HJR

70

(9)

HOUSE COMMITTEE REPORT

Date referred: 3/22/88 FURTHER REFERRALS:

DATE: 4-6-88

The Resources Committee has considered HJR 70

Relating to the need for ice-capable ships for Arctic research.

RECOMMENDS:

[X] replace with CS HJR 70 (Res) [X] the same title

[ ] attached amendment(s) [ ] a new title

[X] do pass

[ ] do not pass

[ ] no recommendation

[ ] individual recommendations

[ ] additional referral to the ____________ Committee

ADOPTS: [ ] ________ letter of intent

ATTACHES NEW FISCAL NOTE(s):

[ ] fiscal impact

[X] zero fiscal note

[ ] zero with analysis

[ ] same as previous fiscal note published ____________

[ ] same as previous zero fiscal note published ____________

SIGNING DO PASS:

Sam Cotten

Mike Navarre

Adelheid Herrmann

SIGNING OTHER RECOMMENDATIONS:

Sam Cotten

Chairman's signature

STATE OF ALASKA
1988 LEGISLATIVE SESSION

BILL VERSION : CSHJR 70 (Res)
PUBLISH DATE :

FISCAL NOTE

REQUEST:

Revision Date:
Title : Ice capable ships
Sponsor : Resources Committee
Requestor :

Agency Affected : None
BRU :
Components :

EXPENDITURES/REVENUES: (Thousands of Dollars)

OPERATING	FY 88	FY 89	FY 90	FY 91	FY 92	FY 93
PERSONAL SERVICES						
TRAVEL						
CONTRACTUAL						
SUPPLIES						
EQUIPMENT						
LAND & STRUCTURES						
GRANTS, CLAIMS						
MISCELLANEOUS						
TOTAL OPERATING	-0-	-0-	-0-	-0-	-0-	-0-

CAPITAL						

REVENUE						

FUNDING: (Thousands of Dollars)

GENERAL FUND						
FEDERAL FUNDS						
OTHER						
TOTAL						

POSITIONS:

FULL-TIME						
PART-TIME						
TEMPORARY						

ANALYSIS : (Attach a separate page if necessary)

Prepared by : Staff
Phone : 465-3711
Division : House Resources Committee
Date : 4/6/88

Approved by Co-Chair ~~Commissioner~~ :
Date : 4/6/88
Agency : House Resources Committee

Distribution (by preparer) :
- Legislative Finance
- Legislative Sponsor
- Requestor
- Office of Management and Budget
- Impacted Agency(ies)

page ___ of ___

Original sponsor: Resources Committee

IN THE HOUSE BY THE RESOURCES COMMITTEE

CS FOR HOUSE JOINT RESOLUTION NO. 70 (Resources)

IN THE LEGISLATURE OF THE STATE OF ALASKA

FIFTEENTH LEGISLATURE - SECOND SESSION

Relating to the need for ice-capable ships for Arctic research.

BE IT RESOLVED BY THE LEGISLATURE OF THE STATE OF ALASKA:

WHEREAS the renewable resources of the American Arctic, specifically fish and shellfish, represent one of the nation's greatest commercial assets with the value of the Bering Sea fisheries alone being estimated at $2,000,000,000 per year; and

WHEREAS the American Arctic is a vitally important rearing and feeding ground for bottomfish, king crab, and a majority of the salmon stocks that serve as cornerstones for a large number of subsistence activities in the state; and

WHEREAS the biological and physical characteristics of the American Arctic are important with respect to producing large numbers of fish and shellfish in the area and in determining optimal opportunities for harvesting the fish and shellfish; and

WHEREAS the American Arctic has been defined by the U.S. Congress in the Arctic Research and Policy Act of 1984 to include bodies of water that are of great importance to Alaska, such as the Bering Sea, the Chukchi Sea, and the Arctic Ocean; and

WHEREAS the Arctic Research Commission has reported to the President and the Congress that research in the Arctic Ocean and marginal seas is vital not only to the management of renewable resources but also to national security, prediction of weather and climate, and development of nonrenewable resources; and

WHEREAS the commission also reported that most Arctic-rim countries possess Arctic technologies far more advanced than those currently available in the United States, which threatens our national security and severely affects the ability of United States citizens to compete in the development of the resources of the Arctic; and

WHEREAS the types of research needed to increase our understanding of the structure of the ecosystems of the Bering Sea, the Beaufort Sea, and the Chukchi Sea include elements related to physical features such as ice edges and hydrographic structures; and

WHEREAS the United States does not have the ships required to conduct this research, especially since the deactivation of the U.S. Coast Guard Icebreaker "Glacier"; and

WHEREAS several foreign icebreakers are currently idle because of the downturn in the oil industry, and one of these vessels might be modified and put under charter to meet immediate needs; and

WHEREAS sponsorship of currently neglected research in basic oceanographic science is a necessary and proper function of the federal government in order to fulfill national objectives in Arctic research;

BE IT RESOLVED that the Alaska State Legislature strongly urges the United States Congress to authorize

(1) construction of a new icebreaking vessel for use in Arctic research;

(2) upgrading of at least one of the planned U.S. Navy additions to the fleet or construction of an additional vessel capable of Arctic research; and

(3) immediate leasing, or leasing with an option to buy, of a foreign icebreaker for use in connection with Arctic research.

COPIES of this resolution shall be sent to the Honorable George Bush, Vice-President of the United States and President of the U.S. Senate; the Honorable Donald P. Hodel, Secretary of the Department of the Interior; the

Honorable Jim Wright, Speaker of the U.S. House of Representatives; and to the Honorable Ted Stevens and the Honorable Frank Murkowski, U.S. Senators, and the Honorable Don Young, U.S. Representative, members of the Alaska delegation in Congress.

Appendix E: The Role of Sea Ice in Controlling Arctic Ecosystems

Executive Summary

- The Arctic marine ecosystem is controlled by the state of the atmosphere, ocean and sea ice. This ICE initiative is a study of the physical controls exerted on the living marine resources--shellfish, fish and mammals--with optimum management as the goal and high national economic return as the payoff. (U.S. Arctic Research Commission Priority; DOC Goal for 1990).

- The proposed research will test the hypothesis that interannual variation of maximum ice extent and seasonal ice retreat account for the major year-to-year variability in the biological productivity of the Bering and Chukchi Seas.

