASKA PENINSULA	PHYSICAL OCEANOGRAPHY	CTD's (PMEL GRID) CURRENT METER ARRAY RECOVERIES (C-1 thru C-8, C-1), K6A thru K13A, MI-A, MI-B, MI-D) MAMMAL OBSERVATIONS	180 20
SURVEYOR (NOAA)	MARCH 3 - MARCH 19	SCHUMACHER, PMEL HAYES, PMEL REYNOLDS, PMEL	LOWER COOK INLET KODIAK ISLAND ALASKA PENINSULA	PHYSICAL OCEANOGRAPHY METEOROLOGY	CTD's (WGOA GRID) DRIFT CARD DEPLOYMENTS AIRSONDE RELEASES MAMMAL OBSERVATIONS	182 1300 cards 13 locat 11

Table 6. Summary of Major Helicopter Flying Missions
April 1, 1977 - March 31, 1978

HELICOPTER	MISSION PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NUMBER OF STATIONS HOURS
BELL 206 (SURVEYOR)	March 15 - April 6	Burns, ADF&G Alexander, IMS	Bering Sea (Ice - Edge)	Phytoplankton Marine Mammals	Mammal Surveys & Collections Sipre Cores	53.2 Operating
UH1H/N57RF (NOAA)	March 9	Shields, U of A Peyton, U of A	Nome	Establish Field Camp	Transport 5,000 lbs. of Scientific Equipment	10.0 Operating
UH1H/N57RF (NOAA)	March 31 - April 4	Alexander, IMS Cooney, IMS	Bering Sea (Ice - Pack)	Phytoplankton Zooplankton	Sipre Ice Cores Water Sampling	44.6 Operating (90 Stations)
BELL 206 (SURVEYOR)	April 18 - May 3	Burns, ADF&G	Bering Sea (Ice - Edge)	Marime Mammals	Mammal Surveys & Collections Mammal Tagging (Seal Pups)	75.5 Operating
BELL 206 (Lease)	May 6 - May 10	Arneson, ADF&G	Alaska Peninsula	Marine Birds	Bird Surveys & Collections	21.3 Operating
BELL 206 (Charter)	May 11 - May 16	Arneson, ADF&G	Alaska Peninsula	Marine Birds	Bird Surveys & Collections	21.3 Operating
BELL 206B N49593	June 27 - July 5	Fay, U. of Ak. Braham, NWAFC	St. Lawrence Is.	Marine Mammals	Beach Transects Marine Mammal Carcasses Located Marine Mammal Necropsies Establish Field Camp	50.0

Table 6 (continued)

HELICOPTER	MISSION PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NUMBER OF STATIONS HOURS
UH1H/N57RF	June 29 - July 30	Pulpan, U of A Kienle, U of A	Kodiak Is. Alaska Peninsula King Salmon Port Heiden St. Augustine Volcano Kenai - West Side of Cook Inlet	Geology	Seismic Network	78.6*
UH1H/N56RF	July 20 - August 1	Dupre, U of Houston	St Mary's Yukon Delta	Geology	Beach Survey Beach Sediment Stations	36.1*
UH1H/N57RF	August 6 - August 22	Davies, Columbia Univ.	Alaska Peninsula Cold Bay Port Moller Sand Point	Geology	Seismic Network	46.4
BELL 206B N49593	August 22 - Aug. 29	Davies, Columbia Univ.	Alaska Peninsula Cold Bay Port Moller Sand Point	Geology	Seismic Network	40.9
UH1H/N57RF	August 23 - Aug. 27	Sallenger, USGS	Alaska Peninsula King Salmon Izembek Lagoon Cold Bay Unimak Island	Geology	Beach Profiles/Sediment Sample Sites Remonitor Beach Profiles Coastal Morphology Transects	24.5
UH1H/N57RF	August 28	Pitcher, ADF&G	Kodiak Island Tigudak Island	Marine Mammals	Pick-up Field Camp	4.7

* include transit time

Table 6. (continued)

HELICOPTER	MISSION PERIOD	PRINCIPAL INVESTIGATOR	WORK AREA	NATURE OF INVESTIGATION	SPECIFIC OPERATIONS	NUMBER OF STATIONS HOURS
UH1H/N57RF	August 28 - Sept. 1	Pulpan, U of A Kienle, U of A	Kodiak Island St. Augustine Volcano Kenai-West Side of Cook Inlet	Geology	Seismic Network Ash Samples Volcano Temperature Survey Valley Transect	7.7
BELL 206B N49593	September 29		Seattle, WA	Returned to Rocky Mountain Helicopter	Lease expired	11.5 for NOAA usage in Sept.
BELL 206 (Charter)	Oct. 25 - Nov. 2	Pitcher, ADF&G Calkins, ADF&G	NEGOA	Marine Mammals	Mammal Surveys & Collections	9.6
UH1H/N57RF	Nov. 8 - Nov. 18	Aagaard	Beaufort Sea	Currents	Meter deployments and retrievals	38.8
UH1H/N56RF	Nov. 5 - Nov. 20	Burns, ADF&G	Beaufort Sea	Marine Mammals	Mammal Surveys & Collections	30.7
UH1H/N57RF	Feb. 18 - March 1	Schumacher, PMEL Coachman, PMEL Charnell, PMEL	Bering Sea	Physical Oceanography	CTD's Mammal Observations	19
UH1H/N56RF	Feb. 20 - March 4	Aagaard, U of W Drake, USGS Cacchoine, USGS	Kotzebue Sound Chukchi Sea	Physical Oceanography Suspended Sediments	CTD/Hydrocasts (NCOP Grid)	39
UH1H/N57RF	March 7 - March 13	Aagaard	Beaufort Sea	Physical Oceanography	Current Meter Array Deployments (Lonely 5 and Lonely 6)	2

