NOAA Coastal Ocean Program

FISCAL YEAR 1997 IMPLEMENTATION PLAN

for

SOUTHEAST BERING SEA CARRYING CAPACITY

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I. Introduction

A. Background

The Bering Sea ecosystem is among the most productive of high-latitude seas, with large biomasses of fishes, birds and mammals. This productivity is important to the U.S. economy. Fish and shellfish constitute almost 10% of the world and 40% of the U.S. fisheries harvest. Pollock, salmon, halibut, and crab generate over 2 billion dollars each year in fisheries revenue and provide a major source of protein. At present, some Bering Sea fisheries, such as pollock, appear not to be overexploited, although there have been major changes in abundance over the last thirty years. Populations of several species, such as king crab and Greenland turbot, however, are at near historical lows. We do not understand the fragility of the present state of the ecosystem. Pollock, however, plays a singularly important role, and its population historically has varied over a wide range.

The relative importance of natural cycles and exploitation in explaining variability in abundance is a key management issue for the Bering Sea. In addition to perturbations created by human activities, environmental factors are seldom stable and are subject to large scale fluctuations. For example, the production of new organic matter, which provides the basis for exploitable fish populations and all other higher trophic level animals, is greatly affected by environmental factors. Research is needed to understand variation in new production and other elements of the ecosystem dynamics of the vast Bering Sea shelf that supports such high productivity.

The 1970s and the 1980s were marked by dramatic changes in abundance for many groups of upper-trophic level species. Populations of some piscivorous seabirds, such as murres and kittiwakes, underwent significant declines. Similarly, estimates of Steller sea lions and northern fur seals showed a declining trend, particularly in the 1980s. Biomass of adult walleye pollock decreased during the 1970s, increased in the 1980s, and has approached a median value in the 1990s. These upper-trophic level predators all use juvenile pollock as a food source.

Southeast Bering Sea Carrying Capacity (SEBSCC) supports studies of the Bering Sea ecosystem. SEBSCC's conceptual model proposes that juvenile walleye pollock (*Theragra chalcogramma*) are a nodal species in the ecosystem in utilizing the high primary and secondary productivity and providing food for the pelagic upper trophic level species, including adult pollock. By nodal, we imply that a large fraction of the system energy flow passes through this species population. We focus on pollock in terms of their linkages to other species. We seek to understand interspecific overlaps in feeding habits through various stages of life history, including energy flow into and out of the pollock population. We want to identify synchronized increases or decreases in biomass at different trophic levels that may indicate the co-influence of factors. SEBSCC will study change in distribution and intensity of secondary productivity as a basis for change in year-class strength. The project will examine pollock as a key to the large

scale changes in productivity of the Bering Sea over the last three decades. As an abundant resource, pollock provides an important measure of the health of the ecosystem.

Build Sustainable Fisheries is the first goal listed in NOAA's Strategic Plan. SEBSCC meets the requirement of the Advance Fisheries Prediction element of the Strategic Plan: The Bering Sea is a major ecosystem and economic resource where there is a large year-to-year pollock recruitment and upper-trophic level variability which is not well understood. SEBSCC's management structure is a proven NOAA-academic-international partnership, effective in providing scientific leadership and subsequent transition to management. Information from SEBSCC will contribute toward the work of the North Pacific Fishery Management Council (NPFMC) and International Convention on Conservation and Management of Pollock Resources in the Central Bering Sea. Results will increase understanding of the response of the pollock population to changes in environmental conditions, and will allow evaluation of alternate management approaches taking into account such responses. Results from indicial models relating to short-term forecast of pollock recruitment will be incorporated into stock assessments used by AFSC to recommend allowable biological catch (ABC) estimates to the Council. Other research results involving factors influencing horizontal and vertical distribution of juvenile pollock to upper trophic level predators would assist Council decisions regarding restriction of fishing around marine mammal rookery areas. The NPFMC is attempting to move in the direction of ecosystem management, and information provided by SEBSCC will expedite this effort by improving knowledge of the role of pollock in the SE Bering Sea ecosystem. Focus on the response of the system, and in particular juvenile pollock, to changes in forcing will provide a context for management in a changing environment.

