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Exxon Valdez Oil Spill Trustee Council FY 2001 Annual Workshop

GEM: Gulf Ecosystem Monitoring & Research Draft Plan

Regal Alaskan Hotel
Anchorage, Alaska
October 12 - 13, 2000

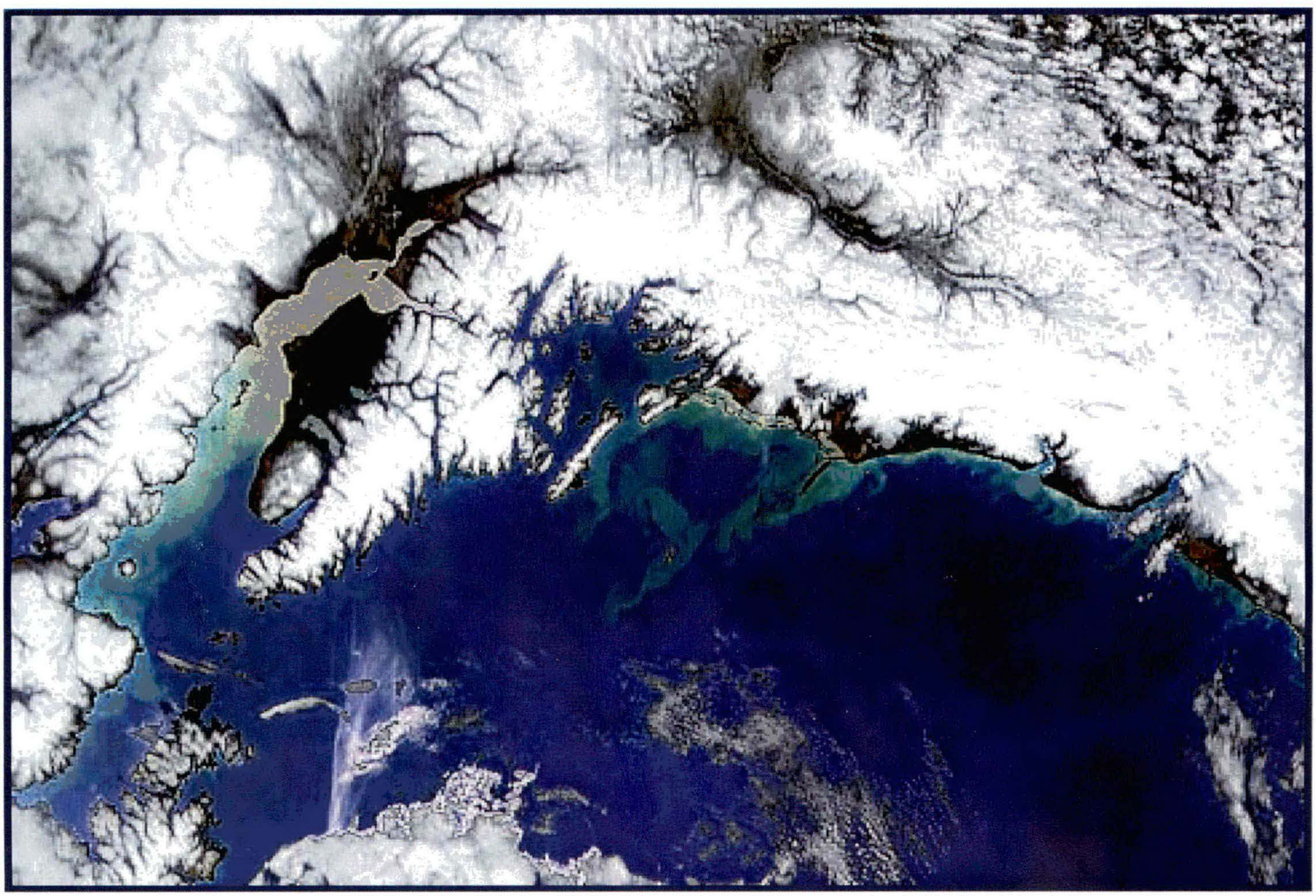
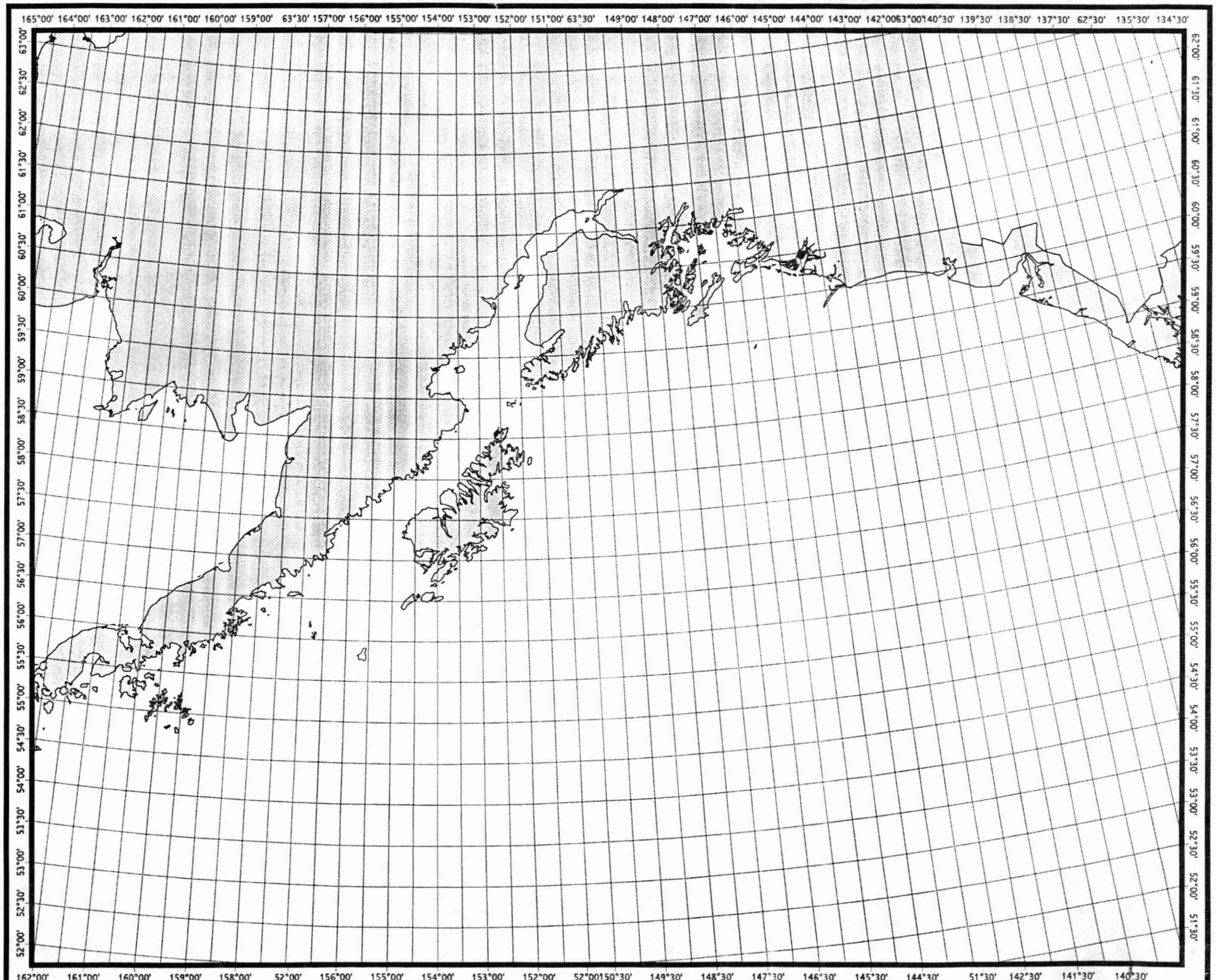


Photo courtesy the SeaWiFS Project, NASA/Goddard Space Flight Center and ORBIMAGE Corporation

Northern Gulf of Alaska



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Exxon Valdez Oil Spill Trustee Council

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September 25, 2000

Dear Workshop Participant:

Thank you for participating in the October 12-13, 2000 annual workshop sponsored by the *Exxon Valdez* Oil Spill Trustee Council. In past years, the annual workshop has provided a forum for oil spill restoration investigators to showcase the results of their research and monitoring efforts, as well as an opportunity for researchers to exchange information and their current state of knowledge of the northern Gulf of Alaska across disciplines.

This year's workshop differs from those in the past, in that it will serve primarily as an intensive work session to help produce a Draft Monitoring and Research Plan for the northern Gulf of Alaska as part of the Trustee Council's GEM—Gulf Ecosystem Monitoring—program.

<u>What you need to do before the workshop</u>
Most of the materials you will need to participate in the workshop are included in this binder. Your participation will be most constructive if you can review the binder in detail and start thinking about the questions identified for each session. The questions are meant to stimulate the initial discussion, not limit it. You need to bring your personal expertise (or that of your agency or organization) regarding various aspects of marine monitoring and the northern Gulf of Alaska ecosystem. If you have additional proposals or ideas that you think should be included in the Draft Monitoring and Research Plan, you should bring them on diskette if possible.

<u>What this binder contains</u>
This binder contains two major sections: "Scientific Background" and "Draft GEM Monitoring and Research Plan". The Scientific Background section is an update of Section IV of the GEM Science Program NRC Review Draft, April 21, 2000 (hereafter the "GEM Program document"). This section provides the overall scientific background that forms the basis for development of the Draft Monitoring and Research Plan, including guidance from past and existing programs, a description of the Gulf of Alaska ecosystem and a conceptual model of how that system works. In addition, definitions of acronyms and associated web sites are included.

The Draft GEM Monitoring and Research Plan section presents a "straw dog" of a draft plan. It consists of summaries of 42 proposed components organized in three ways: "by theme," "by scientific discipline" and "by ecological question." We have chosen the theme approach as our primary means of presenting and discussing the components, and for that reason, more detail is given on the individual themes, including preliminary hypotheses and strategies The components are also presented by scientific discipline and by ecological question in order to provide additional perspectives from which to analyze the draft plan for completeness and scientific integrity Additionally, each component is described in detail on separate pages Any additional components you might want to recommend at the workshop will be considered in conjunction with these—or similar—themes, disciplines and questions

Relationship between the GEM Program document and the Monitoring & Research Plan

Most of you are familiar with the GEM Program document dated April 21, 2000, which is currently undergoing review by the National Research Council Our current thinking is that the final GEM document will likely consist of two volumes Volume I will be the current sections I-III in the GEM Program with background information, the vision for GEM and the northern Gulf of Alaska, and the structure and approach for the overall program Once finalized, these sections of the GEM Program document should stand for a long time Volume II will consist of those sections that need to be reviewed and modified at least every five years, but probably more frequently as information becomes available the current Section IV in the GEM Program document—which describes our current understanding of the northern Gulf of Alaska ecosystem and other programs and projects underway in the region—and a long-term monitoring and research plan

Where we are in the process

The following schedule lays out the proposed timeline for completing the GEM documents