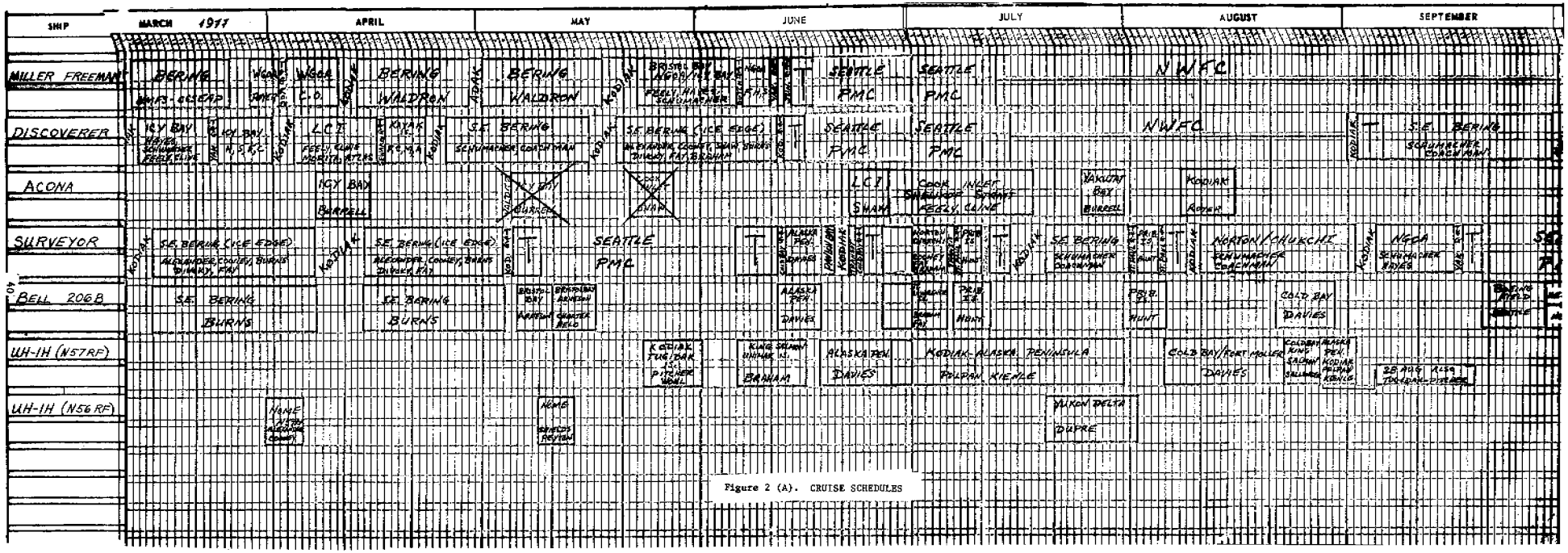


Figure 2 (A). CRUISE SCHEDULES

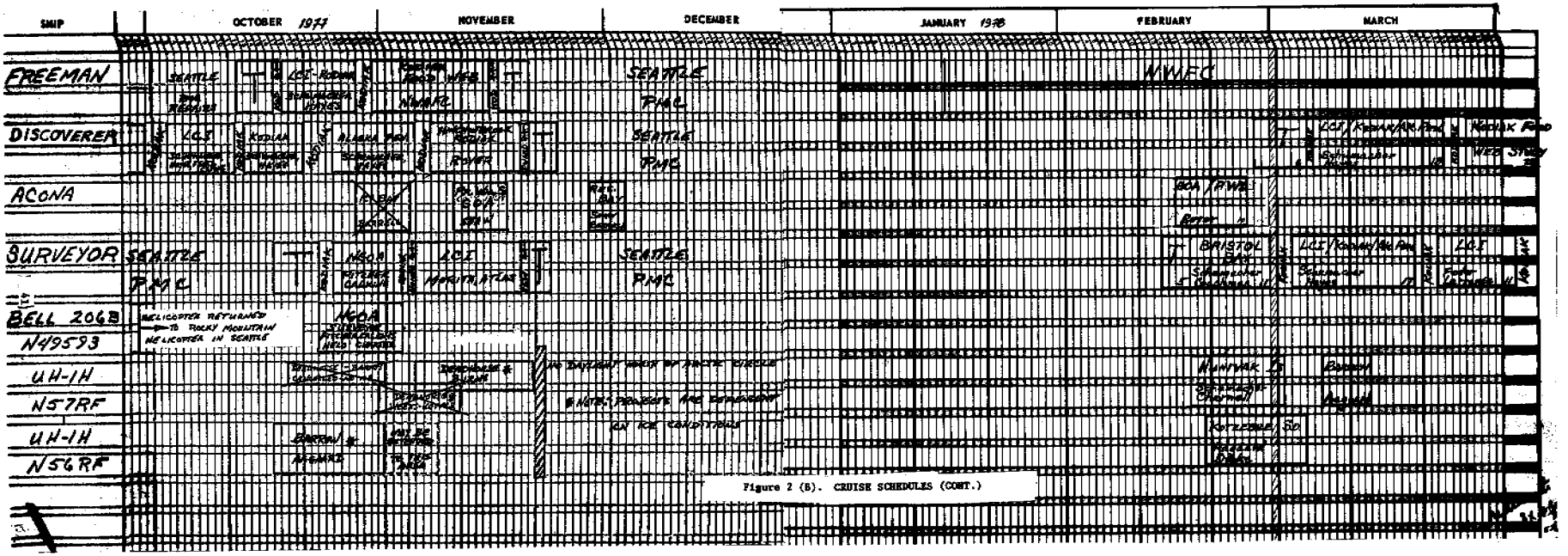


Figure 2 (B). CRUISE SCHEDULES (CONT.)

Scientific results during FY 78 will be discussed under three general geographic units: the Arctic, including Beaufort and Chukchi Seas; the Bering, including Norton Sound in the northern Bering Sea, and Bristol Bay and St. George Basins in the southern Bering Sea; and the Gulf of Alaska, including the Aleutians, Kodiak Island, Lower Cook Inlet and the Northeast Gulf of Alaska (NEGOA).