- The most influential control of the Arctic marine ecosystem is exerted by ice, in particular its location and times of formation and melt. The ice acts as a platform and habitat for mammals, and a substrate for the tiny plants that form the base of the food chain supporting birds, shellfish, fish and mammals. The ice melt water stabilizes the sea and allows a strong spring pulse of food production, making the American Arctic one of the richest commercial fisheries in the world. The retreat of the ice edge through the Bering and Chukchi Seas is equal to fertilizing an area from Texas to the Canadian border and the Rocky Mountains to the Mississippi River. The pathways of energy flow from the plankton to bottom organisms and then to commercial fisheries and mammals is not well understood.

- Dramatic, largely unexplained changes are occurring in the Arctic system:
  - The king crab and Tanner crab harvests have plunged since 1979 with serious economic impact. Other commercial species such as pollock are being heavily exploited.
  - The northern fur seal population is declining rapidly (4-8% per year). All large baleen whale populations have been severely reduced and may not be recovering. The walrus population has become very large and is in danger of crashing. Sea otter populations are increasing and competing with fishermen for shellfish.
  - Dramatic increases in marine growth and survival have been documented for salmon populations of the Bering Sea. Recent indications of an end to the boom in production of the past ten years have very serious economic implications for both commercial and subsistence fisheries.

- The requested $2.25M annual budget (Section 5) for the first 4 years and $2.5M annual budget for the following six years will support these first year activities:
  - Reevaluation of existing biological and physical data sets and initiation of a historical study using satellite and other remote sensing data
  - Reactivation of the Bering Sea ice model developed earlier, its extension to the Chukchi Sea, and its use to design sampling strategies
  - Measuremants of currents, nutrient dynamics, biological productivity and particulate flux in the vicinity of Bering Strait during the ice meltback
  - Begin cooperation with state and local agencies on interpretation of data obtained from the measurement program

Subseq[illegible] year activities include:

- B[illegible]logical and physical oceanographic sampling along the ice ed[illegible]e over an eight year period

- Examination of the dynamics of primary production, nutrient recycling and fluxes at the ice edge
- Examination of benthic population with respect to vertical flux of particulate material
- Examination of the relation of ice edge primary production to occurrence and timing of zooplankton and larval fishes and crustaceans
- Research on variability of high-latitude weather and its effect on ice extent, location, and timing
- Study of sea ice and oceanographic processes in coastal areas by use of *in situ* and remote sensing techniques
- Synthesis of field studies into models and examination of fish and mammal population dynamics in the light of the expanded data base on weather, sea ice and oceanography.

ICE
Role of Sea Ice in Controlling Arctic Ecosystems

1. INTRODUCTION

The coastal aboriginal peoples of Arctic America developed cultures based on exploitation of the marine mammals and fish of the Bering, Chukchi and Beaufort Seas. The same resources were the basis for exploration and settlement of Russian America and later, the interests of distant water fishermen and whalers from the United States provided an important incentive for the purchase of Alaska. From the beginning the Arctic environment has been the major limiting factor in exploitation of these resources.

In his statement on United States Arctic policy (April 14, 1983) the President emphasized that the United States has unique and critical interests in the Arctic region. In light of the region's growing importance, the administration feels that the Arctic warrants priority attention by this country. In the Arctic Research and Policy Act of 1984, the Congress has declared that the following major elements are the basis for U.S. Arctic policy:

Natural Resources. The renewable resources of the American Arctic (Figure 1), specifically fish and shellfish, represent one of the Nation's greatest commercial assets. The recent catch of groundfish in the eastern Bering Sea is illustrated in Figure 2. The catch of groundfish began in the 1950's, grew to 700,000 metric tons in the 1960's with the peak exploitation of yellowfin sole (*Limanda aspera*), rapidly expanded in the early 1970's to 2,250,000 mt based largely on the new technology associated with production of minced fish products (surimi) from walleye pollock (*Theragra chalcogramma*). Total production has declined in the 1970's to about 1,200,000 mt as the fishery came under management control by the United States following passage of the Magnuson Fisheries Conservation and Management Act of 1976. While conventional groundfish are fully exploited, the harvest is principally processed by foreigners. The current trend is toward the development of U.S. fishing industry to replace foreign industry.

The recent catches of king crab in the Bering Sea are shown in Figure 3. This was an international fishery shared with Japan and the USSR until the United States developed the capacity to capture the full harvest in 1981. The catch grew rapidly from 1958 until 1963, reaching a peak of 28,000 mt, then declined from 1964 until 1971 to a low of 9,000 mt. It rapidly increased from 1972 until 1979 with a peak harvest of 65,000 mt, and has since declined to less than 5,000 mt in 1985. Such large year to year variability in stocks, both natural and that due to fishing, has created major difficulties for both industry and management.

The Bering Sea is a vitally important rearing and feeding ground for a majority of the salmon stocks which serve as cornerstones for a large number of commercial and subsistence activities in Alaska and other areas of the Pacific Rim. Very dramatic recent increases in commercial production (Figure 4) from 21.9 million salmon in 1974 to 144.6 million in 1985 have illustrated the importance of the marine environment in determining the well

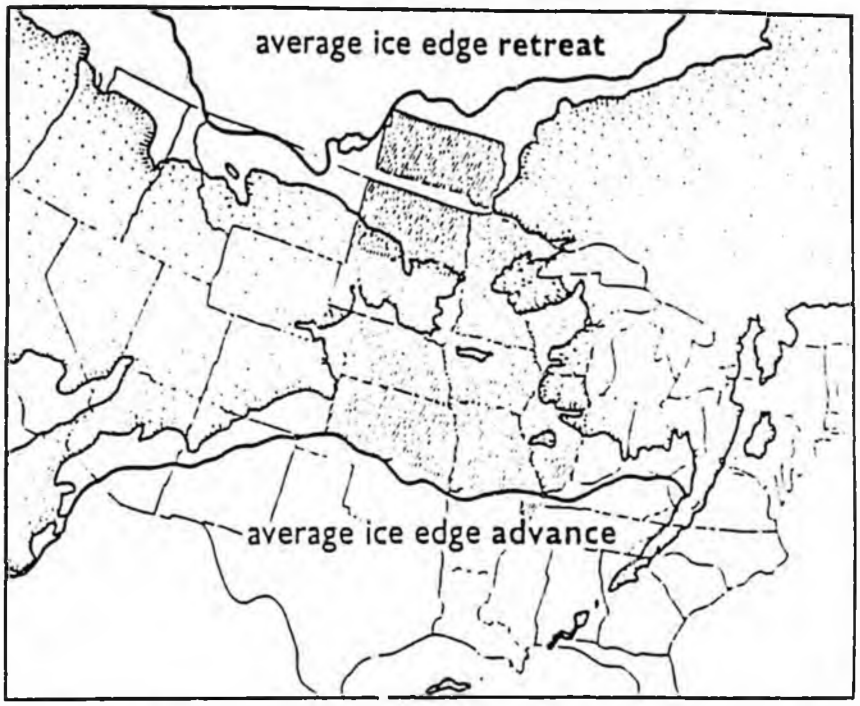

Figure 1. The biologically productive seasonal ice zone of the Bering and Chukchi Seas is roughly equivalent in area to the major grain producing regions of the American farm belt.