- Trustee Council commits to long-term monitoring and research program as major use of Restoration Reserve, March 1999
- Staff prepares draft GEM Program document in consultation with scientists, resource managers, public advisory groups, Trustee agencies, and general public, March 1999-April 2000
- Submit draft GEM Program document to National Research Council (NRC), April 21, 2000
- NRC review committee meets on GEM Program document, June & October, 2000
- Focus groups with regional emphasis meet on Draft Monitoring & Research Plan, July & August 2000
- **Workshop on Draft Monitoring & Research Plan, October 12-13, 2000**
- Revise Draft Monitoring & Research Plan, October 13 – November 24, 2000*
- Trustee Council considers Draft Monitoring & Research Plan, November 27, 2000*
- Public review of Draft Monitoring & Research Plan through January 12, 2001*
- Trustee Council adopts Draft Monitoring & Research Plan for National Research Council review January 15, 2001*
- NRC interim report on GEM Program document to Trustee Council, February 2001*
- NRC begins review of Draft Monitoring & Research Plan, March 2001*
- NRC final report on GEM Program document and Draft Monitoring & Research Plan to Trustee Council, November 2001*
- GEM Program document and Draft Monitoring & Research Plan revised, November 2001-January 2002
- Final GEM Plan, Volumes I and II, adopted by Trustee Council, January 2002*
- First GEM Invitation for Project Proposals based on adopted plan, proposals due April 15, 2002*
- Trustee Council approves first GEM work plan, August 2002*
- Implementation of first GEM work plan begins, October 1, 2002

** indicates tentative dates*

What happens at the workshop
We have tried to organize the agenda to obtain the most input as possible from your participation The first morning is a plenary session that sets the stage for a day and a half of intensive, small group work sessions These sessions will be used to look at the straw dog draft plan enclosed in this binder from a variety of perspectives by "theme", by "discipline", by "question", and by several overarching "issues" We want to see if the plan holds up following this scrutiny or how it needs to be modified Each theme write-up lists a number of questions to be addressed in the individual work sessions, as do the discipline, question and issue summary pages Some of these questions cross all the sessions, others are tailored to a specific session These questions are meant to be the starting point for discussion and not to be limiting Please read the introduction to the Draft Monitoring and Research Plan very carefully It includes information important to understanding how the draft plan was developed

What happens after the workshop
In the back pocket of your binder you will find a Draft Monitoring and Research Plan evaluation form We expect to get detailed feedback on all of the pieces of the plan during the workshop However, the evaluation form provides an opportunity to respond on the overall plan, the use of themes, the choice of particular themes, and the proposed approach to development of the plan These broader questions may not be captured in the work sessions themselves, and we want to make sure you have every opportunity to give us your input After the workshop, the session facilitators will submit their notes to the Restoration Office Staff will evaluate input from the workshop, as well as input from those unable to attend but who submit comments, in view of the GEM Program document A Revised Draft Monitoring and Research Plan will be produced and circulated for public review and comment, tentatively in early December through mid-January

The schedule described above for the completion of the GEM Monitoring and Research Plan is very ambitious Depending on the amount and kinds of input from workshop participants, peer reviewers, other scientists, stakeholders, and the public, considerable revision may be required which could result in delays in the schedule However, given that implementation of GEM isn't expected to begin until October 2002, there is time to do the job right Your help at this stage of the process is greatly appreciated

Sincerely,

Molly McCammon

Molly McCammon
Executive Director

Acknowledgments

Many people made material or intellectual contributions to the Draft Monitoring and Research Plan and its supporting documents Due to the large number of contributors and advisors it is not practical to identify individual contributions, so the efforts of the following individuals are gratefully acknowledged Alisa Abookire, Ken Adams, Vera Alexander, Fred Allendorf, Paul Anderson, Peter Armato, Shannon Atkinson, Jim Ayers, Torie Baker, Kris Balliet, Hal Batchelder, Bill Bechtol, Catherine Berg, Brock Bernstein, Chris Blackburn, John Blaha, Jim Bodkin, Dede Bohn, James Brady, Stephen Braund, Patty Brown-Schwalenberg, Al Burch, Vern Byrd, Robert Clark, Dave Cobb, Ted Cooney, Seth Danielson, Tom Dean, Robert DeVelice, Jane DiCosimo, Gary Drew, Doug Eggers, Dave Eslinger, Bob Foy, Steve Frenzel, Carol Fries, Fritz Funk, Dan Gillikin, David Goldstein, Andy Gunther, Gary Gury, Scott Hatch, Bill Hauser, Robert Henrichs, Ken Holbrook, Anne Hollowed, Charlie Hughey, Dan Hull, Henry Huntington, David Irons, Lisa Ka'aihue, Tom Kline, Gary Kompkoff, Jan Konigsberg, Gordon Kruse, Kathy Kuletz, Pat Lavin, Pat Livingston, Lloyd Lowry, Allen Macklin, Tom Malone, Suzanne Marcy, Paul McCollum, Walter Meganack, Jr , Jennifer Nielsen, Gordon Nelson, Pat Norman, Phil North, Worth Nowlin, Gretchen Oosterhout, Ted Otis, Paul Panamarioff, Kent Patrick-Riley, Charles Peterson, John Piatt, Josie Quintrell, Terry Reed, Stanley Rice, Evan Richert, Monica Riedel, George Rose, Dave Roseneau, Susan Saupe, Andy Schmidt, Carl Schoch, Marianne See, Stan Senner, Bob Shavelson, Hugh Short, Jeff Short, Claudia Slater, Bob Small, Bob Spies, Alan Springer, Stacy Studebaker, Arliss Sturgulewski, Joe Sullivan, Kevin Summers, Gary Thomas, Glenn VanBlaricom, Shari Vaughan, Gale Vick, Jia Wang, Sarah Ward, Tom Weingartner, Steve Weisberg, David Welch, Kent Wohl, Bruce Wright, Kate Wynne We apologize to anyone whose name we may have overlooked

GULF ECOSYSTEM MONITORING
(GEM)
SCIENTIFIC BACKGROUND

Table of Contents **1**

Introduction

The Scientific Background describes and organizes the scientific information available to guide the Trustee Council as it develops and implements GEM It includes

- a synthesis of the literature record on the physics and biology of the Gulf of Alaska, based upon prior regional scientific planning efforts and current understanding,
- a description of other monitoring and research efforts in the region by agency and program,
- a description of the scientific "conceptual foundation" of the GEM program, which explains how physical processes govern biological productivity of valued marine resources and poses ecological questions relating to food production, habitat limitations, and removals by fishing and other human activities,
- a list of commonly used acronyms, many of which are existing monitoring and research programs, with definitions and web links

The document differs somewhat from the version supplied to the National Research Council in April 2000 due to the normal processes of updating scientific information, responding to comments received, and correcting errors and omissions

A Guidance from Prior Programs

1 Comprehensive Investigations and Reviews

Antecedents of the GEM program provide guidance A marine science planning document with a broader geographic scope, the Alaska Regional Marine Research Plan (ARMRP) (ARMRB 1993), was prepared under the U S Regional Marine Research Act of 1991 For all marine areas of Alaska, including the GOA, the plan provided five elements that are of interest to the GEM program 1) an overview of the status of marine resources, 2) an inventory and description of current and anticipated marine research, 3) a statement of short- and long-term marine research needs and priorities, 4) an assessment of how the research and monitoring activities under the program take advantage of existing projects, and 5) descriptions, time tables and budgets of research and monitoring to be conducted under the program The current GEM document does not address element five, since that is the ultimate goal of the three-year process of implementation to be completed by October 2002 ARMRP goals express the scientific needs of the region as of 1992, and they are still quite relevant to the GEM effort

- Distinguish between natural and human induced changes in marine ecosystems of the Alaska Region,
- Distinguish between natural and anthropogenic changes in water quality of the Alaska Region,
- Stimulate the development of a data gathering and sharing system that will serve scientists in the region from government, academia, and the private sector in dealing with water quality and ecosystem health issues, and
- Provide a forum for enhancing and maintaining broad discussion among the marine scientific community on the most direct and effective way to understand and address issues related to maintaining the region's water quality and ecosystem health

Further guidance is available from nearby ecosystems The Bering Sea has warranted a comprehensive planning effort due to concern over long-term declines in populations of high-profile species such as king and tanner crab, Steller sea lions, spectacled eiders, common murres, thick-billed murres, and red-legged and black-legged kittiwakes (DOI-NOAA-ADF&G 1998b) The vision of the federal-state regulatory agencies for the Bering Sea Ecosystem Research Plan (BSERP) (DOI-NOAA-ADF&G 1998a) is consistent with the mission statement of the Trustee Council (Section II A) "We envision a productive, ecologically diverse Bering Sea ecosystem that will provide long-term, sustained benefits to local communities and the nation" The basic concepts of the GEM program are also consistent with the overarching hypotheses of the plan

- Natural variability in the physical environment causes shifts in trophic structure and changes in the overall productivity of the Bering Sea

- Human impact leads to environmental degradation, including increased levels of contaminants, loss of habitats, and increased mortality on certain species in the ecosystem that may trigger changes in species composition and abundance

Further, four of the research themes of the Bering Sea -- variability and mechanisms in the physical environment, individual species responses, food web dynamics, and contaminants and other introductions -- are closely aligned with the basic mission established by the Trustee Council Current research programs for the Bering Sea (DOI-NOAA-ADF&G 1997) often overlap with the programs identified for the GOA

Additional guidance for GEM planning is available from work on the Arctic Ocean Both the Gulf of Alaska and the Bering Sea are linked to the Arctic Ocean through atmospheric and oceanic processes A strategic plan for arctic marine sciences has been submitted to the National Science Foundation (NSF) by the Arctic Research Consortium of the United States (Aagaard et al 1999,Aagaard et al 1999) The overall recommendation of *Marine Science in the Arctic A Strategy* is consistent with ARMRP and BSERP "Understanding the past and present Arctic is essential to predicting its future and to evaluating the global effects of changes in this unique region [and peripheral seas]" (Aagaard et al 1999 page ix) Additional recommendations of particular relevance to the GEM mission include expanding monitoring and research to understand the manifestation of global climate change in the Arctic from both global and regional perspectives and establishing international and interagency coordination and cooperation in developing the infrastructure for monitoring

2 Scientific Legacy of the *Exxon Valdez* Oil Spill

Ecological knowledge gained in the decade following the oil spill forms a substantial portion of the foundation of the GEM program The Trustee Council recognized early in the restoration program the need for basic ecological information to evaluate recovery of injured species The recovery status of each affected resource is based to the extent possible on knowledge of the resource's role in the ecosystem The Trustee Council's scientific legacy points toward the need to understand the causes of population trends in individual species of plants and animals through time Understanding the causes of population trends leads to the need to separate human effects from those of climate and interactions with related species

The studies conducted by the trustee agencies and their contractors since 1989 have resulted in over 300 peer reviewed scientific publications, doctoral dissertations and theses A current bibliography of publications sponsored by the Trustee Council is available on the council's website or on request to the Trustee Council In addition to much specific information on the effects of oil on the biota in the spill area, the studies also provide a wealth of ecological information

As a result of the information gathered during individual research projects and three ecosystem-scale interdisciplinary research projects, the scientific legacy of the Trustee Council includes a wide range of information Topics covered by Trustee Council-funded studies include physical and biological oceanography, marine food web structure and dynamics, predator-prey relationships among birds, fish, and mammals, the source and fate of carbon among species, developmental changes in trophic level within species, marine growth and survival of salmon, intertidal community ecology, and early life history and stock structure in herring (A compendium of Trustee Council projects by fiscal year, as well as a complete list of final and annual reports for projects, are available on the council's website or on request to the Trustee Council)