ARCTIC

Abiota

The outstanding feature of the Beaufort-Chukchi lease areas, both morphologically and logistically, is ice. A final report analyzing historic ice conditions supports the conclusion that although ice conditions show considerable annual variability, polar ice pack has been retreating seaward since 1939. Major ice ridge and flaw lead systems have been mapped using Landsat satellite imagery, and seasonal ice morphology maps show regions of statistically uniform behavior. This implies that probabilities of damage to structures by ice may be computed for geographical zones of differing design and construction criteria. Studies of fast ice decay have resulted in the conclusion that heavy ice conditions such as occurred in 1955 and 1975 may not have occurred otherwise since before the mid 1920's. Other studies on ice hazards show that large areas of ice can act as a single crystal due to orientation of the c-axes of the individual ice crystals. This would necessitate planning the strength of offshore structures to meet ice strengths up to six times those normally used. Further development of a model for engineering properties of sea ice is still under analysis and verification.

Other hazards to oil and gas development in the Arctic are presented by seismicity, sediment stability and subsea permafrost. Seismic studies show the area near Barter Island to be an integral part of the central Alaska seismic zone. Data indicate man-made structures in this area would need to withstand ground vibrations from shallow earthquakes of magnitude 6.0 or greater.

Tundra erosional rates have a direct bearing on the estimated life of islands in the Arctic, either until they become gravel islands or disappear altogether. It is concluded that nearly all the Beaufort Sea islands belong to either erosional remnants or islands constructed by materials reworked from remnants previously isolated further offshore, and as such could not be replaced by natural processes if removed during development. Analysis of channels between islands indicates that, in the "low-energy" Beaufort Sea, sediment cannot bypass a trough deeper than 2.5 m. This information may be useful in considering consequences of man-made islands. A spindrift line of driftwood and other debris deposited by a 1970 storm surge along the Chukchi/Beaufort Sea coasts is generally taken to represent the 100-year event.

Studies of frozen sediments show wide variations in properties. The most significant of the engineering soil property studies is the confirmation of overconsolidated clay-rich sediments. Their occurrence and distribution are important in location, design and techniques for offshore structures and pipelines and in excavation for gravels underlying the clays. Information obtained by analysis of cores from Prudhoe Bay boreholes establishes that the ancient thaw lake, of which Prudhoe Bay is a remnant, once extended almost to the north edge of Gull Island, and rapid settling due to melting of ground ice followed initial submergence of this area. Offshore seismic lines show highly variable depths to the permafrost boundary in the vicinity of Prudhoe Bay. The distribution and extent of ice-bonded permafrost has been found to be very complex and not related to distance from shore.

Ice gouging presents serious problems to pipelines and other offshore structures. Careful measurement of gouges along a given track revealed that gouges up to 1 meter deep are probable in any given year and that in certain areas on the shelf the sediments are reworked by ice to a depth of 30 cm every 30-50 years.

Pollutants are transported by ocean currents and sea ice:

1. Currents. Surface current observations in Harrison Bay indicate that pollutants would be flushed westward at a net rate of 3 cm/sec, but storm surges would generally reverse this flow eastward. Bottom currents up to 13 cm/sec were measured

in Stefansson Sound. Island-lagoon circulation systems are still under study. So far the research has shown that lagoon waters are largely driven by wind and storm surges and that causeways can have an impeding influence on the average flux. Surface drifters indicated that surface pollutants could be spread over a considerable portion of the Beaufort Coast.

Coastal Meteorology. Two coastal meteorological phenomena were identified as major mesoscale influences: seabreeze forcing and mountain barrier baroclinicity. The relative importance of the latter is more pronounced in winter than in summer since cold air piling up against the Brooks Range results in winds parallel to the coast. The seabreeze forcing is being modeled and further measurements to calculate surface winds are desirable for use in predicting oil spill trajectories.

Sediment Transport. A project addressing topics related to sediment transport has found two major substrate habitats: a) sandy mud (>50% sand by composition) lying adjacent to the mainland coast and barrier islands, and b) muddy sand (>50% mud) lying in the central lagoon area. A systematic decrease of organic carbon across the Simpson lagoon area from south to north was attributed to nearshore turbulence acting as a sorting and braking mechanism, with coastal peat as the organic carbon source.

Behavior of Oil in Sea Ice. Studies of oil in sea ice are not yet concluded. They continue in the laboratory and also occur in nature as spills of opportunity present themselves. Work on modeling of oil entrainment in grease ice and pancake ice is important for application to oil trajectory prediction. Analysis of satellite imagery shows that grease ice forms in long, narrow plumes parallel to the wind vector, so that oil spilled in areas of recurring polynyas will be driven into plumes and collect in rows parallel to the grease ice.

Biota

A 1977 USCGC GLACIER trophics cruise was a key feature in the examination of the trophic structure and function of northern Chukchi and Beaufort Sea marine ecosystems. Results indicate that the patchy distribution of prey species forces two predator species, ringed and bearded seals, into a more opportunistic feeding mode. Moreover, previous investigations and earlier sampling suggest that secular changes in the arctic marine food webs are occurring, and the top level consumers are more constrained by prey species' availability now than 20 years ago. Direct competition for clams may exist between bearded seals and Pacific walrus, and an expanding population of bowhead whales could also compete with ringed seals for the summer stock of euphausiid shrimps (*Thysanoessa* and *Parathemisto* spp.).

Epibenthic invertebrates sampled by the 1977 GLACIER trawl series yielded two interesting conclusions. Diversity was greater than anticipated (238 species were recorded in 34 trawls), and two distinct community types, or epifaunal species assemblages, were delineated.

Histopathologic samples have not been processed yet, but hepatic abcesses, fibrosis, and ancillary bacterial infections were noted in the necropsy process, and may be important proximate causes of bearded seal mortality. Further study is needed in this area, especially in light of recent declines in seal numbers in the Beaufort.

A documentation of breeding bird usage of coastal habitats in the Arctic includes all modern information on 74 "active" colonies through the 1976 field effort and thus gives variability and trends since the late 1960's. Some of the sites are sufficiently important to be designated as "critical." Recent heavy helicopter use in some areas is considered in some studies to be a factor in bird population decline. Implications from various studies are that offshore oil and gas activities fall into categories of habitat preemption, disturbance to surface cover, increased traffic and noise, and pollutant discharges. Recommendations include strict regulation and careful planning to minimize human activities in sensitive areas.