B. Goal

SEBSCC's goal is to increase understanding of the southeastern Bering Sea ecosystem, to document the role of juvenile pollock and factors that affect their survival, and to develop and test annual indices of pre-recruit (age-1) abundance.

C. Objectives

SEBSCC has scientific and programmatic objectives. Scientific objectives are to

1. investigate influences of climate variability on the Bering Sea ecosystem,

2. determine what limits population growth on the Bering Sea shelf,

3. identify effects of oceanographic conditions on biological distributions, and

4. understand environmental influences on primary and secondary production regimes.

Scientific pursuits use four approaches: retrospective analysis, observational analysis, process-oriented studies, and numerical modeling, to examine biophysical domains, juvenile pollock productivity, and relationships between them and the ecosystem of the southeastern Bering Sea. SEBSCC engages agencies, groups, and investigators with broad ecological interest in the southeast Bering Sea. This team for the research cycle lasting from 1996 through 1998

will investigate the ecology of juvenile pollock and sources and fate of nutrients in the southeastern Bering Sea. Following review by the Technical Advisory Committee in early 1998, SEBSCC will modify its objectives as necessary and recruit a science team for the second research cycle. The World Wide Web facilitates exchange of project information, preliminary results and data.

Programmatic objectives are to insure that SEBSCC

5. is a first-quality scientific program that supports a specific goal to provide critical knowledge needed for formulating policy and management of resources of the southeast Bering Sea ecosystem;

6. builds partnerships and encourages multidisciplinary cooperative efforts among research scientists within the academic community, NOAA, and other agencies interested in the SE Bering Sea; and

7. provides an open process in establishing research objectives and proposal selection to ensure quality and diversity.

SEBSCC's Project Management Team (PMT, Appendix 3)

II. FY 1996 Annual Report

A. Progress

SEBSCC had five objectives for the fiscal year:

1. refine scientific priorities,
2. recruit research staff,
3. assemble a research council,
4. begin monitoring efforts, and
5. begin retrospective and modeling studies,

to be attained by the following approaches:

- develop World Wide Web pages exploring the theme of the Southeast Bering Sea (1st Quarter),
- conduct a workshop to define specific 2-year and 5-year research objectives for retrospective, observational, process, and modeling studies (1st Quarter),
- release an Announcement of Opportunity (AO) for research based on the SEBSCC Concept Paper, discussion at Workshop, the NRC review of the Bering Sea ecosystem, and the PICES Workshop on the Bering Sea. (2nd Quarter),
- evaluate proposals and award selected investigators (2nd Quarter),
- assemble a Research Council (3rd Quarter),

- conduct initial monitoring based on available ship resources and selected proposals for monitoring studies (3rd, 4th Quarters), and
- begin modeling and retrospective studies (3rd, 4th Quarters).

During FY 1996, SEBSCC completed several steps toward attaining its goal. Four of the five listed objectives were achieved and a Research Council will be established in fall 1996. SEBSCC convened a workshop on the southeastern Bering Sea ecosystem, published a summary of the workshop, published an AO, selected a research team for the first research cycle through an open proposal review process, and began modeling, retrospective analysis and monitoring components.

The Planning Workshop for SEBSCC was held from 28-30 November 1995, in Seattle, Washington. Hosted by the University of Alaska and NOAA, conferees at the workshop discussed research priorities for understanding ecology of the southeastern Bering Sea using pollock as a focal species. The workshop considered four scientific approaches: 1) regionally explicit retrospective analysis of fisheries, oceanographic and other biological and physical data sets, 2) monitoring interannual variability of the environment in the several biophysical domains, 3) process studies quantifying the relation between larval and juvenile pollock and their environment and their role in the ecosystem, and 4) modeling simulations that encompass lower trophic level models, circulation models, and existing fisheries models. Seventy-seven scientists with knowledge of the Bering Sea or those processes affecting its ecosystem attended the workshop. Proceedings of the workshop may be obtained through the World Wide Web from the SEBSCC Home Page at http://www.pmel.noaa.gov/sebscc/, or from the SEBSCC Coordinator.