The Sound Ecosystem Assessment (SEA) is the largest of three ecosystem-level projects undertaken by the Trustee Council Over a period of seven years, SEA brought together a team of scientists from many different disciplines to understand the biological and physical factors responsible for producing herring and salmon in PWS Final products from SEA have not yet been completed When report writing is complete, SEA is expected to provide information on biological and physical oceanography that could be used by the Alaska Department of Fish and Game in its herring and salmon management programs In this regard, SEA is expected to give managers a set of interacting numerical models capable of simulating the dynamic processes influencing the survival and productivity of juvenile pink salmon and herring in PWS SEA has already provided new observations of ocean currents, nutrient levels, mixing of water masses, salinity, and temperatures The new observations have made possible models of how physical factors influence plant and animal plankton, prey, and predators in the food web

The two other ecological studies are also in the final stages of completion Both are expected to provide information that will be of use to natural resource management agencies The Nearshore Vertebrate Predator (NVP) project is a six-year study of factors limiting recovery of two fish-eating species, river otters and pigeon guillemots, and two invertebrate-eating species, harlequin ducks and sea otters The Alaska Predator Ecosystem Experiment (APEX) is an eight-year study of ecological relations among seabirds and their prey species The NVP project has contributed to understanding of the linkages between terrestrial and marine ecosystems (Section D) by studying key species at the interface of these systems The APEX project has contributed understandings of the critical nexus between productivities of marine bird populations and fish species In addition, analysis of food selection by marine birds shows promise of providing abundance estimates for key fish species, such as sand lance and herring

B Existing Agency Programs and Projects

Most major information-gathering programs of the GOA are divisible into three major categories large animals or macrofauna (birds, mammals, fish, shellfish), oceanography (physical, chemical, geological and biological) and human use (land and water use, water quality, contaminants)

The Alaska Department of Fish and Game, the U S Department of the Interior and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service are the primary monitoring agencies for macrofauna Sampling efforts for macrofauna are typically focused on the GOA or smaller areas, including PWS, Cook Inlet, Kodiak and the Alaska Peninsula The National

Aeronautics and Space Administration and the National Oceanic and Atmospheric Administration are the primary sources of oceanographic data, including data on zooplankton, phytoplankton and primary productivity Notably absent are monitoring or assessment programs for large plants, such as kelp and other large marine algae Oceanography programs often include the GOA as part of a larger program The U S Environmental Protection Agency, U S Forest Service, Alaska Department of Environmental Conservation and Alaska Department of Natural Resources all monitor certain human uses of lands and waters and the impacts of human use on resources, as do several nongovernmental organizations

A summary of the major programs conducted by the United States, State of Alaska, transboundary organizations and nongovernmental organizations follows These programs have been incorporated into a database, which will include projects that are actively collecting data as well as projects that are no longer active Inactive projects contain considerable valuable historical information relevant to the production of plants and animals in the GOA Section H contains a reference list of commonly used acronyms and web site links for these programs and others

1 State of Alaska

Alaska Department of Environmental Conservation (ADEC) The Division of Air and Water Quality (AWQ) is concerned with public health and environmental problems throughout Alaska The Year 2000 statewide water quality assessment is a project to describe the nature, status and health of Alaska's waters, and to identify restoration and protection needs The AWQ also monitors ambient water quality through the State Water Discharge Permits and Certification program and the Non-Point Source Water Pollution Control program Discharge permits, such as that for the Alyeska Marine Terminal in Valdez, require that the permitee monitor both surface water and ground water for such contaminants as petroleum, PCBs and heavy metals Monitoring data from about 3,000 sites statewide (1,000 of which are in the oil spill region) are stored in the Contaminated Sites Database The Non-Point Source Water Pollution Control program keeps a list of "impaired waterbodies," that is, waterbodies that do not meet state water quality standards ADEC also funds non-point source water pollution monitoring projects with funds authorized by Congress under Section 319 of the Clean Water Act and administered by the Environmental Protection Agency (EPA)

ADEC has awarded EPA 319 funds to several citizen-based monitoring programs, such as the Cook Inlet Keeper's water monitoring program in lower Cook Inlet, the Kenai Watershed Forum, and wetlands studies by the Nature Conservancy In partnership with other agencies, ADEC is developing a bioassessment project in the Cook Inlet bioregion This project seeks to develop protocols for water sampling that are better suited to conditions in Alaska than the current sampling protocols

The Cook Inlet Information Management and Monitoring System (CIIMMS) is a project, funded by the Trustee Council, to develop a website for finding, contributing and sharing information for the Cook Inlet watershed region CIIMMS is intended to support monitoring, management and restoration of natural resources, in addition to data sets and software relevant to understanding the ecological status of this region

The Division of Environmental Health routinely tests and certifies clams from commercially harvested shellfish beaches and shellfish farms for paralytic shellfish poisoning (PSP) The division also monitors PSP in king crab in PWS and in Dungeness crab and Tanner crab in PWS, Cook Inlet and Kodiak Island The Contaminated Sites program monitors superfund sites, abandoned military sites and other contaminated sites throughout the state

Alaska Department of Fish and Game (ADF&G) The Division of Commercial Fisheries does substantial monitoring of salmon and other anadromous fish species, herring, crabs, shrimp and several other invertebrate species, and some species of mammals ADF&G is responsible for the GOA portion of the Coded Wire Tag database, which contributes to understanding ocean distributions of salmon The department's point of sales (fish ticket) information supports understanding of abundance and distribution of salmon, crabs, herring, and other species ADF&G has extensive historical information on the distribution of some species of crab and shrimp in the GOA from Southeast Alaska to the Aleutian Islands ADF&G has archives of scales and size at age from salmon and herring that enable understanding of historical marine growth regimes

An extensive archive of genetic data on chum, sockeye and other species of salmon is being assembled by ADF&G in cooperation with NMFS and agencies of nations participating in the North Pacific Anadromous Fish Commission (NPAFC) The data enhance understanding of the oceanic distribution of salmon, and thereby contribute to understanding oceanic regime shifts ADF&G also conducts genetic research on crabs, some rockfish, herring, and pollock

The ADF&G and cooperating regional aquaculture associations also collect some physical and biological oceanographic data, such as Kodiak nearshore sea surface temperatures, Kitoi Bay zooplankton biomass (Kodiak), and PWS zooplankton settled volumes The ADF&G Subsistence Division's Whiskers database on subsistence harvest of marine mammals is part of a larger NOAA sponsored program In addition, the Wildlife Conservation Division monitors harbor seals in cooperation with NMFS

The Sport Fish Division conducts port sampling of groundfish for information about the recreational effort, catch and harvest of rockfish, lingcod and halibut in the northern GOA This project consists of catch sampling and angler interviews The Subsistence Division collects data on subsistence fish and shellfish harvest The Habitat Division monitors the effect of certain activities on anadromous fish streams Since 1990, the division has been monitoring compliance with the Alaska Forest Practices regulations on private land Since 1998, the Habitat Division has been researching the effects of stream crossing structures on fish habitat and fish passage on the Kenai Peninsula Note that most ADF&G marine programs serve to provide information to NOAA programs

Alaska Department of Natural Resources (ADNR) The ADNR monitors certain uses of land and resources on state lands and waters The Division of Oil and Gas performs field inspections of activities on state oil and gas leases The Division of Forestry monitors compliance with the terms of state timber sales The Division of Parks and Outdoor Recreation tracks use of state-owned recreation facilities such as campgrounds, cabins and parking facilities Periodically, staff inspect these facilities The Division of Mining, Land and Water issues aquatic farming permits, shore fishery leases and other permits and leases for use of state-owned tidelands and uplands The Division maintains statistics on the number of applications submitted and issued and monitors compliance with terms and conditions of permits and leases

Alaska Department of Community and Economic Development (ADCED) Each year, the department's Division of Tourism publishes *Alaska Visitor Arrivals* and the *Alaska Visitor Industry Economic Impact Study* These studies are based on secondary data No field surveys have been conducted since the *1993-1994 Alaska Visitor Statistics Program III*

Alaska Department of Health & Social Services (ADHSS) The Division of Public Health has conducted several retrospective studies of contamination in subsistence foods One study examined 20 years of data on trace metal analysis in marine mammals and another examined the occurrence of contaminants in subsistence foods, with an emphasis on methylmercury, cadmium and PCB levels

Alaska Science and Technology Foundation (ASTF) The ASTF was established in 1988 by the Governor and the State of Alaska Legislature It's purpose is "to promote and enhance, through basic and applied research and the development and commercialization of technology, economic development and technological innovation in Alaska, public health, telecommunications, and the sustained growth and development of Alaskan scientific and engineering capabilities " GEM and ASTF share interests in development of technologies for resource assessment

University of Alaska The university has extensive programs that are relevant to GEM Four federally and state supported programs within the university system are expected to provide the International Arctic Research Center substantial expertise and information of interest the School of Fisheries and Ocean Sciences, the Sea Grant Program, the National Underwater Research Program, and the Institute of Social and Economic Research

Institute of Marine Science (IMS) School of Fisheries and Ocean Sciences Scientists associated with IMS have compiled much of the historical data relevant to the GEM program IMS produced the comprehensive review (Rosenburg 1972) in preparation for the extensive and intensive environmental studies sponsored by the Minerals Management Service in the 1970s (Hood and Zimmerman 1986) The IMS maintains a historic database of oceanographic measurements from the GOA, and it currently operates the R/V *Alpha Helix*, a 133-foot research vessel, for the National Science Foundation

Pollock Conservation Cooperative Research Center (PCC) School of Fisheries and Ocean Sciences (SFOS) The SFOS operates the PCC Research Center that was established in February 2000 and seeks to improve knowledge about the North Pacific Ocean and Bering Sea through research and education, focusing on the commercial fisheries of the Bering Sea and Aleutian Islands For the 2000 funding cycle, the PCC Research Center is especially interested in trying to improve knowledge through research and education relating to climate regime shifts and interannual variability in the Bering Sea ecosystem, the recovery of the Steller sea lion, including the identification of factors contributing to its decline, bycatch in the fisheries (for example, bycatch of salmon), and the impact of fishing activities on ecosystem dynamics and the diversity and abundance of target and non-target species Funding for the PCC Research Center is provided by members of the PCC, a fishing cooperative of companies that operate catcher/processors in the Bering Sea and Aleutian Islands pollock fishery

International Arctic Research Center (IARC) IARC promotes international collaboration in global change research in the arctic IARC and GEM share a number of common elements In the science plan for IARC, key elements are understanding the relative contributions of natural and manmade causes to climate change, understanding what to measure in order to detect changes, and predicting the impacts of change on humans The IARC Research Framework has eight themes, four of which are relevant to the GEM program 1) detection of contemporary changes, 2) arctic paleoclimatic and paleoenvironmental reconstructions, 3) impacts, consequences of change and education, and 4) integration of research on a regional scale

2 United States Government

a Department of Commerce

1) National Oceanic and Atmospheric Administration (NOAA)

National Marine Fisheries Service (NMFS) or "NOAA Fisheries" NMFS administers NOAA's programs that support the domestic and international conservation and management of living marine resources, including marine fisheries The Office of Protected Resources addresses marine mammals and endangered species and their habitats The Office of Habitat Conservation focuses on habitats for fishery resources and protected species and includes NOAA's Chesapeake Bay Program The Office of Science and Technology oversees NMFS' scientific research and technology development