Beaufort nearshore studies showed arctic populations of three dominant fish species (Arctic char, Arctic cisco and least cisco) to be substantially slower-growing and later-maturing in the open-water season in the Beaufort than in less severe environments, and indications were that they may spawn only in alternate years after maturity. Recaptures of previously tagged fish showed a generally high degree of consistency in timing of movements by mature fish. Several species, however, tended to be making earlier fall movements back to the Sagavanirktok River (char) and Colville River (least cisco). It is suggested that higher salinities observed in 1977 in Prudhoe Bay made the location less attractive to anadromous fishes.

Abundance patterns for Beaufort Sea benthos across the continental shelf demonstrate general bimodality for larger benthic infauna (>1.0 mm) such that maxima occur nearshore and out near the edge of the shelf. Reasons for this bimodality are suggested: 1) nearshore detrital input, 2) mid-depth ice scour, or 3) placid deeper water favoring detrital fallout.

A number of important conclusions concerning structure, function, and vulnerability of littoral communities include: 1) benthic and water column organisms are generally forced out of water depths of 0-2 m by shorefast ice formation annually; 2) these species repopulate the shallows from nearshore water refugia (2 to 20 m depths); 3) an apparent dividing line for littoral community diversity occurs at Point Hope in that 23 genera of organisms commonly found in the southern Chukchi are rare or absent from the northern Chukchi and Beaufort systems; and 4) it cannot yet be concluded whether peat is the driving, or determinant carbon source for the littoral zone and nearshore systems.

Phytoplankton species are now regarded as being distributed widely in the arctic region, whereas zooplanktonic distributions more closely reflect water mass conditions. Certain marginal Beaufort species are suggested as important indicators of Bering-Chukchi water incursions. Further studies are needed outside the traditional July-October sampling period. In situ experiments in sediments and under ice are still

underway to analyze changes in crude oil from biodegradation and abiotic weathering.

Results of the first year of some interdisciplinary process studies in Simpson Lagoon:

1. Confirm and strengthen a number of hypotheses about structure and function of nearshore and coastal systems in the Beaufort Sea. For example, the past year's work supports the belief that shallow nearshore waters are indeed annually re-populated by epibenthic organisms immigrating from deeper nearshore waters.
2. Amplify and broaden the importance of previous uncoordinated observations by tying together apparently unrelated features of the system. For example, the significance of extensive overlap in the selection of prey epibenthic items by the bird and fish consumers, in combination with divers' greatly increased estimates of the biomass of epibenthic organisms, is that vertebrate consumers in the lagoon system are living in the lap of luxury during the open water period.
3. Serve to clarify the relative importance of the various sources of organic carbon identified as the basis of the trophic structure of the lagoon systems of the Beaufort. The best information from this study indicates that the carbon "available" to the Simpson Lagoon system is overwhelmingly terrigenous rather than marine-derived. The supposition that Beaufort coastal trophic systems are "fossile fuel consumers" awaits radio-carbon dating. The potential implications for offshore development, if they are terrestrially-driven, may be significant: major measures to stabilize eroding shorelines in support of industrial facilities could drastically curtail important sources of carbon for the relatively productive shallow water biota of the Beaufort sale area.

4. Provide a prime source and focal point for evaluating the full range of nearshore effects of actions and structures, and alternatives of mitigative measures during OCS offshore development. For example, the whole suite of physical and biological consequences of uninterrupted, or continuous-fill causeways in lagoon systems comes under examination, as related to circulation patterns, water mass characteristics (temperature and salinity), distribution of detritus and sediments, migrations of epibenthic organisms and fishes, and microhabitat responses by the more selective species of birds. This examination lends weight to the encouragement of industry to look for engineering solutions as alternatives to continuous-fill causeways.

BERING SEA

Abiota

Substantial improvement was made in both the computational scheme and the graphical system for the tide and circulation models in Bristol Bay and Norton Sound. This was accomplished by considering the intensity and transport of a subgrid scale turbulent energy. Another modification permits more precise computation of wave propagation, giving an accurate account of bathymetry at each spatial grid point.

Investigations have produced a map showing locations and descriptions of potential geological hazards to oil and gas development (see Figure 3). The gas composition and presence in near surface sediment above a thick underlying section (with acoustic anomalies) suggest both a potential petroleum source and a hazard for any future drilling activity in this area.

The daily mixed tidal cycle and the fortnightly tide are important in establishing the local suspended and bottom sediment conditions in western and probably all of Norton Sound. High currents during peak spring tides generate enough bottom shear to initiate motion of the bottom sediment. The high silt content and organic materials retard this movement, producing a condition of equilibrium between the tidal stresses and the character of the sea floor. Storm events disrupt this equilibrium by causing excessive shear stresses that erode and transport the bed materials. Thus, sediments (and potential pollutants) which have been temporarily deposited on the seafloor can be suddenly remobilized during a short storm.

Mud deposits in the eastern part of the area are supplied by weak or intermittent currents which transport Yukon detritus eastward along the southern coast of the sound. The presence of a remnant body of winter water in the inner sound probably is important in the accumulation of a blanket of mud in this area. Pollutants entering this eastern "cul-de-sac" may be retained for relatively long periods owing to the limited water exchange with the outer part of Norton Sound. A reconnaissance of the physical coastal environment of Cold Bay and Pavlov Bay was undertaken to provide input for siting studies, assess-