Following the workshop, SEBSCC's PMT developed an AO that was widely advertised in the scientific community through announcements in *EOS* (the weekly report of the American Geophysical Union), by distributions to subscribers to PICES and GLOBEC, through the American Minority Colleges and Universities listings, and through WWW notices on the NOAA Coastal Ocean Program and the SEBSCC home pages. The announcement resulted in receipt of 39 proposals, 21 from government agencies and 18 from academic institutions. After a formal scientific review process by 60 independent scientists, the TAC and PMT selected proposals to meet the requirements for FY 1996-1998 research. Fifteen studies from the four scientific approaches defined above will work to determine the sources and fate of nutrients in the southeastern Bering Sea, and the dynamics of shelf/slope exchange. The AO and a list of SEBSCC scientists and their research projects are available from the SEBSCC Home Page.

From September 4 to September 16, 1996, SEBSCC conducted its first field operation, a study of juvenile pollock and their environment near the Pribilof Islands. This effort directly addressed that part of SEBSCC's conceptual model proposing that juvenile pollock are a nodal species in the ecosystem. The objectives of this cruise were (1) to examine the impact of midwater and demersal predators upon juvenile pollock; (2) to examine distribution and feeding of seabird and marine mammal predators in the vicinity of the Pribilof Islands; (3) to continue acquisition of long-term biological and physical time series; (4) to examine vertical distribution of juvenile pollock and zooplankton using trawls and acoustics; (5) to collect samples of juvenile

pollock for studies on growth, feeding and pathology; and (6) to conduct an acoustic and trawl survey of juvenile pollock for examining horizontal distributions in relation to hydrographic fronts.

B. Scientific Accomplishments and Other Outcomes

SEBSCC's scientific program began July 1 with starts in modeling, monitoring, and retrospective analysis. Funded investigators and their projects are listed in Appendix 1. A significant scientific accomplishment during this fiscal year was the execution of the first field exercise described above. All objectives of the cruise were met. Age-0 pollock were the dominant fish caught in midwater trawls although gelatinous zooplankton dominated the catches by weight. Age-0 pollock were in almost every anchovy trawl and also in most of the Methot trawls. Age-0 pollock abundances were highest in the frontal region of all transects and were higher at the transects north of the islands. Some age-1 and adult pollock were caught in the bottom trawl, but flatfishes (rock sole and arrowtooth flounder) were the most abundant fishes caught.

C. Applications from Funded Projects

Publications:

ARCUS: International News- Three Studies Consider Bering Sea Fish and Wildlife. Newsletter of the Arctic Research Consortium of the United States. October, 1997. in press.

Strickland, R., 1996: Summary Report. Planning Workshop for Southeast Bering Sea Carrying Capacity - November 1998. Pacific Marine Environmental Laboratory, Seattle, Washington 98115, 51 pp.

SEBSCC has published information on the World Wide Web. Besides programmatic news at http://www.pmel.noaa/sebscc/, SEBSCC has underwritten development of a Bering Sea and North Pacific Ocean Theme Page at http://www.pmel.noaa.gov/bering/. This theme page serves as a common source for research activities pertaining to the Bering Sea and North Pacific Ocean. It supports multiple program interests based on the physical, chemical, biological and fisheries oceanography of this unique geographic area. This resource is intended to serve as a reference point for the numerous programs and investigators working in this area.

Presentations:

Alexander, V., 1995: The Bering Sea Ecosystem: A Revised Approach. Planning Workshop for Southeast Bering Sea Carrying Capacity. Seattle, Washington, 28-30 November.