Centers responsible for monitoring within NMFS are the Alaska Fisheries Science Center, Northwest Fisheries Science Center, Southwest Fisheries Science Center, and the Alaska Region Major programs include the triennial trawl surveys for groundfish (scheduled to become biennial in 2001), annual longline surveys primarily for sablefish and rockfish, and the Ocean Carrying Capacity program in the GOA with three cruises a year Salmon and rockfish genetic stock identification programs are conducted at Auke Bay Laboratory of the Alaska Fisheries Science Center in Juneau, Alaska Fishing vessel observer programs that collect biological information are conducted out of the Alaska Fisheries Science Center in Seattle

Marine mammal survey programs include the Cook Inlet marine drift and set gillnet observer program and the Cook Inlet beluga population survey Offshore killer whale surveys in the GOA are conducted by the Southwest Fisheries Science Center as part of a coast-wide program

NMFS, in conjunction with the states and other federal agencies (USGS and NIST), conducts the National Marine Mammal Health and Stranding Response Program, which collects and analyzes tissue samples from stranded marine mammals for histopathology, contaminants and disease NMFS also routinely observes fish sampled in resource surveys for the presence of tumors or lesions that may show high levels of contaminants in the environment Human uses of fisheries are monitored through the Fisheries Statistics and Economics Division, which maintains U S commercial and recreational fisheries statistical data, such as pounds and dollar value of commercial landings In the southeastern U S coastal states, NMFS cooperates with the Food and Drug Administration to conduct a Seafood Inspection Program that includes monitoring the level of toxic dinoflagellate, *Pfiesteria piscicida*, and related water quality properties that might pose a threat to human health and the ecosystem

NMFS partners with other federal and state agencies and academic institutions to support ecosystem programs Several of the programs collecting ecosystem information including data on physical and chemical oceanography, phytoplankton, zooplankton and forage fishes are the California Cooperative Fisheries Investigation (CalCoFI) off Southern California, the Marine Monitoring and Assessment Program (MARMAP) in the Northwest Atlantic, SEAMAP in the Southeast U S , and the Fisheries Oceanography Coordinated Investigations (FOCI, NOAA's OAR is also a partner) in the Gulf of Alaska and Bering Sea These programs furnish fundamental information on abundance and distribution of marine fish and invertebrates, and environmental changes which affect them

Office of Oceanic and Atmospheric Research (OAR) OAR consists of 12 laboratories nationwide The office's activities include a complex of geophysical, oceanographic and macrofauna monitoring and evaluation activities that involve NMFS and other NOAA personnel

The Pacific Marine Environmental Laboratory (PMEL) in Seattle focuses on coastal and open ocean observations and modeling to improving understanding of the physical and geochemical processes operating in the world oceans PMEL's fisheries oceanography program (FOCI), which is a collection of NOAA research programs attempting to understand the influence of environment on the abundance of various commercially valuable fish and shellfish stocks in Alaska waters and their role in the ecosystem, has a project in Shelikof Strait between Kodiak and the Alaska Peninsula This and other GOA monitoring projects are partnered with NMFS' Alaska Fisheries Science Center, under its Resource Assessment and Conservation Engineering (RACE) program PMEL also conducts retrospective fisheries and oceanographic studies and the rescue and dissemination of older data collected by PMEL scientists PMEL operates the El Niño-Southern Oscillation (ENSO) Observing System, which supports NOAA's climate prediction mission, primarily on seasonal to interannual time-scales NOAA's environmental satellite systems, with region and basin-wide observations of sea surface temperature and surface wind speed, are supplemented by the ENSO Observing System Seventy moorings in the tropical Pacific (called the Tropical Atmosphere-Ocean or TAO array) provide surface atmospheric and ocean mixed-layer observations Several hundred global Lagrangian drifting buoys in all the major ocean basins, a volunteer observing ships (VOS) expendable bathythermograph (XBT) program of about 40 commercial ships, and a network of tide gauges complete the ENSO system The resulting data are used to initialize climate models, verify model results, and monitor the evolution of the upper ocean

Other observing systems maintained by NOAA that are still in the developmental stage, include a shipboard thermosalinograph effort, the Trans-Pacific Profiler Network, consisting of ten profilers in the equatorial Pacific, a Pacific upper-air sounding network on islands and ships in the Pacific, the Pan American Climate Studies Sounding Network of enhanced atmospheric observations, an ocean carbon-ocean tracer hydrographic program to determine global distributions of key chemical, biological, and physical tracers, a submarine cable providing estimates of Florida Current transport, a Voluntary Observing Ship CO_2 program of semiautomated systems to monitor CO_2, an Atlantic Ocean pilot project (called PIRATA) of 12 buoys in the tropical Atlantic, and an Atlantic profiling float array to study processes important in establishing SST variability

Another of OAR's 12 labs, the Climate Diagnostics Center, holds the Comprehensive Ocean-Atmosphere Data Set (COADS) with surface marine data since 1854

OAR's Arctic Research Office partners with the University of Alaska Fairbanks to run the Cooperative Institute for Arctic Research (CIFAR) in Fairbanks Proposals are being solicited in FY 2001 for research on (1) climate variability and change in the Arctic, and (2) Bering Sea productivity These funds will be made available from the Department of Commerce/NOAA through the Arctic Research Initiative, which started in FY 97

National Ocean Service (NOS) This branch of NOAA is the Nation's principal advocate for coastal and ocean stewardship through partnerships, and supports the science and information needed for the proper balance between environment and economics In cooperation with the National Science Foundation, NOS supports oceanographic research in the GOA, providing about half the support for the Northeast Pacific subprogram of the US GLOBEC Substantial projects of the GLOBEC program are retrospective analyses and monitoring studies NOS oversees the newly established Kachemak Bay National Estuarine Research Reserve and its Kachemak Bay Ecological Characterization study The system of 25 estuarine reserves nationwide monitors physical, chemical and biological parameters in order to depict, track and forecast long-term changes and short-term variability in the resources of these areas NOS also conducts the National Status and Trends Program which measures levels of toxic contaminants, including trace metals, pesticides, petroleum hydrocarbons, and other toxic organic contaminants and their effects on fish and shellfish This national program currently includes GOA samples in the Mussel Watch contaminants project and formerly included the Benthic Surveillance Project in Alaska Specimens are held in the Specimen Banking Project at the National Institute of Standards and Technology (see NIST, below)

NOS conducts a number of projects nationally that do not have a presence in Alaska, but may be relevant to Alaska conditions or programs, and could be potential sources of funding for future efforts One example is NOAA's National Water Level Network along the nation's ocean and Great Lakes shorelines, which includes almost 200 continuously operating water level measurement systems At five extremely busy harbor entrances, NOS operates Physical Oceanographic Real-Time Systems (PORTS) These systems include acoustic Doppler current profilers with anemometers, packet radio transmission equipment, a data acquisition system and an information dissemination system

National Environmental Satellite, Data, and Information Service (NESDIS) NESDIS holds most of the historical information gathered by NOAA agencies and current satellite, oceanographic, and buoy data, global climatological data, and sea ice information Much of the information is stored at the National Oceanographic Data Center (NODC), the National Climate Data Center (NCDC), and the National Geophysical Data Center (NGDC) These three data centers cooperate with NASA, the National Weather Service, and many international agencies to provide global information such as sea surface temperature, wind speeds and vectors, biological productivity, salinity, absolute sea height, and other types of observations NODC is a major partner in the Global Ocean Observing System (GOOS)

NESDIS has a role in ensuring national security, since it serves as the operational and command authority for the Defense Department's Defense Meteorological Satellite Program NOAA's environmental satellite data are shared in near real-time through an agreement with the Department of Defense in support of the Air Force and the Navy's global and regional weather and ocean forecasting model prediction services During national emergencies (both military and natural hazards response), NOAA enhances local environmental satellite coverage through its polar orbiting satellites worldwide For emergencies affecting the western hemisphere, images from NOAA's geostationary satellites are enhanced

National Weather Service (NWS) NWS collects weather, hydrologic and climate data for coastal and ocean areas The National Data Buoy Center has over 100 buoys and several Coastal Marine Automated Network (C-MAN) shore-based stations, some of which are based in Alaska The center has real-time weather and oceanographic data and cooperates with NODC to provide historical monitoring data

2) National Institute of Standards and Technology (NIST)

The NIST cooperates with USGS, NMFS, and NOAA's Office of Protected Resources with the National Biomonitoring Specimen Bank

b U S Department of the Interior

Fish and Wildlife Service (USFWS) The Alaska Maritime National Wildlife Refuge (AMNWR) monitors ten seabird colonies annually, four of which are in the GOA The AMNWR also monitors other sites on a periodic basis largely dependent upon availability of funds

The Office of Subsistence Management is entering its second year of the Federal Subsistence Fishery Monitoring Program The program is directly administered by the Fishery Information Services Division, which consists of staff with expertise in both fisheries and social sciences, and funds studies that gather, analyze and report information needed for subsistence fisheries management on federal lands in Alaska Funded studies focus on three information types Traditional Ecological Knowledge, Subsistence Fishery Harvests, and Fishery Stock Status/Trends Most studies contribute to developing the capabilities and expertise of agencies, local communities and rural residents to participate in subsistence fishery resource management For purposes of management and research, Alaska federal subsistence fisheries have been grouped into 10 regions Each region has an Advisory Council consisting of local residents who represent the geographic and cultural diversity of that region In addition to providing recommendations on policies, Advisory Councils also identify study needs and make recommendations on project proposals for their region

Minerals Management Service (MMS) The MMS provides substantial support for projects related to the potential effects of oil and gas exploration and recovery that are largely conducted by other agencies and contractors Studies envelop a wide range of resources such as sediment quality, seabird monitoring, mapping of rip tides, Cook Inlet forage fish and others MMS has funded a varied range of project types for many years

U S Geological Survey (USGS) The Biological Research Division's (BRD) Alaska Biological Science Center maintains a seabird database and a pelagic seabird atlas BRD cooperates with many other projects from several agencies to obtain the contents of this database In addition, since the 1970s BRD has had an extensive seabird-monitoring project at Middleton Island, the Marine Biological Station BRD also is in the process of assembling the Pacific Seabird Monitoring Database The Alaska Marine Mammals Tissue Archival Project (AMMTAP) and the Seabird Tissue Archival Monitoring Project (STAMP) are probably the most significant contaminants studies in Alaska

The Water Resources Division of the USGS in Alaska maintains the Cook Inlet Basin Study Unit, part of the National Water Quality Assessment program (NAWQA), which examines trends in water quality over a nine-year period Measurements are made to determine water chemistry in streams and aquifers, the quantity of suspended sediment and the quality of bottom sediments in streams, the variety and number of fish, benthic invertebrates and algae in streams, and the presence of contaminants in fish tissues The Water Resources Division also maintains a long time series of measurements of groundwater and freshwater runoff for various stations in Alaska

The Geologic Division has the capability to produce high-resolution maps of the sea floor through its Marine and Coastal Geology Program in Menlo Park, California c National Science Foundation (NSF)

The National Science Foundation is a quasi-independent U S government agency supporting science and engineering programs worth over $3 3 billion per year Program areas of potential interest to GEM are Polar Research, Geosciences, and Biology NSF also contributes funding for GLOBEC, FOCI and other projects of interest to GEM

Technology, instrument development, and infrastructure have been funded by NSF over the last several years The ALVIN submersible, the best known and one of many ocean observing instruments sponsored by NSF, is continually upgraded to provide state-of-the-art, long times-series, deep ocean observations