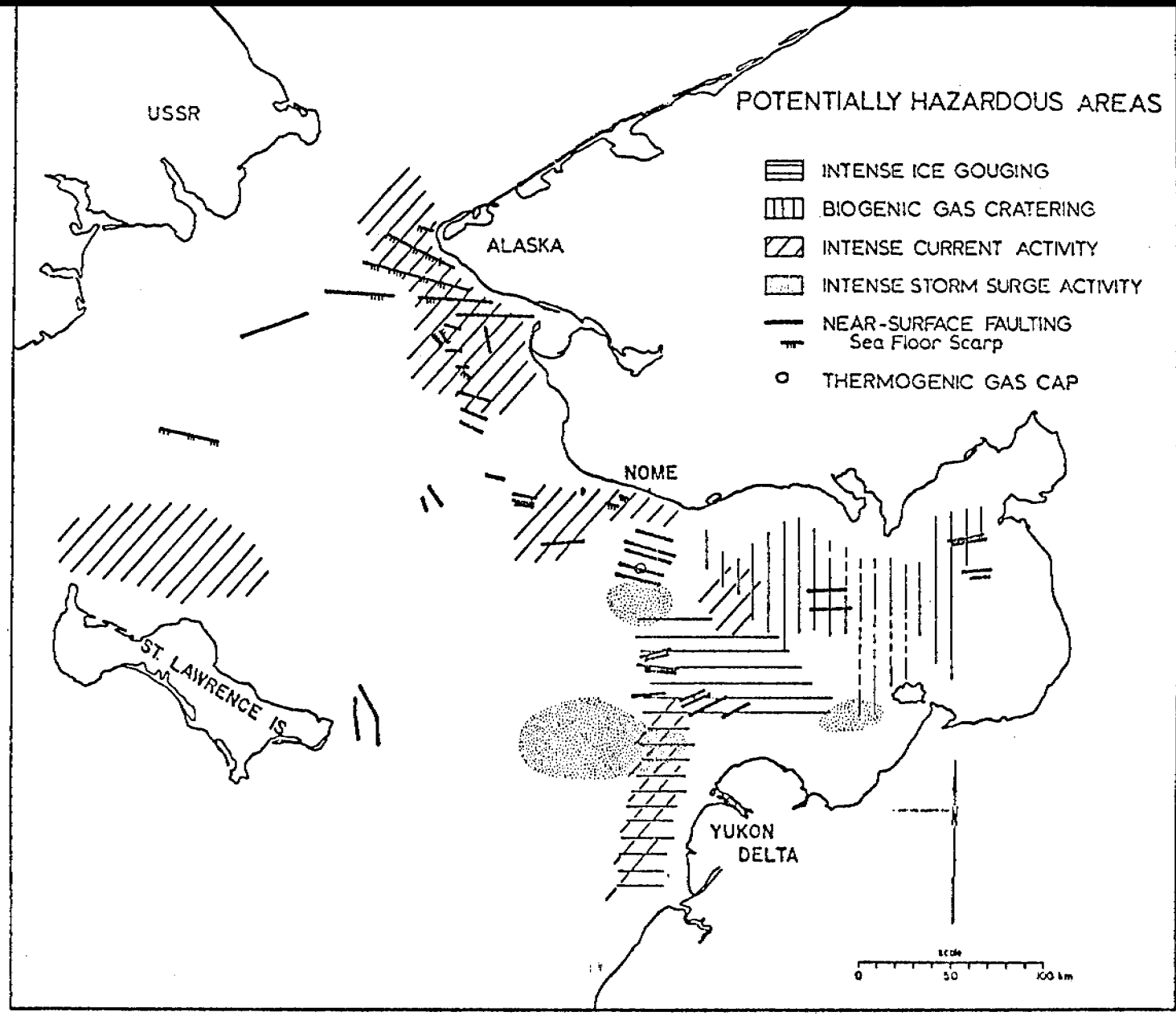


Figure 3. Summary of potentially hazardous regions in northeastern Bering Sea.

ment of coastal stability, and determination of long term sediment (or pollutant) transport directions along the coast. These bays may one day be considered for port facilities which could service offshore petroleum production in both the Bering Sea area and areas offshore from the Alaska Peninsula.

Preliminary results show that ice transport of sediment may be highly significant in the Norton Sound area. Samples of the water column beneath the ice contain substantial amounts of suspended matter in concentrations appearing to be slightly lower than in the summertime. Suspended sediment transport beneath the winter ice cover is clearly important and is not dependent upon wave action and wind-driven currents.

Biota

Studies of primary productivity related to the edge of the seasonal ice pack in the Bering Sea result in the following tentative conclusions:

1. The major effects of the ice field appear to be in limiting light energy to the water column and reducing windmixing at the surface. This means that water column plant production is probably negligible until the pack ice begins to break up. While loose ice is present at the sea surface (in the retreating edge zone) it tends to stabilize the wind-mixed layer and this greatly enhances the opportunity for rapid plant production. With reduced mixing, ample light, and nutrients, an exceedingly intense bloom of short duration often occurs. This band of production follows the ice northward in the late spring.
2. The very cold ice-related water tends to sink away from the surface as warming progresses. There is evidence that algal populations also sink with the water mass. The implications of oil contamination are obvious, particularly since a surface spill could become incorporated and carried to depths.

Other Bering Sea studies show that low diversity and sparse populations marked the regions where cold, under-ice water masses extended to the bottom in depths less than 80 meters. In deeper water the

community abundance and diversity increased markedly, presumably due to inclusion of organisms dwelling in warmer, near-bottom oceanic waters. Remnants of the under-ice water masses persisting as a thermal band in the late spring to early fall period probably exclude many oceanic species. Thus the distribution of taxa within and between specific bathymetric regimes is related to the physical structure of the shelf water masses and the biology of the major species involved.

Investigations of subsistence use of herring and other fishery resources showed geographical variations, with the heaviest use between the Yukon and Kuskokwim Rivers ascribed to lack of large game and marine mammals in that region.

Some "critical" habitats for marine birds have also been identified in the Copper River-Bering Sea system. Breeding seabirds are found on or in the vicinity of the Pribilof colonies for a major portion of the year. They are present on these islands from mid-April through October. Furthermore, seabirds will use the waters near the Pribilofs in mid-winter if ice conditions permit. Numerous patterns of seabird foraging have been discerned from the shipboard and helicopter transects in the vicinity of the Pribilofs. Observed densities of seabirds were highest within ten nautical miles of the islands and in the vicinity of the 200 m isobath south of St. George.

GULF OF ALASKA

Abiota

Two physical characteristics of the Gulf of Alaska predominate in consideration of any oil and gas leasing and development activity. Foremost is the definition and modeling of the general circulation over the continental shelf in the Gulf. There is a remarkably coherent along-shore flow westward, paralleling the coastline for hundreds of kilometers. Between this coastal current and the Alaskan Stream lies a band of weaker meandering currents with variable flow rates. This band is intersected by the narrow shelf off Cape St. Elias, where the coastal current is deflected offshore, injecting coastal water into the Alaskan Stream. The combined effects of Kayak Island and the Copper river freshwater plume result in one or two gyres west of Kayak Island.