Alexander, V., 1996: Southeast Bering Sea Carrying Capacity. Arctic Research Commission. Anchorage, Alaska, 19 August.

Alexander, V., 1996: Southeast Bering Sea Carrying Capacity. Arctic Research Commission. Dutch Harbor, Alaska, 21 August.

Balsiger, J., 1995: Integration with Alaska Fisheries Science Center. Planning Workshop for Southeast Bering Sea Carrying Capacity. Seattle, Washington, 28-30 November.

Brodeur, R, and T. Wyllie-Echeverria, 1995: The Bering Sea Ecosystem: Roles of Juvenile Pollock. Planning Workshop for Southeast Bering Sea Carrying Capacity. Seattle, Washington, 28-30 November.

Fritz, L., and V. Wespestad, 1995: Contributions to Fisheries Management. Planning Workshop for Southeast Bering Sea Carrying Capacity. Seattle, Washington, 28-30 November.

Hermann, A., P. Livingston, and D. Eslinger, 1995: Modeling Applications for the Bering Sea Ecosystem. Planning Workshop for Southeast Bering Sea Carrying Capacity. Seattle, Washington, 28-30 November.

Hollowed, A., 1995: Goals and Objectives. Planning Workshop for Southeast Bering Sea Carrying Capacity. Seattle, Washington, 28-30 November.

Hollowed, A., 1996: Overview of SEBSCC. GLOBEC Steering Committee. Washington, D.C., April.

Loughlin, T., 1995: Bering Sea Marine Mammal Program and SEBSCC. Planning Workshop for Southeast Bering Sea Carrying Capacity. Seattle, Washington, 28-30 November.

Overland, J.E., 1995: Overview of Southeast Bering Sea Carrying Capacity. Planning Workshop for Southeast Bering Sea Carrying Capacity. Seattle, Washington, 28-30 November.

Scavia, D., 1995: NOAA's Coastal Ocean Program. Planning Workshop for Southeast Bering Sea Carrying Capacity. Seattle, Washington, 28-30 November.

Springer, A., 1995: Examining the Bering Sea Ecosystem. Planning Workshop for Southeast Bering Sea Carrying Capacity. Seattle, Washington, 28-30 November.

Stabeno, P.J., and J.M. Napp, 1995: Biophysical Domains. Planning Workshop for Southeast Bering Sea Carrying Capacity. Seattle, Washington, 28-30 November.

Collaborations:

SEBSCC is a unique administrative partnership between a state university (University of Alaska Fairbanks) and two federal agencies (NMFS/Alaska Fisheries Science Center and OAR/Pacific Marine Environmental Laboratory). SEBSCC's research team blends the talents of scientists from five universities (University of Alaska Fairbanks, University of California Irvine, University of Washington, Rutgers University, University of Texas at Austin) and three federal agencies (NMFS, NESDIS, OAR).

International collaboration with Japanese and Korean scientists established under NOAA Coastal Ocean Program's Bering Sea FOCI are continuing with SEBSCC. Planning meetings with Japanese scientists will be held during October 1996.

III. FY 1997 Implementation Plan

A. Background

SEBSCC's goal is to study the southeastern Bering Sea ecosystem and the role of juvenile pollock in it, including the factors that affect their survival. A product to be developed and tested from this study is a set of annual indices of pre-recruit (age-1) abundance. The time scale for attaining these results is about five years.

In its first year SEBSCC defined its scientific goals, assembled a project management team and a technical advisory committee, recruited a research staff for 1996-1998, and began retrospective, modeling, and monitoring efforts. In year two, SEBSCC will continue the modeling, monitoring and retrospective research begun in year one, and add ecological research components that use the fourth approach: process-oriented studies. Fiscal year 1997 will bring the first complete realization of SEBSCC's annual field program. Early in the year, a Research Council will be added to the administrative/scientific team. The Research Council will provide a forum for exchange of information on the multidisciplinary aspects of the Bering Sea. Continuity of the council will foster extensive cross-disciplinary cooperation and help coordinate SEBSCC's role in the Bering Sea with other projects supported through PICES, GLOBEC, Bering Sea Impact Study (BESIS) and Bering Sea Ecosystem Study.