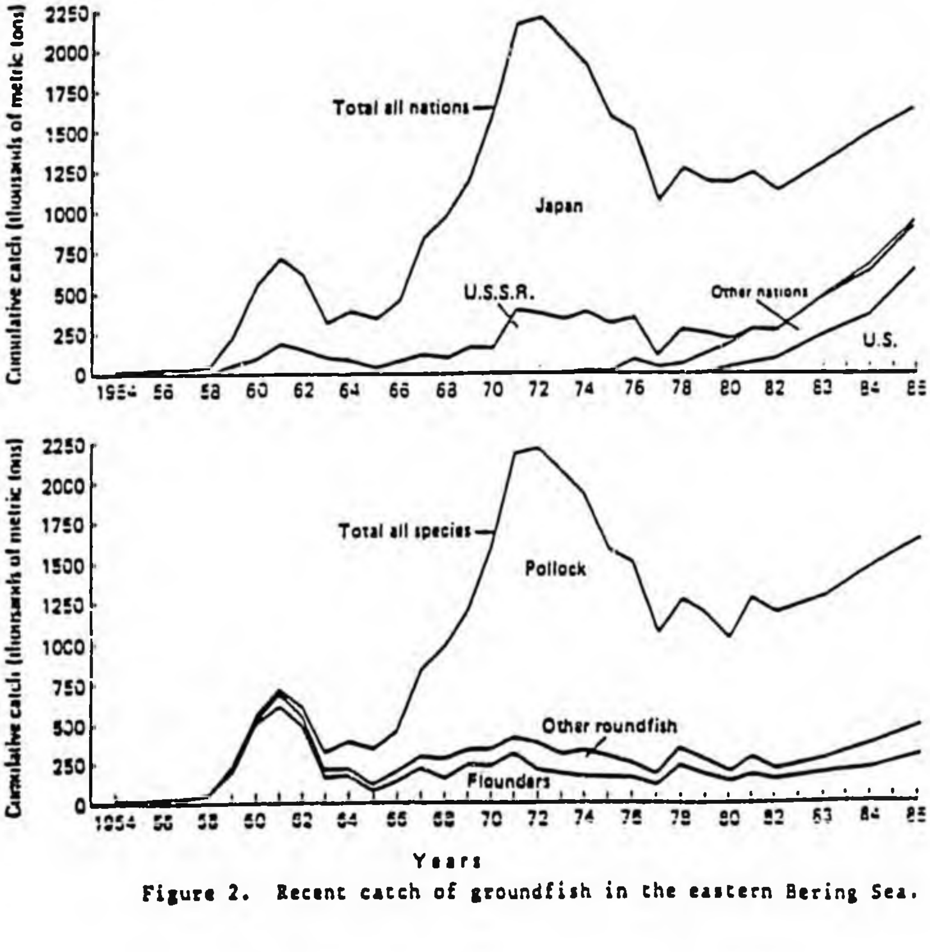

Figure 2. Recent catch of groundfish in the eastern Bering Sea.

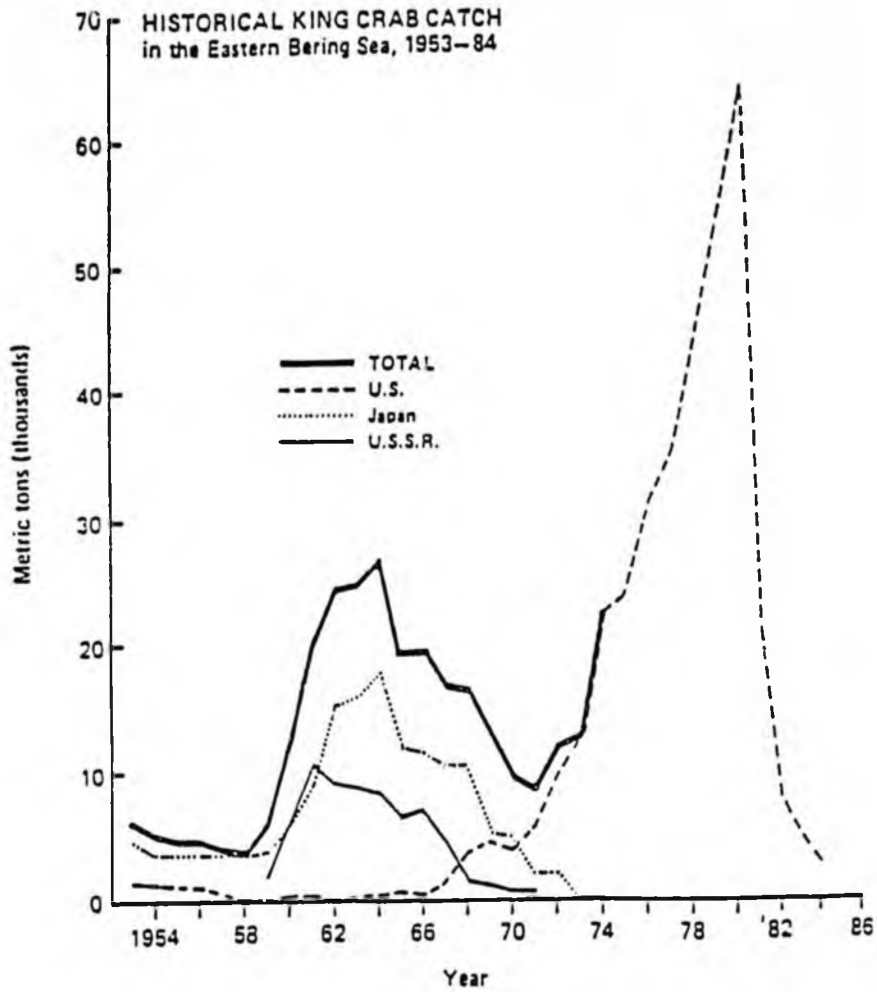

Figure 3. Recent catch of king crab in the Bering Sea.