Three observatories the Hawaii Undersea Geo-Observatory (HUGO)-automated submarine volcano observatory, the Hawaii-2 Observatory (H2O)-broad-band seismometer, and the Long-term Ecosystem Observatory (LEO-15)-broad array of sensing systems are currently involved in technological developments

A fiber optic cable connecting a series of sea floor nodes capable of supporting real-time transmission of data and images from hundreds of instruments is a design concept being pursued with the National Ocean Partnership Program (NOPP) Another program initiated in 1996 by NSF was Deep Earth Observatories on the Seafloor (DEOS) for observations beyond the reach of fiber optic cables

A five-year look at the global density and property field of the ocean was obtained from the World Ocean Circulation Experiment (WOCE) Numerous hydrographic sections were repeated during the experiment at regular intervals to address overall structure, meridional overturning, and transport through particularly important "choke points "

The Atlantic Climate and Circulation Experiment (ACCE), a study conducted during WOCE between Greenland and latitudes below the equator using independent subsurface profiling floats, is the model for the Array for Real-time Geostrophic Oceanography (ARGO) Early in the next decade ARGO will furnish a major portion of the database for the Global Ocean Data Assimilation Experiment (GODAE)

The large number of independent floats released under ARGO, supported by NSF, is planned as a part of the long-term climate research program In addition to ARGO, Global Eulerian Observations (GEO) will provide diagnostic and verification of the Lagrangian measurements, greatly decreasing their uncertainties, and lead to more accurate portrait of global heat fluxes

In 1977, the Oceanic Flux Program (OFP), the first continuous time-series particle flux in the deep ocean was inaugurated at Hydrostation S The observation that the particulate flux to depth was not constant but seasonally dependent on the plankton production cycle amazed the oceanographic community

In 1988, as a part of U S JGOFS, several stations in the North Pacific, North Atlantic and near Bermunda, were funded by NSF to collect (oceanic time-series) to provide a greater understanding of the oceans' role in global and climate change The stations in the North Pacific and near Bermuda have become prototypes for other national and international oceanic time-series observatories

The principle goal of the Carbon Retention In A Colored Ocean Program (CARIACO), instituted in 1995, was studying the relationship between surface biogeochemical processes and the fluxes of carbon and nutrients in a continental margin setting influenced by seasonal upwelling

The U S GLOBEC Northwest Atlantic-Georges Bank Program is intended to assimilate the population dynamics of major species on the Bank in terms of their relationship to the physical environment, predators and prey The ultimate goal is to be able to forecast changes in the distribution and abundance of these species as a result of changes in their physical and biotic environment as well as to predict how their populations might respond to climate change Continuing observations will be essential in the foreseeable future A similar U S GLOBEC Northeast Pacific Program (NEP) has initiated a study of the effects of past and present climate variability on the population ecology and population dynamics of marine biota and living marine resources

NSF has funded studies of existing ocean and coastal data sets, including the Continuous Plankton Recorder Surveys and the California Cooperative Fisheries Investigations (CalCoFI) NSF has also helped to sponsor a series of workshops to gather all the historical data surrounding major fish stock explosions and crashes, subjecting them to extensive modeling exercises in an effort to prove or disprove the many speculative hypotheses established to explain them

For several years studies in the Great Barrier Reef have focused on coral and algae, as have the ecology of reefs in relation to El Niño events in the eastern tropical Pacific, rocky shore sites along Northern Massachusetts and the outer coast of Washington State These studies were expanded to include Long-Term Ecological Research (LTER) in Land/Ocean Margin Ecosystems The network includes freshwater and tidal forcings and geomorphology, watershed land-use types, and aquatic and terrestrial biogeographic provinces and climatic regions These programs have been useful in measuring coastal ecological system responses to ENSO and other long-term climactic variability

Comprehending the causal linkages and covariations among the physical, chemical, and biological components of mid-ocean ridge volcanic and hydrothermal systems, and the long-term temporal evolution of these systems is an important aspect to a number of on-going and planned programs Six areas are involved in the programs three on the Juan de Fuca Ridge in the northeast Pacific Ocean, one on the East Pacific Rise off southern Mexico, one on the East Pacific Rise off northern Peru, and one on the Mid-Atlantic Rise south of the Azores Through repeat visits, the programs involve long-term temporal observations and could evolve into permanent, real-time observatories in the future

The Earth's climate system varies on time scales greater than the instrumental record, from the major changes of glacial/interglacial cycles to the recently-identified millenial cycles of the North Atlantic and the decadal oscillations of the North Pacific Capturing the full natural variability of the system, requires highly-resolved records spanning hundreds or even thousands of years Preservation of these "paleo" time-series are recorded in oceanic sediments and other geo-archives such as massive corals

Future focus

1) Global system of tropical-subtropical coral records of sea-surface temperature at seasonal resolution spanning the last 200 years, to identify decadal variability in each region, and to

ascertain relationships (if any) between regions For example, the interaction of the ENSO cycle with that of the North Atlantic Oscillation, or with that of the Indian monsoon

2) Explore signs of century-millenial cycles outisde the North Atlantic, and review dating of such events to determine global linkages For example, are the North Atlantic events a cause or a consequence of variations in the Southern Ocean?

d U S Environmental Protection Agency (EPA)

The mission of the Environmental Protection Agency is to protect human health and to safeguard the air, water, and land of the nation Of particular interest to the GEM program is the EPA's Environmental Monitoring and Assessment Program (EMAP), which seeks to fulfill a national mission that is very similar to some elements of GEM's regional charge The purposes of the EMAP program are to provide a comprehensive report card on the status of the ecological resources nationwide and to detect trends in these resources In addition to having common concerns, the review of the design phase of EMAP by the National Research Council (NRC 1995) is also relevant to GEM EMAP is a partnership between EPA and NOAA for long-term, integrated monitoring, research, and assessment to ascertain the status of our nation's ecological resources EMAP's purpose is to develop the scientific understanding for translating environmental monitoring data from multiple spatial and temporal scales into assessments of ecological condition and forecasts of the future risks to the sustainability of our natural resources This data supports the National Environmental Monitoring Initiative of the Committee on Environment and Natural Resources EMAP implements monitoring programs that operate on regional scales, highlighting different ecological resource categories, over periods of several years, including five monitoring activities (1) completion of the Mid-Atlantic Integrated Assessment Geographic Initiative, (2) initiation of the Western Pilot Geographic Initiative, (3) planning for a National Coastal Survey, (4) developing probabilistic coastal monitoring in all coastal states, and (5) establishment of an interagency (EPA, NOAA and NASA) effort to develop an intensive coastal site network of monitoring and research locations throughout the United States

EPA also issues National Pollution Discharge Elimination System (NPDES) permits, which typically require that the permittee monitor discharges Permittees include the Alyeska Marine Terminal in Valdez, seafood processors, hatcheries and logging companies EPA also maintains a list of hazardous waste handlers under the Resource Conservation and Recovery Act (RCRA) and may require that the handlers monitor certain aspects of their activities The RCRA list is based on those who report the handling of hazardous wastes through, for example, storage or transport EPA also monitors Superfund sites

EPA research laboratories and program offices support several coastal ocean observation studies Additionally some federal, state and local governments, and private entities' projects fall under EPA's jurisdiction

EPA maintains observations to ensure compliance with legislative mandates and regulatory requirements Protection of marine ecosystems from the adverse effects of the disposal of dredged materials and treated wastewater encouraged development of Ocean Dumping and Ocean Discharge Programs Possible impacts include problems associated with eutrophication, pathogens and toxics that result in adverse effect on human health and biological integrity of the coastal waters, as well as habitat modification and loss Data includes the quality of dredged materials or treated wastewater, and the physical, chemical, and biological circumstances of the marine environment surrounding the disposal or discharge area

States are required by the National Water Quality Inventory to report water quality conditions to EPA for inclusion in the National Water Quality Inventory Reports to Congress The water quality includes physical, chemical, and biological conditions, and is processed according to monitoring results of the water quality of waters, including estuarine and coastal waters

The National Estuary Program (NEP) was founded by Congress to restore and preserve estuaries, the program currently includes 28 estuaries that represent 42% of the shoreline of the continental U S These programs are in various stages of development Each individual estuary program inventories existing Federal, State, local and volunteer monitoring programs in their area and combines pertinent details from these on-going activities into their own monitoring plans according to EPA guidance Each NEP is developing its own database management system

The Chesapeake Bay Program established in 1984 by the Chesapeake Bay Executive Council, is a Bay-wide EPA/state joint effort The program is made up of over 165 stations below the fall line, and combines the efforts of Maryland, Pennsylvania, Virginia, the District of Columbia, several federal agencies, 10 institutions, and over 30 scientists Nineteen physical, chemical, and biological characteristics are monitored 20 times a year in the main stem of the bay and its many tributaries A volunteer citizen monitoring program was started in 1985

The Great Lakes National Program combines several Federal, state, tribal, local, and industry partners in an integrated, ecosystem approach to protect, maintain, and restore the chemical, biological, and physical integrity of the Great Lakes The program monitors Lake ecosystem data, manages and provides public access to Great Lakes data, and helps communities address contaminated sediments in their harbors

The Gulf of Mexico Program is made up of many State and local monitoring projects An integrated coastal monitoring and assessment program for the Gulf of Mexico is currently being designed, with four main focus areas excessive nutrient enrichment, public health associated with seafood consumption and recreational use, habitat loss, and non-indigenous species introduction

The Clean Water Action Plan, a new initiative, is an ambitious multi-agency proposal to speed the restoration of our nation's waterways One important component is development of a Coastal Research Strategy involving integrated studies of coastal waters and a public report on the condition of the nation's coastal waters in 2000

e U S Department of Agriculture (USDA)

<u>U S Forest Service</u> (USFS)--The U S Forest Service has substantial responsibility for controlling and directing the impacts of human uses The USFS conducts occasional surveys of recreational use in PWS These surveys are not conducted on a regular basis and are therefore not intended to serve as a long-term monitoring instrument The USFS also reports on use of campgrounds, visitor centers and other facilities operated by the agency in the GOA region The Forest Service has extensive experience in watershed analysis and planning for ecosystem-based management Extensive experience in developing scientific information relevant to balancing multiple uses of public lands and waters is available for planning monitoring and research

f U S Department of the Navy

Ocean observations collected by the U S Navy were originally developed around two objectives due to national security reasons (1) Up-to-date forecasts for open ocean waves, weather and ice flow patterns for the safety of fleet operations, and (2) the Cold War requirement for open-ocean temperature, salinity and sound velocity measurements to support sonar performance in the tracking of Soviet ballistic-missile submarines The national security-supported ocean observation system has, therefore, included heavy emphasis on open-ocean temperature, salinity, winds and ice observations Several elements included in that system are expendable temperature probes, used by navy ships and aircraft to take bathyermograph (XBT) measurements around the globe during fleet operations using probes that measure temperature with water depth as the probe falls through the water column and satellite temperatures of the sea surface taken by infrared satellite sensors

National security requires real-time global data and the Navy acts as a national Core Processing Center for sea surface temperature (SST) data from various satellites and disseminates the data to civil and military users worldwide Other types of satellite measurements are used in remote areas where ship and buoy measurements are not readily available Satellite altimetry measures the height of the sea surface roughness to infer winds Products include sea-surface topography, currents, eddies, wave heights, and surface wind-speed and direction

Drifting buoys are deployed yearly by the Navy with hourly feedback via satellite They measure surface atmospheric pressure, air and sea surface temperature, winds and wave, and surface currents, that provide excellent "ground-truth" for satellite observations, as well as water temperature with depth, and "ambient" (background) noise levels that support Nave sonar operations