B. Objectives for FY 1997

The project has five objectives for the coming year:

1. continue modeling, monitoring, and retrospective studies begun in FY 1996, and begin process studies,
2. coordinate field activities for 1997 and 1998,
3. conduct first full year of field studies, and
4. assemble a research council.

C. Approach

SEBSCC will attain these objectives by the following approaches:

1. continue ecosystem modeling
   a. implement coupling of regional circulation model with 2-D global model (4th Quarter)
   b. configure Bering Sea IBM model with region-specific parameters (4th Quarter)
   c. complete multispecies virtual population analysis of the eastern Bering Sea for input to spatial model of upper-trophic level interactions (3rd Quarter)

2. continue environmental monitoring
   a. acquire and analyze satellite images to compile eddy census for manuscript (4th Quarter)
   b. process 1996 monitoring data; survey juvenile pollock, pollock prey and sea birds; begin index identification (4th Quarter)

3. continue retrospective studies
   a. obtain set of cores of deposited sediments from coastal embayments (3rd Quarter)
   b. compile inventory of and begin sectioning seal teeth (4th Quarter)
   c. develop conceptual model of relationships between pollock recruitment and biophysical correlates (2nd Quarter)
   d. locate, collate, process and analyze atmospheric, cold pool and productivity data (4th Quarter)

4. begin process-oriented components
   a. sample and process sinking organic matter, phytoplankton, zooplankton (4th Quarter)
   b. collect nutrient samples, deploy moored *in situ* nitrate sensor (4th Quarter)
   c. identify a mesoscale eddy, track and observe it with drifters (3rd Quarter)
   d. obtain, incubate, sample, and preserve pollock eggs (3rd Quarter)
   e. analyze historical distributions of juvenile pollock and associated zooplankton samples; parameterize bioenergetics model (4th Quarter)
   f. develop and test algorithm to distinguish juvenile pollock and plankton from hydroacoustic data (3rd Quarter)

5. administer and manage
   a. conduct a meeting of SEBSCC principal investigators at 7 p.m. on Tuesday, October 15, 1996, during the PICES Fifth Annual Meeting, at Nanaimo, British Columbia (1st Quarter),
   b. solicit membership in SEBSCC's Research Council from key scientists representing elements of the Bering Sea ecosystem (2nd Quarter),
   c. coordinate and conduct cruises aboard the NOAA Ship *Miller Freeman* and UNOLS Ship *Wecoma* (2nd, 3rd, 4th Quarter)

D. Proposed Budget

The second year of funding for SEBSCC is proposed to be $1.07M and the third year is $0.95M. Long range budgeting is discussed in Sec. III. The FY 1997 budget is divided into two parts: Research and Management. Project Management ($45K) will provide for PMT activities,

a principal investigators' meeting, communications (including WWW development), and formation of the Research Council. Research contracts ($1,025.5K) were awarded to principal investigators for two or three-year proposals beginning July 1, 1996, to address retrospective studies, modeling, or monitoring, and beginning October 1, 1996 for process-oriented studies of lower and upper trophic levels. FY 1997 awards to research staff are shown in Appendix 2. The following table shows a general SEBSCC budget for FY 1997.

SEBSCC FY1997 General Budget

Research	*$1,025.5K*
Modeling	$122.3K
Monitoring	$289.9K
Lower-trophic studies	$245.9K
Upper-trophic studies	$200.2K
Retrospective analysis	$167.2K
Project Management	*$45.0K*
Project Management Team	$10.0K
PI Meeting	$5.0K
Communications	$25.0K
Research Council	$5.0K
TOTAL	*$1,070.5K*

IV. Outlook

A. Annual Steps

FY 1997 is the mid-year of SEBSCC's first research cycle. During the research cycle, SEBSCC conducts annual workshops of investigators to facilitate exchange and synthesis of scientific results, to promote formation of small working groups, and to facilitate planning of scientific operations. As the first cycle comes to a close, the PMT with the guidance of the TAC will refocus scientific objectives and the mix of investigations, as necessary. A second AO will be developed for fiscal years 1999-2001.