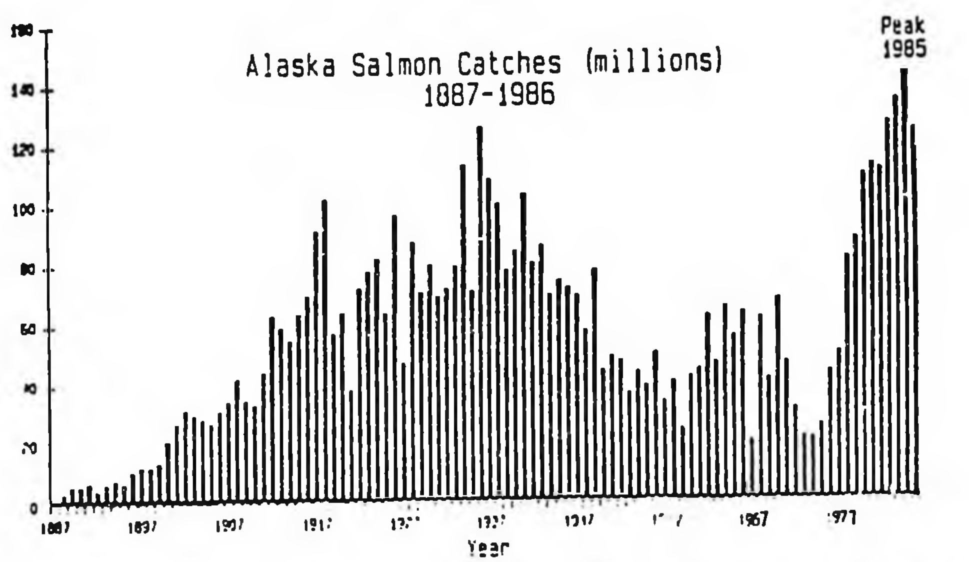

Figure 4. Recent explosive increase in commercial salmon production from 1974 to 1985.

being of both subsistence and commercial fisheries. In addition to their importance in determining production, the biological and physical circumstances of the Bering Sea are also important in defining opportunities to harvest the seasonal bonanza of maturing salmon. Clearly the answers to the important questions of production of groundfish, crabs, and salmon, and of the timing of salmon harvests, lie in understanding the dynamics of the Alaskan continental shelves.

Research in Basic Science. The Arctic and Antarctica are less well known than any other area of comparable size. Most Arctic-rim countries, particularly the Soviet Union, possess Arctic technologies far more advanced than those currently available in the United States. Sponsorship of currently neglected research in basic science is a necessary and proper function of the federal government to fulfill national objectives in Arctic research.

A review of national issues and priorities for the Arctic Research and Policy Act has been completed by the Polar Research Board of the National Research Council[1] and the U.S. Arctic Research Commission.[2] Based on these reports, both the Interagency Arctic Research Policy Committee (IARPC) and the State of Alaska established an implementation plan to address the following as a priority area of research:

Programs are needed to determine the structure of ecosystems of the major Arctic shelves (Bering Sea, Beaufort Sea, and Chukchi Sea). These must be planned as integrated programs with a strong physical oceanographic and weather/climate component. Elements requiring attention include biological production and food web dependencies in relation to physical features such as ice edges, polynyas and hydrographic structures (i.e. fronts). The studies must encompass natural cycles or trends[3].

NOAA was directed to prepare this ICE initiative to implement the required research for the Alaskan Arctic. The task was completed jointly with the University of Alaska and the Alaskan Department of Fish and Game.

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2. BACKGROUND

We now have some understanding of regional variations in primary production in the southeastern Bering Sea and ideas of the physical/chemical factors which produce these variations. The annual primary production cycle of most of the Bering Sea shelf is dominated by a spring pulse. Spring blooms occur at the onset of ocean stratification, with their duration highly dependent on storms to replenish the surface layer with nutrients. Nutrient enhancement by wind mixing from deeper layers is responsible for from 10% to 50% of the yearly spring bloom total nitrate uptake, depending on year. Ice cover plays an important role in determining the timing of the spring bloom. Increased stratification from ice melt allows the development of an intense phytoplankton bloom at the ice edge as soon as active meltback begins. Consequently, the growth season is initiated earlier than would be possible in the absence of sea ice. For this reason, variations in the southerly extent of sea ice in winter have major ecological consequences. The retreat of the ice edge fertilizes a region equivalent to Texas to the Canadian border and the Rocky Mountains to the Mississippi River of the continental U.S. (Figures 1 and 5).

The influence of year-to-year variations in sea ice extent and retreat is an important question if the impacts on the biological system are so extreme. A significant climatic change occurred during the span of the

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[1] Polar Research Board, 1985: *National Issues and Research Priorities in the Arctic*, National Research Council, Washington D.C., 123 pp.

[2] U.S. Arctic Research Commission, 1986: *National Needs and Arctic Research: A Framework for Action*, Los Angeles, CA, 27 pp.

[3] Polar Research Board, 1985: Ibid, p. 44.