The National Ice Center receives information from the Navy, NOAA, and the Coast Guard on global, regional, and local sea-ice analyses and forecasts, including ice edge, concentration, drift and thickness, for military and civil users Ice observations come from U S and European satellites, U S and Canadian ice reconnaissance flights, and from specially instrumented buoys placed each year through the Arctic ice

A dedicated fleet of Navy ships has collected the following data for years water depth, bottom type, tides and currents or "hydrographic" data in coastal areas worldwide to improve and update nautical charts, deepwater bathymetry (water depth) and gravity measurements to support strategic submarine operations, physical oceanography (temperature, salinity, sound velocity), ambient noise, seafloor structure and sediment type to support sonar performance and acoustic surveillance arrays, and a wide range of other observations (water clarity, bioluminesence, currents, magnetics) that affect naval operations

The Navy's national security needs for ocean data are now focused not only in the open ocean but also increasingly on the coastal waters of the world They are a significant supporter of a national academic research fleet, funding both worldwide basic ocean observations and applied research projects Data from the open ocean through coastal waters, the surf zone, and over the beach are all required to sustain modern naval operations Because of the greater variability, shallow coastal waters require more observations in time and space Of particular interest are water depth, sea surface temperature and temperature at depth, bottom type, waves, tides, currents, and coastal ambient (or background) noise While the main national security requirements for coastal ocean observations are in sensitive areas overseas, the diversity of environments in U S coastal waters provides many analogues of coastal systems overseas For this reason, national security needs must play a significant role in design of the coastal observing system Navy home-porting, and coastal training, test and exercise functions in U S waters require expanded observations

g U S Department of Transportation

U S Coast Guard (USCG)-- USCG ocean data buoys take synoptic meteorological and oceanographic measurements for both the National Data Buoy Center and the National Ice Center They also provide a number of other ocean or lake observations The USCG operates a Vessel Traffic Service (VTS) for nine United States coastal ports Each VTS is a service of active waterways management using advanced technology such as radar, closed circuit TV, differential GPS (DGPS), and VHF-FM radio communications In addition, the VTS also receives information from various sources on predicted vessel movements, hazards to navigation, aids to navigation discrepancies, and other information of interest to VTS users The VTS involves individuals off the vessel that receive, process, and communicate information related to the safe navigation of a waterway with a primary focus of public safety and protection of the environment This information is communicated in general public advisories or in the form of specific recommendations to assist a vessel in avoiding hazardous conditions early on VTS does not usually interfere with the vessel's sailing route

Sea ice and icebergs are monitored by the International Ice Patrol (IIP), which is supported by 17 member nations and operates in the North Atlantic under the provisions of the U S Code and the International Convention for Safety of Life at Sea (SOLAS) It monitors iceberg danger near the Grand Banks of Newfoundland during the ice season, and advises ships of safe and efficient navigation routes The USCG International Ice Patrol sets drifting buoys for the use of iceberg/sea ice prediction The observations of position and sea surface temperature are reported via satellite eight times per day The IIP obtains water temperature profiles from AXBTs deployed by Coast Guard aircraft and sea surface temperature data made available by commercial ships These data are sent to the Navy The National Ice Center provides sea-ice analyses and forecasts using data from satellites, aircraft reconnaissance flights, and arctic buoys received from the USCG, NOAA and the Navy USCG Polar icebreakers provide a number of oceanographic observations in the Arctic and Antarctic to Navy, NIMA, and/or NOAA databases The reports include ocean temperature, salinity, bathymetry, and marine mammal data

USCG cutters send weather information to the Navy and NOAA Coast Guard stations also send meteorological data to NOAA for use in analyses and forecasts

h U S Department of Energy (DOE)

The Department of Energy, Biological and Environmental Research (DOE-BER) is funding peer-reviewed research in marine biology and oceanography relating to the impact of anthropogenic CO2 on global warming DOE also encourages technological developments that support new global ocean observational capabilities Examples of specific programs include

- Marine Biotechnology - the application of the tools of modern molecular biology to linkages of carbon and nitrogen cycles
- Synthesis of Global CO2 Data (with NOAA) - development of tools and models to synthesize the existing data set on ocean CO2, and related parameters

- Quality Assurance of CO2 Survey Data - QA/QC and dissemination of CO2 data through the Carbon Dioxide Information Analysis Center
- Carbon Sequestration in the Ocean - establishment of center(s) of excellence as part of the Climate Change Technology Initiative

i National Aeronautics and Space Administration (NASA)

NASA's Earth Science Enterprise remote sensing missions provide a wealth of information that support ocean programs at a fundamental level Regarding sea level, the TOPEX/Poseidon and Jason-1 altimetry missions will provide high quality sea level estimates for interpretation in climate studies Sea surface height (SSH) data provide information about the ocean geostrophic flow-field near surface and when assimilated into an ocean circulation model, in the interior ocean as well SSH data also provide a measure of upper ocean heat and haline variability NASA and CNES have combined forces to build and operate altimetric missions for obtaining high accuracy SSH data since August 1992 Jason-1 will be the follow-on mission to TOPEX/Poseidon and is slated for launch in May 2000

Seawinds instruments on the QuikSCAT and ADEOS-II satellites provide estimates of vector wind over the ocean Wind stress is the primary mechanical forcing function of the ocean circulation Remote sensing observations of surface winds are the only way to assure a truly global coverage of wind data over the ocean and to assure that meteorological models provide high-quality wind-stress fields NASA launched its Seawinds scatterometer on the QuikSCAT mission in mid-1999 to provide 25-km resolution of vector surface winds over 90% of the ice-free ocean each day A second Seawinds instrument is slated for launch in late 2000 on the Japanese ADEOS-2 satellite

Sea surface temperature is now delivered operationally using a combination of AVHRR data from NOAA satellites and in situ data for calibration NASA's new technology delivering sea surface temperature includes the MODIS instrument on EOS AM and PM platforms and microwave (all-weather) temperatures from the NASA/NASDA Tropical Rainfall Measurement Mission

The concentration of chlorophyll in the upper ocean layer can be deduced from relatively small contrasts in ocean color While absolute calibration of such contrast measurements carried out with different instruments may be a challenge, easily observable fast space-time variations provide valuable insight into the dynamics of primary production and the processes that control it Such ocean color measurements will be provided more or less systematically by a number of satellite missions and operational programs, including NASA/SeaWiFS, ESA/ENVISAT, NASDA/ADEOS-2, NASA/EOS AM-1 and PM-1, and eventually NPOESS (beginning around 2009)

The Gravity Recovery and Climate Experiment (GRACE) satellite is slated for launch in March 2001 It will provide a high accuracy measurement of the time varying gravity field Knowledge of the marine geoid is fundamental for using altimeter data to study the absolute ocean currents This mission also provides information about variable deep ocean currents which is complimentary to that obtained from altimetry

NASA is currently developing the technology to remotely sense the ocean surface salinity from low earth orbit The scientific issues are discussed in a report of the Salinity and Sea Ice Working Group

Sea-ice concentrations (percent areal coverages) to a resolution on the order of 30km have been obtainable from satellites since the early 1970's using passive microwave radiometer technology The record from the early and mid 1970's contains many large data gaps, but since Oct 1978 is reasonably complete in terms of obtaining a consistent global sea ice coverage dataset every 1-3 days This record demonstrates significant seasonal and interannual variability in the sea-ice cover and its dynamics This dataset is currently being continued with the DMSP Special Sensor Microwave/Imager (SSM/I) and will be further continued with the Advance Microwave Scanning Radiometer (AMSR) on both the EOS-PM platform and the Japanese ADEOS-II platform, both scheduled for launch in the year 2000

j Partnerships

National Ice Center (NIC) The National Ice Center is a multi-agency operational center partnered by the Department of Defense (Navy--Naval Ice Center), the Department of Commerce (NOAA—National Weather Service and National Environmental Satellite Data Information Service), and the Department of Transportation (U S Coast Guard) NIC ice data are a key part of the U S contribution to international global climate and ocean observing systems

National Oceanographic Partnership Program (NOPP) NOPP is a legislatively-mandated collaboration of 12 U S government agencies designed to promote cooperative activities among government, academia, and industry for the advancement of ocean science, technology and education The Program is chaired by top-ranking officials from the U S Navy, NSF, Department of Energy, U S Coast Guard, Defense Advanced Research Projects Agency, NOAA, NASA, EPA, USGS, MMS, and the Office of Management and Budget NOPP is preparing The Ocean Observations Task Team report "An Integrated Ocean Observing System A Strategy for Implementing the First Steps of a U S Plan" NOPP has agreed to be a partner with the Alfred P Sloan Foundation to help implement the Census of Marine Life (CoML) and specific studies that are relevant to the common research interests and goals of the CoML and the U S oceanographic agencies

U S Arctic Research Commission (USARC) The U S Arctic Research Commission was established by Congress under the Arctic Research and Policy Act of 1984 to promote Arctic research, develop national research plans, and facilitate interagency coordination within the federal government and state and local governments in Arctic research The Commission is composed of seven members appointed by the President plus the director of the National Science Foundation USARC has produced its set of research priorities for FY 2001 that includes a renewed emphasis on the Bering Sea and a call for increased efforts dealing with climate change in the Arctic Under the Arctic Council, the U S has taken the lead role in the preparation of an Arctic Climate Impact Assessment (ACIA), to be prepared by experts from all of the arctic countries and other countries with arctic interests

3 Nongovernmental Organizations

Regional Citizens Advisory Council (RCAC) bodies were established following the 1989 *Exxon Valdez* oil spill under the federal Oil Pollution Act of 1990 (OPA 90) The act established, among other things, demonstration programs to involve local citizens in overseeing the environmental impact of oil terminals and tanker operations in two locations, Cook Inlet and PWS

The Cook Inlet Regional Citizens Advisory Council (CIRCAC) monitors the environmental impacts of terminals and tankers in Cook Inlet The CIRCAC's environmental monitoring program includes studies of sediment chemistry, hydrocarbon accumulation, sediment toxicity and ballast water issues

The PWS Regional Citizens Advisory Council (PWSRCAC) has conducted an environmental monitoring program for the past six years The Long-Term Environmental Monitoring Project monitors nine sites in PWS and the GOA for hydrocarbons in the water, sediment and mussels The data provide a benchmark for assessing the impacts of oil transportation and future oil spills The study discriminates among hydrocarbons resulting from biological processes (Mathisen 1972), combustion sources (pyrogenic) and petroleum products or residues from natural coal deposits (petrogenic) The PWSRCAC has also studied the risk of invasion by non-indigenous species through the discharge of ballast water, control of tanker loading vapors, ballast water influent at the Valdez Marine Terminal, and the use of caged mussels to monitor effluent from the Alyeska Ballast Water Treatment Facility

Cook Inlet Keeper is a nonprofit group dedicated to protecting Cook Inlet's watershed The Lower Kenai Peninsula Watershed Health Project monitors four high value salmon streams with increasing human use This group also trains volunteers to monitor water quality at many sites in the Cook Inlet watershed Currently, monitoring sites are established around Kenai, Homer and Anchor Point Parameters measured are temperature, pH, dissolved oxygen, salinity, turbidity, conductance, bacteria, oxidation-reduction potential, macroinvertebrates, ortho-phosphate, apparent color and nitrate-nitrogen