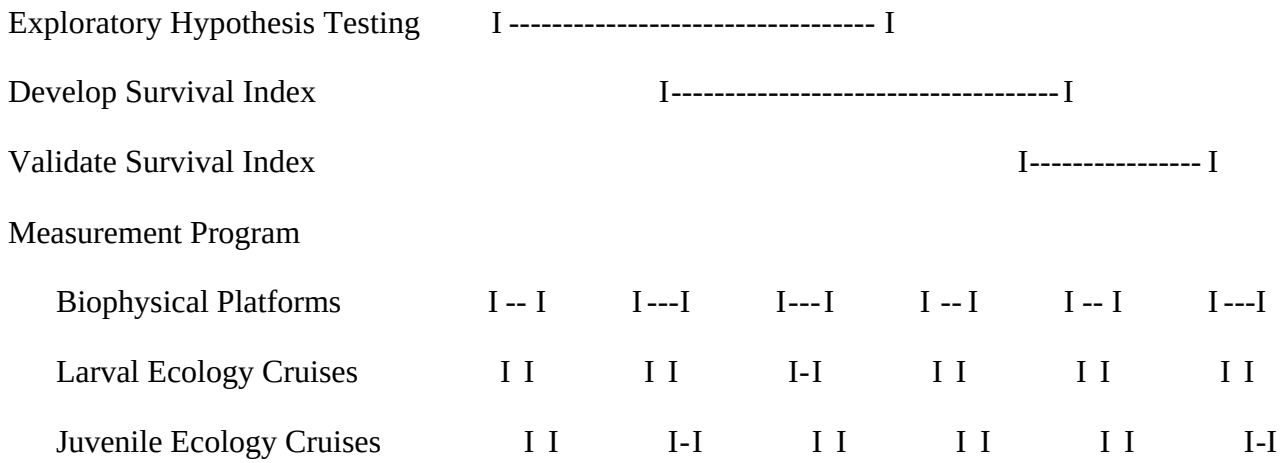
Intermediate, first research cycle products include a regional model of southeastern Bering Sea circulation with output to an individual-based model of walleye pollock, and a spatial model of upper-trophic level interactions in the eastern Bering Sea. From satellite altimetry analysis we will have a census of eddy-like features. Analysis will indicate dynamics responsible for eddy generation, evolution and influence on exchange of properties and material between the Bering Sea basin and shelf. If SEBSCC is successful in deploying ocean color monitoring drifters in an eddy, effects of local enhancement of primary productivity on higher trophic levels will be better understood. Reproductive processes on the shelf occur at a variety of temperatures from year to year, depending on long and short-term climate. SEBSCC will have examined development of pollock eggs at water temperatures spanning the expected range; results from this study will help regulate the individual-based model of pollock and shed light on temporal and spatial synchrony in the ecosystem. Other expected first-cycle results are determination of scales of variability in the coastal marine ecosystem from analysis of deposited sediments, historical changes in prey availability to upper trophic level predators as determined by seal foraging records, and effects of interannual climate fluctuations on pollock abundance through control of oceanographic conditions. To support data collection, SEBSCC will deploy biophysical platforms measuring a suite of atmospheric, oceanic, and biological information, and conduct cruises phased with important events in the ecosystem such as the spring bloom.