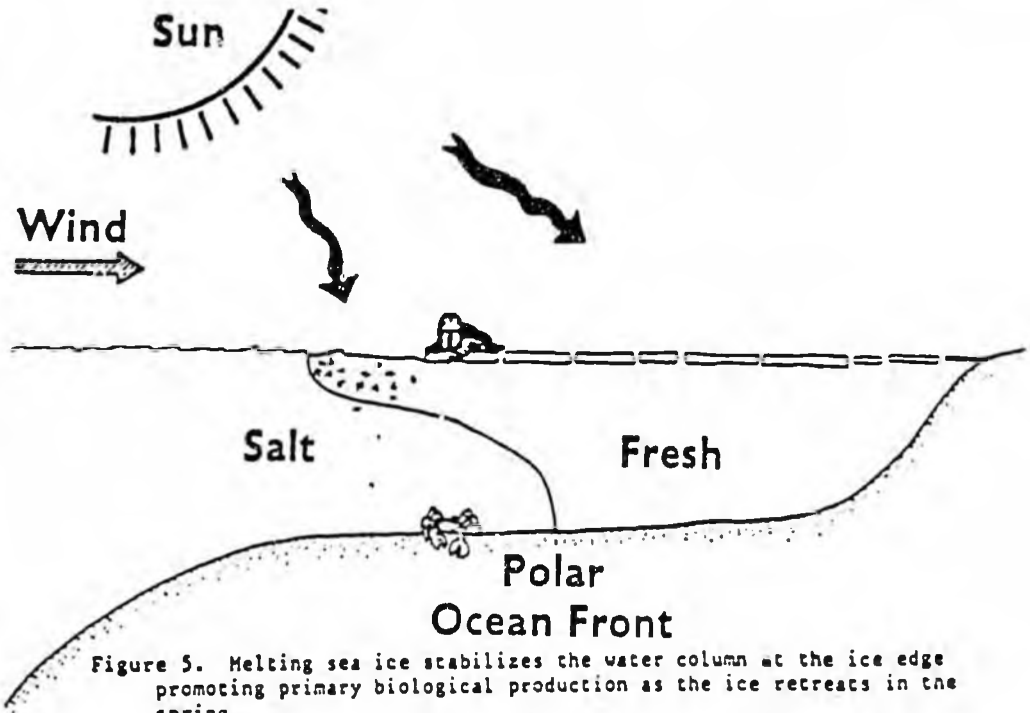

Figure 5. Melting sea ice stabilizes the water column at the ice edge promoting primary biological production as the ice retreats in the spring.

previous interdisciplinary Bering Sea ice edge work (1975, 1976, 1977, OCSEAP/NOAA; 1982, 1983, NSF/Ocean Sciences; 1983 ONR/Arctic Programs). The first three years were cold with the ice reaching across the Bering Sea Shelf, whereas in the warm years 1982 and 1983 the ice only reached the latitude of St. Matthew Island. The chlorophyll content of the water at the ice edge and the primary production were significantly lower during the warm years than during the cold years. When the ice edge is closer to the shelf break, the higher nutrient concentration below the surface layer increases nutrient supply through ice-edge upwelling. Furthermore, the earlier water column stratification associated with ice melt prolongs the total bloom period. The total annual primary production in the outer shelf domain is probably increased significantly during a cold year. Therefore, we state the hypothesis for the ICE program as follows: *Interannual variation of maximum ice extent and seasonal retreat account for the major year-to-year variability in the biological productivity in the Bering and Chukchi Seas.* To clarify the effects of the position of the ice edge, it will be necessary to follow the ice northward during its retreat and examine variations in ice-edge phytoplankton productivity as the ice retreat passes over various parts of the shelf.

A large proportion of the ice edge production probably reaches the benthic community, since the grazing community in the water is small and not very active. As the bloom progresses, organic material sinks through the water column. Food chain relationships linking the ice edge and spring bloom to the other ecosystem components are not well known, but it seems reasonable that the rich benthos on the shelf and its top level consumers, shellfish, walrus, whales and fishes, are in part dependent on this efficient use of early-season solar radiation. In particular, the benthic-mammal food link may be exceptionally important in the American Arctic, and these large organisms provide a degree of biological stability. Their role in nutrient recycling is not known. Spring bloom phytoplankton may also be particularly important in feeding juvenile fishes and crustaceans.

For crab, the period from egg hatch to settlement of larvae is likely to be the major determinant of year-class strength. The area of hatching must be more clearly delineated using intense survey efforts. Oceanographic and sea ice information is important in determining advection of larvae and subsequent settlement. Because considerable spawning and subsequent larval dispersion occur near the ice edge, ice edge phenomena may be important to this stage of crab larvae survival. This is particularly true for crabs in the northern Bering Sea and Norton Sound.

The seasonal variability of the extent of ice cover and of its residual melt water is governed by the storm climatology. Figure 6 shows the composite storm tracks for the 5 heaviest (A) and 5 lightest (B) years during 1958-1982. During the heaviest ice years the tracks were shifted southward along the Aleutian Islands and eastwards into the Gulf of Alaska. This gives rise to more north and northeast winds which move the ice farther south, increasing the extent of ice cover. During the lightest ice years (Fig. 6B) more storms move north across the western part of the Bering Sea. The result is a greater incidence of south and southwest winds on the shelf, compacting the ice cover and closing the ice-growing leads. Figure 6C shows the maximum extent of ice cover in the Southern Bering Sea. In an average year about one-half of the domain is covered. In heavy years ice surrounds the Pribilof Islands and covers the entire continental shelf. *Interannual variability in seasonal sea-ice extent in the Bering Sea is controlled by variation in storm-track position related to large-scale differences in the general weather circulation.*

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3. TEN YEAR SCIENCE PLAN

Introduction: Setting the stage.

The research is based on a ten year program of field measurements, historical analysis, and modeling. Physical process studies address the movement of ice by variable ocean currents, the relative importance of local radiation versus heat advection by currents to melt during ice retreat, and the link between seasonal and interannual atmospheric variability and ice extent. Biological process studies address the influence of the ice edge on primary productivity and the efficiency of transfer of energy from the surface to bottom living organisms. Remote sensing provides a means of longer term monitoring. Modeling activities will synthesize the understanding of causal mechanisms between sea ice and the regional biology determined from the field studies with the historical atmospheric time series to test the ICE hypothesis and corollaries.

Sea Ice Processes: Forcing by the atmosphere and ocean determines ice conditions.

To extend our knowledge of sea ice behavior and biological consequences to the northern Bering Sea, Bering Strait, Chukchi and nearshore Beaufort Seas, all regions of intense environmental, commercial, and strategic interest, three important physical processes must be considered. First, the transport of ice by ocean currents must be understood. Net ocean transport through Bering Strait is toward the north and over a year averages about 30 cm/s. On shorter time-scales, meteorological forcing results in stronger events (current speeds up to 125 cm/s) which can reverse the flow over time periods of two to seven days. This current system varies remarkably in strength and direction and can cause the ice to move in the opposite direction as the local wind, but is poorly understood. Second, the role of heat advection by this current in the spring and summer months versus the local vertical heat flux and radiation balance in the melt-back of the ice pack is not known. Third, there is no realistic theory describing the interannual variations of ice cover and their relation to atmospheric circulation. Understanding of the seasonal cycle of arctic weather can be improved by basic research on the relation of high-latitude atmospheric circulation to forcing by the land and sea ice distribution and by lower latitude circulation.