The flow regime*in Lower Cook Inlet is southerly along the western third of the lower inlet and consists primarily of freshwater input into upper Cook Inlet. This flow rounds Cape Douglas in summer as a warm, low salinity band, exiting through Shelikof Strait. A westerly flow extending from Kennedy Entrance toward Cape Douglas is driven partly by the westerly Alaska Current and partly by the influence of coastal freshwater input. This confluence leads to an upwelling tendency in the lower Inlet. Water flows westerly into Shelikof Strait through Stevenson Entrance at about 30 cm/sec, but currents over Albatross Bank are weak with frequent flow reversals. The deep shelf edge water moves inshore up the troughs (e.g., Kiliuda). Over the banks the column tends to be vertically homogeneous, less saline and colder than over the troughs or over the shelf-edge.

Other important physical characteristics of the Gulf of Alaska are those concerning seismicity and volcanism. The high level of seismic activity northeast of Icy Bay and Kayak Island continues. Large magnitude earthquakes were located northeast of Middleton Island and southwest of Kayak Island. Another area of intense activity near Iliamna was the source area of the two largest Alaskan earthquakes in the past year (5.3 and 6.0). Volcanology studies indicate that the principal offshore hazards associated with Augustine Volcano are pyroclastic flows. There are no sites on the island itself that would be safe to erect permanent

*See Figure 4.

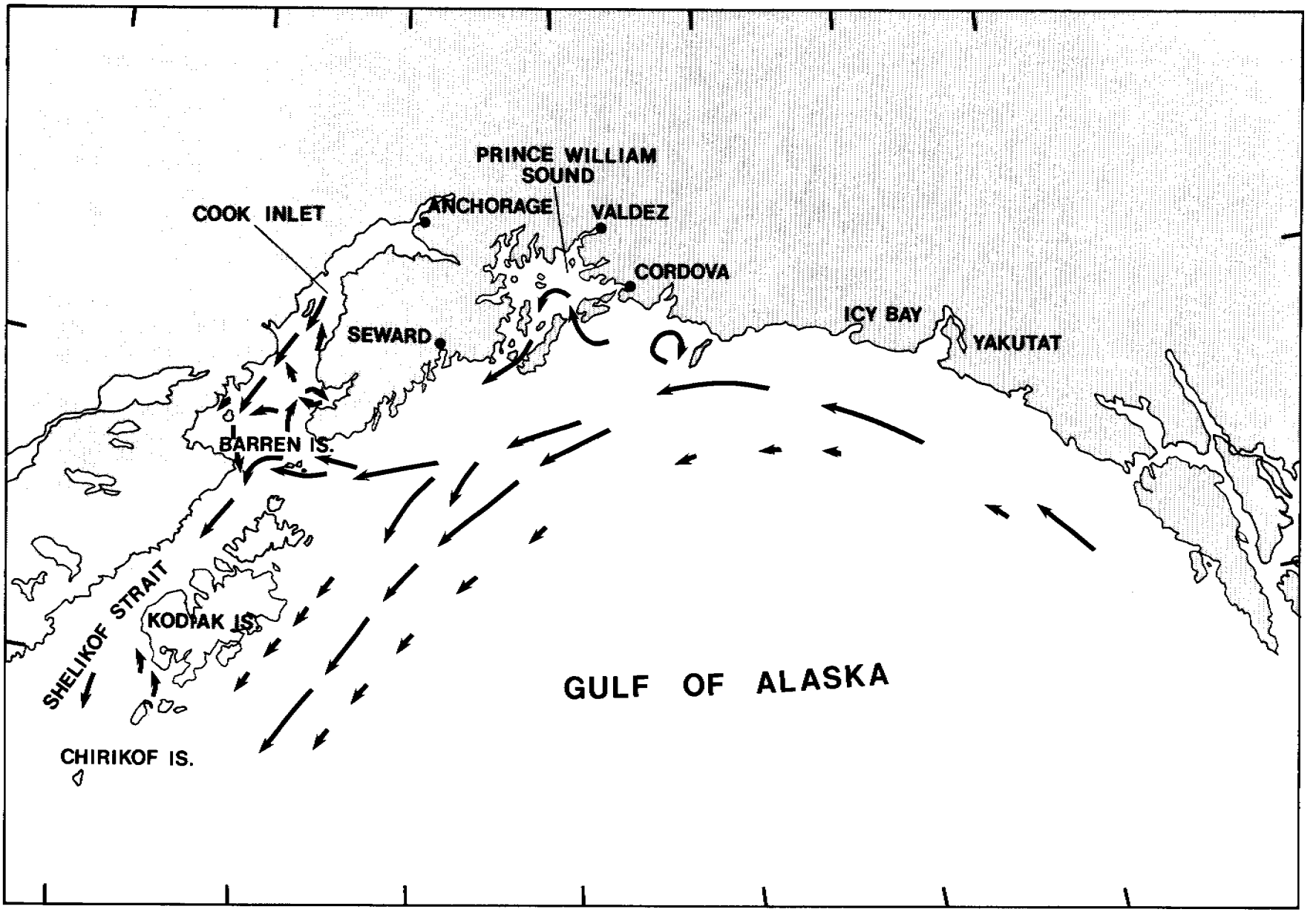


Figure 4. Major current patterns of the Gulf of Alaska and Lower Cook Inlet.

structures unless they were underground.

Associated with volcanism and seismicity are studies of unstable sediments, slumps and slides. These are investigated by coring, seismic profiling, sidescan sonar, bottom sampling, and underwater TV and camera. Seismic profiles obtained on the Kodiak Shelf revealed some major near-surface faults which may be active since they trend across young sediments. One major set of potentially active near-surface faults cuts across the head of Chiniak Trough.

As a result of other studies the following conclusions were made regarding sediment transport: (1) during periods of high discharge (maximum glacial melt) turbid water is visible on the green band satellite imagery more than 50 km offshore; (2) The Copper River delta is building westward along the inner shelf and is filling Prince William Sound (local sediment sources of Prince William Sound are small compared to the input of Copper River sediments); and (3) today relatively little of the modern continental sediment reaches the outer shelf.