Over its six-year lifetime, SEBSCC will provide information to help assess resources of the Bering Sea. Synthesis of information from two research cycles will be used to quantify ecosystem concerns. An ecosystem focus will be the role of juvenile pollock in the Bering Sea, both as a consumer of energy from the bottom of the food chain and as a source of food to apex predators and other pollock. SEBSCC will develop an index of juvenile pollock abundance based on measurable ecosystem characteristics documented by retrospective studies and by data from biophysical platforms and annual spring through fall cruises. Steps to develop the index are data collection, exploratory hypothesis testing, and development and testing of the index. In the final year, 2001, cruises and moorings will be used to validate the index.

The SEBSCC budget calls for initial year (FY 1996) funds of $0.5M and level funding of $1.0M from 1997 through 2001. Inflation is expected to provide a downward financial ramp over the life of the project. We exploit that ramp by procuring capital equipment for monitoring at the start of the project, then shift to process studies, leading to synthesis, evaluation and validation, and information dissemination. The following timeline presents a schedule of major program elements for the duration of SEBSCC.

SEBSCC Timetable of Major Program Elements

	FISCAL YEAR					
	96	97	98	99	00	01
Workshop	*	*	*	*	*	*
Proposal Cycle	*			*		



B. Collaborative Planning

SEBSCC is a highly leveraged program. It works collaboratively with ongoing efforts by other National Marine Fisheries Service (NMFS) programs examining pollock resources and ecology of the Bering Sea (fishery acoustics group, stock assessment group, and Marine Mammal Protection Act Studies), programs at the University and State of Alaska, EPA, Shelikof Strait FOCI, Japan Far Seas Fisheries Laboratory, Ocean Research Institute of Tokyo University, Faculty of Fisheries, Hokkaido University, the Japanese Marine Science and Technology Center, Tokai University in Sapporo, Tohoku National Fisheries Institute, Korean Ocean Research and Development Institute and the Institute of Marine Biology, Far East Branch of the Russian Academy of Sciences. We also coordinate with inhabitants of St. Paul Island. We promote collaborative research with the ONR, NSF, and NASA. Marine mammalogists from the AFSC, ornithologists from the University of California-Irvine, and bioacousticians from the Southwest Fisheries Science Center (NMFS) and Scripps Institute of Oceanography collaborate on ecosystem studies as begun by a sister project, Bering Sea FOCI, and continued by SEBSCC. Researchers at NESDIS collaborate on remote sensing of ocean color. Another example of existing leverage is that Japanese and SEBSCC researchers in October of 1996 will coordinate summer cruises in the eastern Bering Sea for 1997. When combined with NOAA cruises, this will allow several larval cohorts to be followed through their period of maximum mortality. There is ongoing University of Alaska Fairbanks and Hokkaido University collaboration on climate change and Bering Sea productivity. Japanese researchers (JAMSTEC) also are cooperating with University of Alaska scientists in research on the northern Bering Sea and Chukchi Seas in consort with Russian participants, and are providing financial support for ship time. SEBSCC is considered a component of the PICES-GLOBEC Climate Change and Carrying Capacity (CCCC) Program.

C. Projected Resource Issues

For FY 1997, SEBSCC has planned 64 sea days aboard the NOAA Ship *Miller Freeman* during February, April, May and September; and 41 days aboard the UNOLS Ship *Wecoma* during May, June and July. The project will require similar (~100 days) ship time in 1998 aboard the *Miller Freeman* and a Class I vessel. Cruises need to coincide with ecosystem events such as the spring bloom and with larval and juvenile life stages of pollock.