Anchorage Waterway Council (AWC) is a nonprofit organization whose membership reside in the Municipality of Anchorage and believe that Anchorage's waterways and related habitats are a valuable resource AWC focuses on waterways within the Municipality of Anchorage and intends to prohibit further degradation They seek to enhance the waterways through public outreach and education, ensuring safe and productive aquatic and riparian habitat for fish, wildlife, and monitoring activities that affect the Municipality's waterways

Kenai River Sportfishing Association (KRSA) is a nonprofit organization that provides financial support for riparian zone habitat conservation and rehabilitation KRSA works in cooperation with other organizations, such as state and federal land and fisheries management agencies, and volunteers to stabilize and revegetate banks eroded by human recreational use and housing development KRSA has also been instrumental in widespread installation of riverfront walkways on public and private property The walkways are constructed of open metal bar screen that allows riparian plants to grow for bank stabilization, while preventing erosion from trampling by humans and providing access for recreation

Prince William Sound Science Center (PWSSC) is an independent, non-profit organization devoted to implementing an ecosystem approach to research, monitoring and management of natural resources The Science Center played an important role in implementation of the Trustee Council's ecosystem study, the Sound Ecosystem Assessment (SEA) (Section IV A 2) The Center's research interests, its history of ecosystem research, and its location in Cordova in southeastern Prince William Sound make it a strategic venue for GEM implementation

Prince William Sound Oil Spill Recovery Institute (OSRI) was authorized by the United States Congress through Section 5001 of the Oil Pollution Act of 1990 (OPA 90) and through amendments included in the Coast Guard Authorization Act of 1996 The institutional goals of OSRI and GEM coincide to the extent that both recognize long-range monitoring programs as essential to assess and understand the long-range effects of Arctic or subarctic oil spills on the natural resources of Prince William Sound and its adjacent waters

Census of Marine Life (CoML) is being developed as a decade-long program to promote and fund research assessing and explaining the diversity, distribution, and abundance of species in the world oceans Related activities integral to this research include the design and implementation of innovative biological sampling techniques for the marine environment Consultations and workshops during 1997-1998, largely funded by the Alfred P Sloan Foundation (New York City), explored the potential benefits, issues (technical, scientific, and social), and limits of a marine Census A broad set of precepts for the Census of Marine Life has been prepared An international Steering Committee fosters development of coherent goals and a scientific plan for the CoML A report on the goals and plan for the Census of Marine Life should be issued in the summer of 2000

Consortium for Oceanographic Research and Education (CORE) (Finney 1998) promotes, encourages, develops, and supports efforts to advance knowledge and learning in the science of oceanography and to disseminate such knowledge to the scientific community and to the public It serves as a coordinating body for more than 50 marine-related institutions in the United States, including universities, governmental laboratories, and non-profit aquaria CORE is the base for the International Steering Committee for the Census of Marine Life and the Secretariat, which the Steering Committee guides CORE also acts as the Program Office for the National Oceanographic Partnership program, NOPP

M J Murdock Charitable Trust, Partners in Science Program sponsors high school science teachers participation in research with scientists during two summers

Partnership for the Interdisciplinary Study of Coastal Oceans (PISCO) is a long-term ecological consortium that consists of four universities (Oregon State University, UC Santa Cruz, Stanford University, and UC Santa Barbara) investigating the physical and biological processes of the nearshore region along the Oregon and California coasts The David and Lucile Packard Foundation originally funded PISCO to provide a new model for solving environmental problems faced by our seas

The North Pacific Universities Marine Mammal Research Consortium (MMRC) was formed with four participating institutions the University of Alaska, the University of British Columbia, the University of Washington, and Oregon State University The mission of the Consortium is to undertake a long-term program of research on the relation between fisheries and marine mammals in the North Pacific Ocean and Eastern Bering Sea Studies will focus initially on the biology of the Steller sea lion and could include research on the effects of species interactions and oceanographic conditions on changes in sea lion abundance

The National Outdoor Leadership School (NOLS) was founded in 1965 and is the leader in wilderness education NOLS is the largest backcountry permit holder in the United States and offers courses on four other continents NOLS is committed to the quality of courses and programs offered in the wilderness environment that serves as its classroom

The Alaska Native Harbor Seal Commission's (ANHSC) mission is conserving and sustaining the harbor seal for the cultural well-being of the Native community Through funding from the EVOS Trustee Council, it gathers biological samples from harbor seals harvested by Native hunters and makes them available to researchers

4 Transboundary Organizations

Transboundary organizations coordinate information-gathering across national, provincial and state boundaries As a result of transboundary conventions addressing fishery management, pollution control, and other matters of concern in the North Pacific, multinational and interstate management institutions have been in place for most of the twentieth century These institutions have amassed some of the longest time series of biological observations in the North Pacific

The umbrella transboundary organization for the North Pacific, the North Pacific Marine Science Organization (PICES) (Welch and Batten 2000), was established in 1992 among Canada, People's Republic of China, Japan, Republic of Korea, Russian Federation, and the United States PICES coordinates North Pacific (above 30° N) marine information and research on topics such as the ocean environment, global weather and climate change, living resources and their ecosystems, and the impacts of human activities In order to facilitate the exchange of information, the PICES Technical Committee on Data Exchange has links to long time series on biological, physical, and chemical oceanography, fisheries, and meteorology and marine science organizations The long time series data set is a compilation of voluntary submissions from data sources and is therefore not exhaustive

The International Pacific Halibut Commission (IPHC) was the first multinational fishery management organization in the North Pacific, established by the United States and Canada in 1923 The IPHC annual survey provides a long time series of standardized catch of Pacific halibut and associated species The IPHC time series of research vessel surveys starts in 1925 It is a particularly valuable record of organisms associated with the benthos because of the scrutiny it has received as the basis for many peer reviewed publications over the years

The International Pacific Salmon Fishing Commission (IPSFC) (1937-1985) was established by the United States and Canada in 1937 to restore the sockeye salmon of Canada's Fraser River and to allocate the catches between nations The IPSFC and its successor, the Pacific Salmon Commission (PSC), have compiled a very long time series of annual Fraser River salmon production, augmented by substantial time series of estimated sockeye salmon productivity by year of spawning The PSC also has time series of annual harvest and exploitation rates for selected chinook salmon populations, as well as catch and other time series data for all salmon species

The International North Pacific Fisheries Commission (INPFC) (1952-1993, U S , Canada, Japan) and its successor, the North Pacific Anadromous Fish Commission (NPAFC) (1993 on), coordinate research and harvest of salmon and other anadromous species above latitude 33° N outside the 200-mile zones of the signatories Signatory nations are the United States, Canada, Japan and Russia and the cooperating nations are Poland, South Korea, and Taiwan The INPFC published long time series of catches for principal groundfish species, crab, shrimp and herring for the signatories and cooperating nations The INPFC statistical yearbooks (produced from 1952-1992) contain biological time series on groundfish, crabs, and marine mammals The NPAFC statistical yearbooks (produced from 1993-1995) are the definitive source for catch, weight and hatchery releases for salmon in the North Pacific, as well as principal groundfish species, crab, shrimp, and herring

The Arctic Monitoring and Assessment Programme (AMAP) is an international circumpolar program which seeks to monitor anthropogenic pollutants in all parts of the arctic environment Observations extend into the Bering Sea, but not into the GOA as yet At a meeting in Rovaniemi, Finland the nations of Canada, Denmark/Greenland, Iceland, Norway, Sweden, the Soviet Union, and the United States entered into the "Rovaniemi process" to promote arctic environmental protection. The "Rovaniemi process" produced a series of "State of the Arctic Environment" reports on potential pollutants in different parts of the arctic environment and its ecosystems in 1991. The First Arctic Ministerial Conference in Rovaniemi, Finland (Cuenco et al. 1993) established international cooperation for the protection of the arctic, and led to the adoption of the Arctic Environmental Protection Strategy (AEPS). The AMAP reports contain time series data on contaminants in the areas of interest. The policy body for AMAP is the Arctic Council.

The Pacific States Marine Fisheries Commission (PSMFC) is an interstate organization created by the U.S. Congress in 1947 to coordinate fisheries issues among California, Oregon, Washington, Idaho, and Alaska. The PSMFC Regional Mark Processing Center is the keeper of the salmon coded wire tag data base, an authoritative source for time series observations on distribution of ocean catches from California to Alaska, including Canada, since 1972.

The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) was founded in 1982 as part of the Antarctic Treaty System, in response to concerns that an increase in krill catches in the Southern Ocean could have a serious effect on populations of krill and other marine life, particularly on birds, seals and fish which mainly depend on krill for food.

The CCAMLR Ecosystem Monitoring Program (CEMP) is a scientific program intended to identify changes in condition, abundance and distribution of the animals within the convention area. Since it is not realistic to monitor all the animals and their interactions that make up the Antarctic marine ecosystem, species and parameters likely to be particularly sensitive to changes in food availability have been identified. Information obtained from monitoring these species is taken into account in determining the regulation of human activity so as to ensure that the conservation principles of the convention are being applied.

The parameters being studied fall into four categories: reproduction, growth and condition, feeding ecology and behavior, and abundance and distribution. Any changes found in the parameters will be because of changes either in food availability or environmental conditions. In order to identify the source of change, it is necessary to monitor krill abundance and distribution, and certain environmental parameters simultaneously with the monitoring of predators.

5. Global Climate Change Research

The United States is participating as part of a world-wide network dedicated to measuring and understanding global climate change. Global change research programs are valued in the billions of dollars, with state, national and international partners and cooperators. Four international oceanographic investigations on global climate change have elements relevant to the North Pacific. Global Ocean Ecosystems Dynamics (GLOBEC), World Ocean Circulation Experiment (WOCE), Joint Global Ocean Flux Study (JGOFS), and Global Ocean Observing System (GOOS) each rely on the personnel, facilities and finances of the nations and organizations that participate in the transboundary organizations described above.