The first measurement component of the ice program is an array of satellite-position drifting ice buoys deployed in key areas along the coast. These measurements will be used to evaluate the extent of shore effects from the coast on the ice velocity, to test open pack constitutive laws, and to create a nearshore constitutive law, if necessary. A second set of measurements will be conventional current meters and pressure gauges to address year-to-year and seasonal variations in ocean transport. A third measurement component will estimate thermodynamic variables. Sensible and latent heat fluxes from the atmosphere to the ice and sensible heat flux from the ocean to the ice can be computed by careful temperature measurements in the boundary layers. High resolution thermistors will be added to the

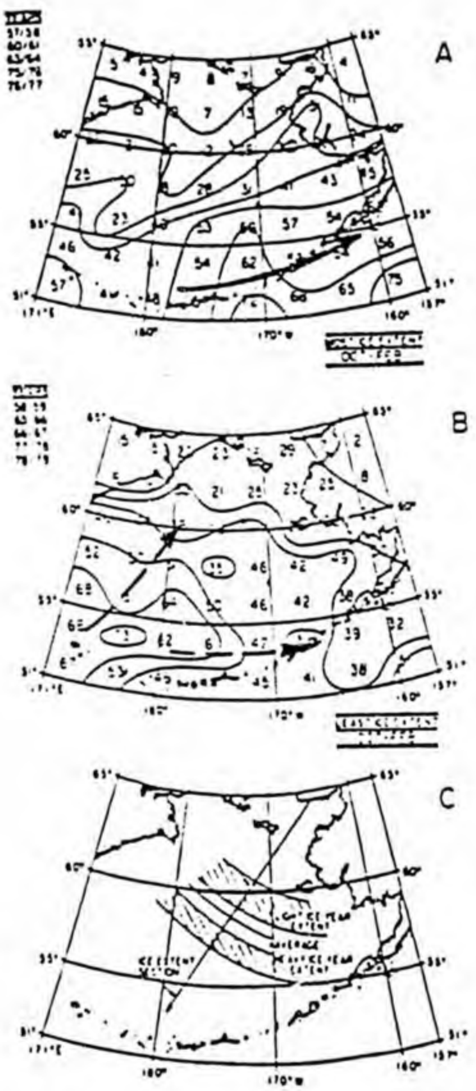

Figure 6. Storm track counts by 2° latitude × 4° longitude over October to February for the five heaviest (A) and five lightest (B) ice years in the period 1957 to 1980. The arrows suggest core pathways of the preponderant storms. Panel (C) shows the corresponding extents of the ice cover.

anemometer and current meter masts at the drifting buoy sites for this purpose. In addition, a broad-band radiometer will be attached to each station for estimates of the solar and long-wave radiation incident on the upper surface of the ice. This measurement program will be able to differentiate the relative contribution to melting of the local radiation budget versus northward advection of heat by ocean currents.

Studying the ice pack will require measurements over eight years, since the interannual variability of the weather conditions and the severity of the resulting ice conditions is large. The variability of the barotropic current component through the Bering Strait also has large variations from year-to-year which may affect the ice drift patterns.

The coupling between the atmosphere and sea ice on seasonal and interannual time scales will be addressed by detailed analysis of the North Pacific Oscillation (NPO) from historical atmospheric data sets in the context of the northern hemispheric general circulation. The first element is to determine the persistence of the NPO as a basis for statistical prediction. Such approaches have not been entirely successful at mid-latitudes, but, since the duration of NPO events is often greater than 10 days and the anomalies are large, such approaches should be attempted. Statistical methods now exist but they must be based upon more complete causal hypotheses. The data base which exists for the study are the sea level pressure, 500-1000 mb thickness (which correlate with air temperature) and 500-mb steering level wind fields beginning in 1947 as well as long time series of weather observations from Arctic stations and sea ice extent fields derived from satellite observations continuously since 1969 and sporadic before that time.

A second feature is to systematically assess the possibility of positive feedback of heat between atmosphere, land, and ice surfaces for the sub-Arctic. It is known that the land/sea distribution and coastal orography provide forcing to the long-wave atmospheric circulation pattern. Of particular concern to the seasonal time scale is the feedback between the seesaw relation of Bering Sea and the Sea of Okhotsk, and the Alaska and Siberian landmasses. The thermal mass of Alaska and Siberia are substantial and ground temperatures can increase by several ten's of degrees over a week's time. These temperatures reinforce the long wave atmospheric weather patterns ability to maintain the existing storm track pattern. Sea ice acts as an extension of the continent and effectively acts as an insulator between the air and the relatively warm sea temperatures. When ice is retreating in the Bering Sea due to southerly winds, it is advancing in the Sea of Okhotsk. It is not known whether this relative ice motion tends to reinforce the existing weather pattern.

<u>Biological Processes</u>: The solar-induced spring bloom at the ice edge generates a pulse of food for the benthos.

Our current knowledge of the American Arctic is inadequate to allow effective management. However, recent research has indicated productive directions for pursuit. The fundamental issue is the cycle of solar energy and its propagation through the ecosystem. Due to its northerly position, the American Arctic receives highly seasonal solar radiation. The ecosystem must have developed strategies which optimize its utilization by photosynthetic organisms and the subsequent distribution through the food chains. The very high biomass at upper trophic levels requires efficient transfer and effective retention. The two parts of biological processes are to document the influence of the ice edge on enhancing primary production and determining the efficiency of energy transfer to the benthos.

The biological sampling strategy is to make standard nutrient, nutrient dynamics, productivity and vertical flux measurements in the vicinity of the melt-water stabilized region of the ice edge and contrast these measurements with adjacent open-ocean measurements. These tasks will follow the retreat of the ice edge through the Bering and Chukchi Seas. The second part of the sampling strategy is to determine benthic (bottom) biological activity to determine the efficiency of transfer of energy from primary production to bottom fauna. The shallow Bering and Chukchi Seas may be unique in their efficiency of transferring energy from the ice edge enhanced primary productivity to higher trophic level species via intermediate bottom communities. Sampling will be oriented on primarily south-north transects and will occur during spring ice retreat. Measurements will be required over a five year period to provide representative sampling and consider year-to-year variability. This strategy will allow determination of the variations in the importance of ice by biological regimes over the entire north-south area. To date, ice edge biological work has been restricted to its southwest parts.

In parallel with field experiments, efforts to model regional ice/ocean circulation, heat budget, and biological system will be undertaken. Initially modeling will concentrate on regional ocean circulation, ice drift, and stabilization of the mixed layer by ice melt. As results from the field measurement programs and atmospheric studies become available, systems studies can be formulated to address the causal links between interannual atmospheric variability and year-to-year changes in the biological communities of the Bering and Chukchi Seas.