Appendix 1. SEBSCC Investigators Funded during FY 1996

Investigator	Institution	Project title	FY96 award ($K)	Total award ($K)	Thru
Livingston, Pat and Hinckley, Sarah	NOAA/AFSC	A spatial model of upper-trophic level interactions in the Bering Sea			1998
Hermann, Al	University of Washington	Circulation modeling for the S.E. Bering Sea			1998
Stabeno, Phyllis	NOAA/PMEL				1998
Haidvogel, Dale	Rutgers University				1998
Musgrave, David	University of Alaska Fairbanks				1998
Schumacher, Jim and Stabeno, Phyllis	NOAA/PMEL	Monitoring and development of biophysical indices of the southeastern Bering Sea			1998
Brodeur, Ric and Napp, Jeff	NOAA/AFSC				1998
Hunt, George	University of California Irvine				1998
Henrichs, Susan	University of Alaska Fairbanks	Isotopic and biomarker composition of sinking organic matter in the southeast Bering Sea: indicators of food web structure			1998
Swartzman, Gordie	University of Washington	High-resolution acoustic and juvenile pollock retrospective data analysis			1998
Brodeur, Ric	NOAA/AFSC				1998
Niebauer, Joe	University of Alaska Fairbanks	The role of atmospheric forcing on the “cold pool” and ecosystem dynamics the Bering Sea shelf: a			1998

		retrospective study	
Bond, Nick and Wyllie-Echeverria, Tina	University of Washington		1998

Appendix 2. SEBSCC Investigators Funded during FY 1997

Investigator	Institution	Project title	FY97 award ($K)	Total award ($K)	Thru
Hinckley, Sarah, and Megrey, Bern	NOAA/AFSC	Individual-based modeling of walleye pollock in the southeast Bering Sea			1998
Hermann, Al	University of Washington				1998
Livingston, Pat and Hinckley, Sarah	NOAA/AFSC	A spatial model of upper-trophic level interactions in the Bering Sea			1998
Hermann, Al	University of Washington	Circulation modeling for the S.E. Bering Sea			1998
Stabeno, Phyllis	NOAA/PMEL				1998
Haidvogel, Dale	Rutgers University				1998
Musgrave, David	University of Alaska Fairbanks				1998
Schumacher, Jim and Stabeno, Phyllis	NOAA/PMEL	Monitoring and development of biophysical indices of the southeastern Bering Sea			1998
Brodeur, Ric and Napp, Jeff	NOAA/AFSC				1998
Hunt, George	University of California Irvine				1998
Okkonen, Steve	University of Alaska Fairbanks	An altimetric census of mesoscale eddy-like features in the Bering Sea			1997
Whitledge, Terry	University of Texas at Austin	Investigation of the origin and dynamics of nutrients on the southeast Bering Sea shelf in relation to dominant physical and			1998

		biological processes	
Henrichs, Susan	University of Alaska Fairbanks	Isotopic and biomarker composition of sinking organic matter in the southeast Bering Sea: indicators of food web structure	1998
Stabeno, Phyllis	NOAA/PMEL	Using optical measurements to explore the influence of mesoscale eddies on the interaction of lower and higher trophic levels in the southeast Bering Sea	1998
Swartzman, Gordie	University of Washington	High-resolution acoustic and juvenile pollock retrospective data analysis	1998
Brodeur, Ric	NOAA/AFSC		1998
Brodeur, Ric and Napp, Jeff	NOAA/AFSC	Habitat differences in frontal regions around the Pribilof Islands and their importance to juvenile pollock growth and survival in the Bering Sea	1998
Doyle, Miriam	University of Washington		1998
Blood, Debbie	NOAA/AFSC	Low-temperature incubation of walleye pollock eggs from the southeast Bering Sea region	1998
Francis, Bob	University of Washington	Natural scales of variability in coastal marine ecosystems of the eastern Bering Sea	1998
Loughlin, Tom	NOAA/AFSC	Historical trends in the number of foraging trips made by lactating northern fur seals	1998
Niebauer, Joe	University of Alaska Fairbanks	The role of atmospheric forcing on the “cold pool” and ecosystem dynamics the Bering Sea shelf: a retrospective study	1998
Bond, Nick and Wyllie-Echeverria,	University of Washington		1998

Tina			
Megrey, Bern and Wespestad, Vidar	NOAA/AFSC	A retrospective investigation into relationships between southeast Bering Sea pollock recruitment and biophysical correlates	1998

Appendix 3. Personnel

A. Project Management Team

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