Biota

FY 78 biological studies placed heavy emphasis on the Lower Cook Inlet and Kodiak lease areas. Highest densities of several species of nearshore benthos were found in the region between the Copper River delta and Kayak Island. It is postulated that primary and secondary production may be higher there as a result of nutrients supplied by the Copper River. This enhanced productivity may also be related to the presence of gyres extending vertically from water surface to bottom. Another area of particular interest is Kachemak Bay. Studies show that the early life history stages of the commercially important fishes, shrimps, and crabs repeatedly appear most abundant in inner and outer Kachemak Bay, which receives clear, nutrient-rich oceanic water from the Gulf of Alaska. Kachemak Bay is also characterized by the development of a strong pycnocline, and has at least two gyres in the outer portion which tend to stabilize the water column and enhance phytoplankton blooms. Early spring (March) data on phytoplankton biomass and primary productivity indicated that the spring bloom in Cook Inlet had not yet taken place.

Site-specific fish studies in the Lower Cook Inlet area indicated the possibility of low numbers of demersal fish in the area of rapid bedform movement in the central zone of Lower Cook Inlet. Different demersal fish species appeared to occupy specific depth zones during the sampling period with a shift to deeper waters during September. Pink and chum salmon, due to their intertidal spawning habits, probably have a greater potential for being impacted by oil spills than other salmonids. In forage prey studies based on an anlaysis of all demersal species for Lower Cook Inlet, the prey with the greatest frequency of occurrence were mysids, shrimp, amphipods, and polychaetes.

An extensive final report on fishery resources and activities was received. It includes the mean geometric catch-per-unit effort (CPUE) of all species combined, and generalized plots describing the distribution of larvae and juveniles, when such information was available.

Intensive bird studies were carried on in areas suspected of being critical marine bird habitats. Distribution patterns reflected species behavioral patterns with respect to habitat preferences for oceanic, continental shelf or protected bay waters. No density differences between bank and trough areas of the continental shelf were apparent, but it appeared that the steeper slopes between these areas are probably the most important part of the shelf habitat. Marine bird densities (all species) were highest in mid-summer. However, aerial survey results indicated a migration peak in mid-May.

A site-specific study on Ugaiushak Island indicated that during 1976 and 1977 food resources appeared to be the most important single factor determining productivity at the Ugaiushak Island bird colonies. The apparent abundance of available prey during the 1977 breeding season was reflected in greater breeding success, more rapid growth of young, and the immigration of large numbers of subadult birds. A definitive work on population dynamics and trophic relationships was completed by several investigators. It presents, for each of eleven dominant species or species groups, data on breeding distribution and abundance, nesting habitat, breeding phenology, production, factors affecting production, food habits and pelagic distributions. Studies show that

all species surveyed would be greatly affected by an oil spill during a spring storm. If they were not killed directly by oil contamination, their food organisms could be destroyed.

Dall porpoises migrate across the Kodiak and Northeast Gulf of Alaska (GOA) oil lease sites, apparently in greatest numbers in the spring (especially May). Preliminary plots indicate that Prince William Sound is an important summering area; however, the Kodiak Island oil lease area also appears to be of as yet undetermined importance during the summer. The location of greatest concentration from June through August is Unimak Pass and along the continental edge in the southern Bering Sea. Whether these animals are migrants from the GOA or the western North Pacific Ocean is unknown. California gray whales twice migrate through six oil lease tracts in Alaska each year (NEGOA, Kodiak, St. George Basin, Outer Bristol Bay, Norton and Hope Basins). If gray whales are vulnerable to man's activities in the near-shore evirons, then the movements of whales en masse through Unimak Pass during a rather narrow time frame are of considerable concern. Any adverse effects on gray whales resulting from oil-gas development would be accentuated during this period of animal concentration.

The St. George, Bristol Bay and Aleutian oil lease tract areas are important feeding grounds for many pinniped and cetaceans, but they are of particular importance for northern sea lions because of their proximity to the Aleutian Islands breeding grounds. It is significant that a population decline has been identified for the Aleutian Islands sea lions before exploration of the Saint George, Aleutian Shelf and Bristol Bay oil lease tracts has begun, for two reasons: first, if in the future the population continues down, it may not be attributed to oil development (although in a synergistic manner, additional activities of man may depress the population more); and second, future monitoring programs must take into account a host of interrelated factors (e.g., a westerly shift in population distribution, or the effect of heavy commercial fisheries on sea lion foraging) which have not yet been measured.

Some research has been directed toward characterization of the microbial populations of Lower Cook Inlet, including their potential for degrading hydrocarbons. Hydrocarbon biodegradation potentials in Cook Inlet water samples were lower in November than April, in particular for non-nutrient limited growth. This suggests that the "weathering" of spilled oil in Cook Inlet will be highly dependent on season. Studies have been devoted to effects of exposure to hydrocarbons and trace metals of various types of biota under varying conditions including temperature, concentration, and location. Pathological investigations of living as well as dead or moribund mammals disclosed that predation and parasitism are apparently the principal causes of natural illness or death, with malnutrition a close third. The overall frequency of disease was lower in the Gulf of Alaska than in the Bering Sea.

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 include 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 predictive biological impact information.

The Chukchi Sea lease area is not on the current lease schedule. Consequently, the research effort in this area is being limited to investigations 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 three potential lease areas in the OCSEA program. Industry interest in these has always been high but the current lease schedule only includes the Norton Basin in the northeastern Bering Sea, scheduled for a December 1981 sale. To date, 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 dynamics of physical and biological phenomena in the area are poorly understood. A substantial program to study the Norton Basin will be required between FY 79 and FY 81 to obtain necessary assessment information.

Although not on the current lease schedule, there is industry interest in the St. George and Bristol Bay areas. 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^{o}N parallel are four lease areas. Sales have occurred in two of 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 Aleutian 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 will be required in these disciplines in addition to the synthesis of available data, in progress.