These measurements will be used by the Alaska Department of Fish and Game to test the hypothesis that the times of arrival of maturing salmon at the fixed geographic reference frames sampled by commercial fisheries are driven by physical factors related to ice edge location.

Remote Sensing Support: To economically monitor the ongoing ice/biological interactions.

In situ measurements of sea ice and biological processes are cumbersome, expensive, and limited with respect to areal coverage and spatial and temporal resolution. Fortunately, the presence or absence of ice on the ocean affects virtually all regions of the electromagnetic spectrum and is, therefore, an ideal parameter to be measured remotely from aircraft or from space.

The first promising instrument is the passive microwave imager, SSM/I flown on the DMSP satellite in 1987. The bands selected for passive microwave sensing are largely unaffected by clouds and require few atmospheric corrections at high latitudes. At present a single reading is incapable of being interpreted beyond the statement that ice is present or absent. With the new instrument, it should be possible to use a set of multi-spectral, multi-polarization readings to distinguish various sea ice properties for Alaskan waters.

The most powerful instrument, combining high spatial resolution with virtual independence of atmospheric effects, especially in the dry polar atmosphere, is the synthetic aperture radar (SAR). The European Space Agency plans to launch a satellite (ERS-1) with SAR in 1990. A SAR receiving station for ERS-1 is planned for Fairbanks, Alaska which will be made available for dissemination SAR data for research, and will provide the all-season, all-weather data base necessary for sea ice processes research on scales as small as 25 m. Analysis of SAR imagery will provide baseline information for verification of the sea ice and climatology models proposed for the Alaska region.

Biological studies can benefits from synoptic coverage with color imaging for chlorophyll, a measure of phytoplankton biomass. Aircraft-based capability would be of greatest use, to provide coverage in communities with less surface-based sampling from a research vessel.

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4. SUMMARY

The hypothesis to be tested by the ICE program is that the interannual variability of the location of maximum ice extent and seasonal ice retreat is the primary cause of year-to-year variation in the biological productivity of the waters of the American Arctic. This program will implement the highest priority research recommendation of the U.S. Arctic Research Commission as mandated by the Arctic Research and Policy Act of 1984. The program is based on a ten-year program of physical and biological field measurements, study of historical variability of arctic weather and its influence on ice motion, and modeling. Modeling activities will synthesize the understanding of causal mechanisms between sea ice and the regional biology determined from the field studies with the historical atmospheric time series to test the ICE hypothesis.

The requested $2.25M annual budget (Section 5) for the first 4 years and $2.5M annual budget for the following six years will support these first year activities:

- Reevaluation of existing biological and physical data sets and initiation of a historical study using satellite and other remote sensing data
- Reactivation of the Bering Sea ice model developed earlier, its extension to the Chukchi Sea, and its use to design sampling strategies
- Measurements of currents, nutrient dynamics, biological productivity and particulate flux in the vicinity of Bering Strait during the ice meltback
- Begin cooperation with state and local agencies on interpretation of data obtained from the measurement program

Subsequent year activities include:

- Biological and physical oceanographic sampling along the ice edge over an eight year period
- Examination of the dynamics of primary production, nutrient recycling and fluxes at the ice edge
- Examination of benthic population with respect to vertical flux of particulate material
- Examination of the relation of ice edge primary production to occurrence and timing of zooplankton and larval fishes and crustaceans
- Research on variability of high-latitude weather and its effect on ice extent, location, and timing
- Study of sea ice and oceanographic processes in coastal areas by use of *in situ* and remote sensing techniques
- Synthesis of field studies into models and examination of fish and mammal population dynamics in the light of the expanded data base on weather, sea ice and oceanography.

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5. BUDGET FY 88 - FY 93

In Thousands per year

		YEAR 1-4	YEAR 5-10
A.	Physical Process Studies		
	(Sea ice and physical oceanography)	$ 675	$ 750
B.	Biological Process Studies	725	800
C.	System modeling	200	225
D.	Atmospheric Prediction	300	325
E.	Remote Sensing		
	(data acquisition, processing, interpretation)	150	175
F.	Vessel and other logistic support	200	225
		$2,250	$2,500

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6. MANAGEMENT

The Director of ICE will be the NOAA Assistant Administrator for Oceanic and Atmospheric Research. The scientific research will be carried out by a consortium of government, university and private sector researchers lead by the Pacific Marine Environmental Laboratory/NOAA and the University of Alaska. The program manager is the Director, PMEL, whose responsibilities will include program coordination, logistics, budget, contracts and the monitoring of individual projects. A scientific council will be organized through a NOAA/University of Alaska Joint Institute which shall be responsible for establishing and maintaining the program focus, evaluating its progress and recommending changes in direction and/or emphasis based on scientific results and operational considerations. The council will consist of members from NOAA, the University of Alaska and the Alaska Department of Fish and

Game. The prog... will be periodically reviewed by an advisory group of experts external to NOAA. The appointment of scientific council and advisory group members will be based on scientific expertise, interest, and proven ability in Arctic related research. Scientific objectives will be refined at the four-year point as new discoveries are made.

Native residents, and studies of genetic factors in cancer in the relatively large, stable Arctic Native families could make significant contributions to understanding of this disease. Support in the amount of $500,000 per year would be required for the recommended five-year program of epidemiologic and laboratory research.

The low incidence of coronary heart disease among Eskimos has been attributed to the omega-3 polyunsaturated fatty acids in the cold water fish that make up a substantial part of their diet. A research program to develop a better understanding of dietary influences on prostaglandins, thromboxanes, cholesterol, and lipids associated with traditional foods of Arctic indigenous peoples could have major implications for the prevention or reduction of atherosclerosis and heart disease. The recommended research would require some $750,000 per year for five years.

Infectious diseases, especially respiratory diseases, have long been a leading cause of death among Alaskan Natives. Cooperative federal/state programs of research and improved health care delivery have reduced morbidity and mortality, but there are still many opportunities for research in the Arctic that would have far-reaching implications for understanding and control of respiratory and diarrheal diseases, hepatitis A, botulism, and chlamydia. The task group proposed research on the causes, diagnosis, and prevention of respiratory diseases, especially pneumonia, in the Arctic at an estimated cost of $200,000 per year. To attack other diseases such as botul hepatitis A, gastrointestinal infections, and sexually transmitted diseases w require an additional $300,000 per year for five years.

As in the case of the proposed marine ecosystem research, the Commission has wr to members of Congress commending the proposed research initiatives and ui their serious consideration. It will continue to call attention to these research op tunities and urge their implementation. The benefits to the state and the nation c be far greater than the cost of the needed research.

The Council on Northern Resources Information Management submitted a report for Commission consideration at its July meeting. This report will be sidered in a separate section on Management of Arctic Information and Data.

A principle concern of the Commission has been the lack of an ice-capable ship dedicated to Arctic research.

Logistic Support of Arctic Research

In the preceding fiscal year (see *The United States: An Arctic Nation*. Los Angeles, CA: U.S. Arctic Research Commission, January 1987) and in this one, a principle concern of the Commission has been the lack of an ice-capable ship dedicated to Arctic research. In a letter of 24 April 1987 to the President of the United States, the Commission Chairman noted that research on the Arctic Ocean and marginal seas was vital to national security, prediction of weather and climate, development of nonrenewable resources, and management of renewable resources, such as the approximately $2 billion per year Bering Sea fisheries. He further stated that at the present time the United States does not have the ships required to conduct this research, a situation that worsened with the deactivation of the U.S. Coast Guard Icebreaker *Glacier*. Even if authorization of construction of a new icebreaking vessel occurred, some three or four years would elapse before the ship could be commissioned. Thus, as a short-term measure, the Commission urged that consideration be given to lease of a foreign icebreaker, or lease with an option to buy. Several icebreakers are currently idle because of the downturn in the oil industry, and one of these vessels might be modified and put under charter to meet immediate need. Over the longer term, upgrading of at least one of the planned U.S. Navy additions to the fleet or construction of an ice-worthy Arctic research vessel is needed and is very much in the national interest.

The Commission also encouraged the NSF in its decision to charter a vessel for research in the Antarctic this past year. The need for such a vessel for Arctic research was reiterated by the Commission in letters to members of Congress and in testimony before the Subcommittee on Coast Guard and Navigation of the Committee on Merchant Marine and Fisheries, U.S. House of Representatives, in July 1987.

In addition to continuing to promote awareness of the imperative need for an ice-capable vessel dedicated to Arctic research, the Commission explored other aspects of logistic support of Arctic research during FY 1987. It organized a workshop on 18 November 1986 in Anchorage, which was attended by approximately 80 people concerned with Arctic research. The objective was to obtain background information on the current status of U.S. logistic support, problems in its provision, and major needs. Workshop presentations further underlined the need for an ice-capable research vessel in the Arctic and suggested a potential problem in access to and application of the growing volume of satellite data.

Throughout the months following the workshop, Commission staff continued to gather information about logistic support of Arctic research through interviews, site visits, correspondence, and literature searches. By the end of the fiscal year a preliminary draft compilation of the findings, titled "An Overview of U.S. Arctic Research Logistics: Report to the Arctic Research Commission," had been developed. The document summarizes information about ocean-based instrumentation and facilities (e.g., buoys, undersea vehicles, ice-worthy ships), terrestrial facilities and support (e.g., laboratories, accommodations, centers for the reception, analysis and distribution of satellite and other types of data), and airborne and space-based instrumentation (e.g., airborne sensors and photography, rocket sounding, balloons, and satellite sensing systems and telemetry).

At the end of FY 1987, based on the information obtained in the workshop and subsequent surveys, the Commission was developing a position paper on "Logistic Support of Arctic Research: First Findings and Recommendations" for publication and transmission to the President and the Congress. In addition to a recommendation on acquisition of an arctic research vessel, the Commission will also consider the need to create or designate an agency or organization to serve as a focus for Arctic logistic planning and coordination. In the U.S. Arctic, many government agencies, industries, universities, and other private groups conduct research, each being responsible for its own logistic support arrangements. A central source of information on what instrumentation, facilities, and support services are available, and of assistance with arrangements for use is a basic requirement.

Management of Arctic Information and Data

Under the Arctic Research and Policy Act, the Commission is charged with suggesting methods for improving efficient sharing and dissemination of data and information on the Arctic among interested public and private organizations. To obtain assistance in meeting this charge, early in 1986 the Commission Chairman and the Governor of Alaska requested the Council on Northern Resources Information Management (CONRIM) to act as a federal/state task force and to explore cooperative arrangements for the creation of an Arctic and Alaskan natural resource, scientific, and technological information transfer network. In January 1987, the Commission Chairman specifically requested the Chairman of CONRIM to prepare for Commission consideration a report on the current status of Arctic data and information handling and to recommend a course of action that federal and state agencies might pursue to achieve an effective Arctic information network.

The goal of an arctic information network is to allow any user to obtain any existing arctic information with federal, state, and local governments, universities, and private companies participating in the network.

At its July meeting, the Commission considered a draft document titled "A National Arctic Information Network." The goal of such a network is defined as follows: to make it possible for any user, anywhere in the United States, to ascertain if a particular aspect of information about the Arctic exists, and if so, where and how to obtain it. The draft suggests that the network be initially organized by linking and strengthening existing resources and that it be capable of some cost recovery, with the possibility of becoming self-supporting. It was emphasized that participation not only of federal agencies but of the State of Alaska, local governments, universities, and private organizations will be crucial if the network is to reach its full potential. (It was recognized that once an effective national network is in place, the addition of international links will be the next step.) A plan for network structure and governance is proposed, with emphasis on interactive cooperation among network participants. The plan calls for a small management group to serve as program development officers and for a larger governing body on which all categories of participants are represented. It next specifies certain actions that will be necessary to implement the network: (a) recognition of scientific, technological, and natural resource information networking as part of State of Alaska policy, and authorization for state participation in both Alaskan and national Arctic networks; (b) development of a procedure for federal agency participation in the network, especially those agencies that do not have a presence in Alaska; (c) provision of opportunity and encouragement for academic, private, and public organizations to participate in network governance; and (d) formal recognition and authorization of the organizational structure that would bring federal, state, academic, private, and public interests into collaborative effort.

Some steps toward implementation have been taken. For example, a bill before the Alaska legislature would amend the Alaska Research Policy Act to recognize CONRIM's role in information and data management and to authorize state agencies to join CONRIM; to designate state and university organizational roles in the network as a part of state policy; to include representation from the information management community on the Alaska Science and Engineering Advisory Commission; and to provide for annual review by this state Commission of state agency and university information and data programs.