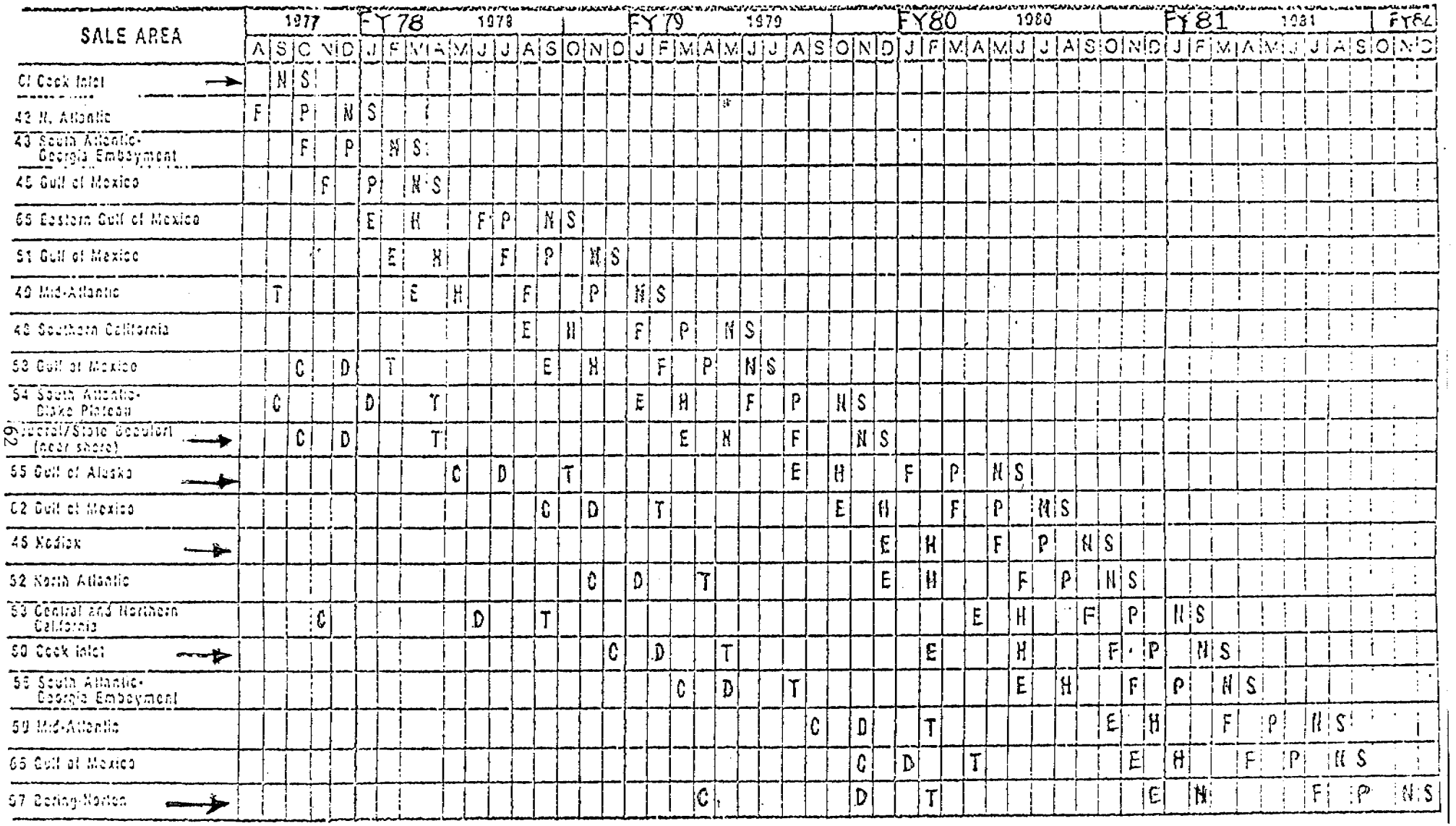
Proceeding westward, Lower Cook Inlet is scheduled for its second sale (#60) in March of 1981. The synthesis currently in progress will be of great usefulness. However, there is a possibility that the Shelikof Strait area may be included in this sale. Lower Cook Inlet and Shelikof Strait have long been 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. Even after completion of the current synthesis, it is anticipated that additional field work will be necessary in transport, geohazards and biological effects.

The Kodiak lease area just south and west of Lower Cook Inlet and Shelikof Strait is included in the proposed lease sale #46 for October 1980. A synthesis of all OCSEAP and non-OCSEAP generated information is currently underway. 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 and geohazards as they affect the high biological productivity, 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 as well as 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 mammals. Future work in this lease area will depend upon leasing schedule revisions. The latest lease schedule is shown in Figure 5.

Figure 5. PROPOSED OCS PLANNING SCHEDULE

August 1977



C - Call for Nominations
D - Nominations Due
T - Announcement of Tracts
E - Draft Environmental Statement
S - Sale
H - Public Hearing
F - Final Environmental Statement
P - Proposed Notice of Sale
N - Notice of Sale

The Department of the Interior

Requested funding for FY 79 and FY 80 is given for each lease area in the table which follows. At the present time (as of November 1978) both FY 79 and FY 80 budgets are uncertain. The table provides figures tentatively agreed upon with BLM. Amounts under 1979S represent funding included in an FY 79 Supplemental request from BLM to OMB and Congress, to cover work begun in previous fiscal years but not possible to continue under funding limitations. Amounts under FY 1980 represent OCSEAP's request to BLM for studies needed in FY 80. These figures can be compared with the funding received in FY 77 and FY 78, $21.1M and $19.1M, respectively.

BUDGET SUMMARY
ALASKA
(dollars in thousands)

	FY 1979 (Planned)	FY 1979S (Requested)	FY 1980 (Requested)
Beaufort Sea	5,281	2,739	4,825
Kodiak	2,994	1,374	4,146
Gulf of Alaska	1,440	828	4,198
Lower Cook Inlet	3,823	2,345	5,013
Norton Basin	474	1,677	4,237
Bristol Basin	192	140	923
St. George Basin	292	46	556
Aleutians	138	137	700
Chukchi Sea	218	714	1,002
TOTAL	14,852	10,000	25,600

Our 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, alledgedly, entire lease areas have been removed from sale consideration because there was insufficient environmental information to know that development could proceed safely. OCSEAP is working hard to obtain this missing information. In order to meet the 4-6 year study minimum for lease areas opening up after 1981, we must have 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).