GLOBEC is the global change program of the International Geosphere-Biosphere Programme (IGBP) of the International Council for Science. The IGBP provides an international, inter-disciplinary framework for the conduct of global change science. GLOBEC is an oceanography program that is examining a number of hypotheses that include a commercially harvested fish species, pink salmon. A key GLOBEC hypothesis is that rapid growth and high survival of pink salmon depend on cross-shelf import of large zooplankton from offshore to nearshore waters. GLOBEC is also collecting data on zooplankton species, including a copepod and several krill species Physical processes to be examined include stratification, cross-shelf-transport, downwelling and mesoscale circulation in the GOA Another part of IGBP is the Joint Global Ocean Flux Study (JGOFS), which is studying the role of the ocean in controlling climate change through the storage and transport of heat

The GOOS, organized by the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational Social and Cultural Organization (UNESCO), is to be a permanent global system for collecting data, modeling and analyzing marine and ocean processes worldwide Another IOC-sponsored program is the World Ocean Circulation Experiment (WOCE) under the auspices of the World Meteorological Association WOCE sponsors a large number of investigations directed at understanding the movement of water masses in the world's oceans, including the Pacific and North Pacific

C The Gulf of Alaska Ecosystem

The basic scientific information relevant to GEM crosses many disciplinary boundaries Although roughly organized into meteorology, oceanography and biology, naming these basic areas of scientific study does not exclude others Such disciplines as economics, fisheries, public administration, and many others also contribute to the very large body of scientific information relevant to GEM

Scientific observations for the scientific literature were first recorded in the GOA about 1741 Accounts of exploration in the mid-to-late 18th century were followed rapidly by the commercial records of exploitation starting in the late eighteenth century and continuing to present Records contributed by trained scientists accumulated steadily but slowly from 1741 until the end of the nineteenth century Efforts to apply science to management of exploited wild animal populations, especially fur seals and salmon, started in the late nineteenth century The original observations were formal descriptions and nomenclature for marine mammals and salmon, followed by physical oceanography and cartography

Given the long time span and diversity of available information, it is fortunate that summaries are available in three key reviews (Francis et al 1998,Hood and Zimmerman 1986,Rosenburg 1972) Rosenburg (1972) presents the status of knowledge up to 1970 Hood and Zimmerman (1986) summarize much of the very large volume of scientific data collected in relation to oil and gas exploration during the decade ending about 1982 Efforts to synthesize and focus multidisciplinary data to explain changes in production of birds, fish and mammals are addressed by Francis et al (1998) A fourth source provides a brief review of the most recent work on linkages between meteorology, oceanography and biology in the North Pacific Ocean (Welch and Batten 2000)

Based on the key reviews and the most recently published literature, the following is a synopsis of biological and geophysical aspects of the northern GOA ecosystem, beginning with the geological features that define the oceanic and coastal regimes Next, ocean circulation and how it affects nutrient recycling is described Finally, the physical and chemical processes that set the bounds for productivity and control the transport of organic matter are discussed This sets the stage for the conceptual foundation that is described in the following section

1 The Gulf of Alaska

The GOA encompasses watersheds and waters south and east of the Alaska Peninsula from Great Sitkin Island (176° W), north of 52° N to the Canadian mainland on Queen Charlotte Sound (127°

30' W) Twelve and a half percent of the continental shelf of the U S lies within GOA waters (Hood 1986)

The area of the GOA directly affected by the *Exxon Valdez* oil spill (Figure 2) encompasses a broad diversity of terrestrial and aquatic environments Within terrestrial, freshwater, estuarine, nearshore marine, and offshore marine environments, geological, climatic, oceanographic, and biological processes interact to produce the highly valued natural beauty and bounty of this region

Human uses of the GOA are extensive The GOA is a major source of food and recreation for the entire nation, a source of traditional foods and culture for indigenous peoples, and a source of food and enjoyment for all Alaskans Serving as one of the "lungs" of the planet, GOA resources are part of the process that provides oxygen to the atmosphere In addition, the GOA provides habitat for diverse populations of plants, fish and wildlife and it is a source of beauty and inspiration to those who love natural things

a Terrestrial Boundaries

The eastern boundary of the GOA is a geologically young, tectonically active area that contains the world's third largest permanent ice field, after Greenland and Antarctica (Figure 3) Consequently, the watersheds of the eastern boundary of the GOA lie in a series of steep, high mountain ranges Glaciers head many watersheds in this area, and the eastern boundary mountains trap weather systems from the west to largely define the climate of the GOA From the southeastern GOA limit (52° N at landfall) moving north, the eastern GOA headwater mountain ranges and height of the highest peaks are the Pacific Coast (10,290 ft), St Elias (18,000 ft), and Wrangell (16,390 ft) Northern boundary mountain ranges from east to west are the Chugach (13,176 ft), Talkeetna (8,800 ft) and Alaska (20,320 ft) The western boundary of the GOA headwaters is formed in the north by the Alaska Range and to the south-southwest by the Aleutian Mountains (7,585 ft)

Relatively few major river systems manage to pierce the eastern boundary mountains, although thousands of small independent drainages dot the eastern coast line and islands of the Inside Passage Major eastern rivers from the south moving north to the perimeter of PWS are the Skeena and Nass (Canada), the Stikine, Taku, Chilkat, Chilkoot, Alsek, Situk, and Copper All major and nearly all smaller watersheds in the GOA region support anadromous fish species For example, although PWS proper has no major river systems, it does have over 800 independent drainages that are known to support anadromous fish species

To the west of PWS lie the major rivers of Cook Inlet Two major tributaries of Cook Inlet, the Kenai and the Kasilof, originate on the Kenai Peninsula The Kenai Peninsula lies between PWS, the northern GOA and Cook Inlet Cook Inlet's largest northern tributary, the Susitna River, has headwaters in the Alaska Range on the slopes of North America's highest peak, Mt McKinley Moving southwest down the Alaska Peninsula, there are only two major river systems on the western coastal boundary of the GOA, the Crescent and the Chignik, although many small coastal watersheds connected to the GOA abound Kodiak Island, off the coast of the Alaska Peninsula, has a number of relatively large river systems, including the Karluk, the Red, and the Frazer

The nature of the terrestrial boundaries of the GOA is important in defining the processes that drive biological production in all environments As described in more detail below, the ice cap and the eastern boundary mountains create substantial freshwater runoff that controls salinity in the nearshore GOA and helps drive the eastern boundary current The eastern mountains slow the pace of and deflect weather systems that influence productivity in freshwater and marine environments

b Coastal Boundaries

The GOA shoreline is bordered by a continental shelf ranging to 200 meters in depth (Figure 3) Extensive and spectacular shoreline has been and is being shaped by plate tectonics and massive glacial activity (Hampton et al 1987) In the eastern GOA, the shelf is variable in width from Cape Spencer to Middleton Island It broadens considerably in the north between Middleton Island and the Shumagin Islands and narrows again through the Aleutian Islands The continental slope, down to 2000 meters, is very broad in the eastern GOA, but it narrows steadily southwestward of Kodiak, becoming only a narrow shoulder above the wall of the deep Aleutian Trench just west of Unimak Pass The continental shelf is incised by extensive valleys or canyons that may be important in cross-shelf water movement (Carlson et al 1982), and by very large areas of drowned glacial moraines and slumped sediments (Molnia 1981)

c Marine-Terrestrial Linkages

The role of marine inputs to the watershed phase of regional biogeochemical cycles has been recognized for some time (Mathisen 1972) Marine nutrients are transported to watersheds by anadromous species, such as salmon (Kline Jr et al 1993, Ben-David et al 1998a), by marine feeding land animals, such as river otters (Ben-David et al 1998b) and coastal mink (Ben-David et al 1997a), and by such opportunistic scavengers as riverine mink (Ben-David et al 1997a), wolf (Szepanski et al 1999) and martens (Ben-David et al 1997b) In theory, any terrestrial bird or mammal species that feeds in the marine environment, such as harlequin duck or black-tailed deer, is a pathway to the watersheds for marine nutrients Species that transport marine nutrients play important roles in supporting a wide diversity of other fauna and flora, as determined from levels of marine nitrogen in juvenile fish, invertebrates, and aquatic and riparian plants (Bilby et al 1996, Piorkowski 1995, Ben-David et al 1998a, 1998b) In studies of a small Alaska stream containing chinook salmon, Piorkowski (1995) supported the hypothesis that salmon carcasses can be important in structuring aquatic food webs In particular, microbial composition and diversity determines the ability of the stream ecosystem to utilize nutrients from salmon carcasses, a principal source of marine nitrogen

The role of marine nutrients in watersheds is key to understanding the relative importance of climate and human-induced changes in population levels of birds, fish and mammals Indeed, losses of basic habitat productivity due to low numbers of salmon entering a watershed (Kline Jr et al 1993, Mathisen 1972, Piorkowski 1995) may be confused with the effects of fisheries interceptions or marine climate trends Comparison of anadromous fish-bearing streams to non-anadromous streams has demonstrated differences in productivities related to marine nutrient cycling Import of marine nutrients and food energy to the lotic ecosystem may be retarded in systems that have been denuded of salmon for any length of time (Piorkowski 1995)

Paleoecological studies in watersheds bearing anadromous species can shed light on long-term trends in marine productivity Use of marine nitrogen in sediment cores from freshwater spawning and rearing areas to reconstruct prehistoric abundance of salmon offers some insights into long-term trends in climate, and into how to separate the effects of climate from human impacts such as fishing and habitat degradation (Finney 1998)

Watershed studies linking the freshwater and marine portions of the regional ecosystem could pay important benefits to natural resource management agencies As agencies grapple with implementation of ecosystem-based management, conservation actions are likely to focus more on ecosystem processes and less on single species (Mangel et al 1996) In the long-term, protection of Alaska's natural resources will require extending the protection now afforded to single species, such as targeted commercially important salmon stocks, to ecosystem functions (Mangel et al 1996) In process-oriented conservation (Mangel et al 1996), production of ecologically central vertebrate species is combined with measures of the production of other species and measures of energy and nutrient flow among trophic levels to identify and protect ecological processes such as nutrient transport Applications of ecological process measures in Alaska ecosystems have shown the feasibility and potential importance of such measures (Kline Jr et al 1990, Kline Jr et al 1993, Mathisen 1972, Piorkowski 1995, Ben-David et al 1997a, 1997b, 1998a, 1998b, Szepanski et al 1999), as have applications outside of Alaska (Bilby et al 1996, Larkin and Slaney 1997)

d Coastal and Ocean Circulation

The flow along the shore over the shelf and slope of the GOA is counterclockwise or cyclonic on average (Reed and Schumacher 1986) The flow over the continental slope consists of the Alaska Current, a relatively broad, diffuse flow in the north and east GOA, and the Alaska Stream, a swift, narrow, western boundary current in the west and northwest GOA (Figure 4) The Alaska Stream continues westward along the southern flank of the Aleutians with portions of it flowing northward into the Bering Sea through the deeper passes intersecting the Aleutian Chain Together these currents comprise the poleward limb of the North Pacific Ocean's subarctic gyre and they provide the oceanic connection between the GOA shelf, Bering Sea, and the Pacific Ocean Reed and Schumacher (1986) suggest that flow in the Alaska Stream is relatively constant year round However, Musgrave et al (1992), Okkonen (1992), and Thomson and Gower (1998) show that sometimes the Alaska Current and Alaska Stream contain large eddies or form prominent meanders that could be important means for exchanging water with the shelf

The shelf is topographically complicated, consisting of submarine canyons that punctuate the shelf break, glacially carved troughs and moraines on the inner shelf, and numerous banks and shoals The coastline is similarly complex, consisting of numerous capes and embayments These features interact with the tidal and subtidal circulation, causing mesoscale flow variability that suggests regions of locally enhanced (or depressed) biological production Many of the submarine canyons extend across the shelf break, which suggests that these might be important pathways for cross-shelf transport

The most striking feature of the shelf circulation is the Alaska Coastal Current (ACC), which is a swift (0 2 - 1 8 m s^{1}), coastally constrained flow, typically found within 35 km of the coast (Royer 1981b), (Stabeno et al 1995) The offshore boundary of the ACC consists of a front, which might be an important barrier to cross-shelf transport of physical, chemical, and biological properties This current persists throughout the year and circumscribes the GOA shelf for at least 2500 km from where it originates on the northern British Columbia shelf (or possibly even the Columbia River depending on the season) to where it enters the Bering Sea through Unimak Pass In contrast to the ACC, the shelf flow between the offshore edge of the coastal current and the shelf break is weaker and more variable (Niebauer et al 1981) The source of this variability is uncertain, but potential mechanisms include separation of the coastal current as it flows around coastal promontories (Ahlnes et al 1987), baroclinic instability of the coastal jet (Mysak et al 1981), flow over topography (Lagerloaf 1983), or meandering of the ACC along the shelf break (Niebauer et al 1981)

The dynamics of the basin and the shelf are closely coupled to the Aleutian Low pressure system Storm systems propagate eastward into the GOA and are blocked by the mountain ranges of Alaska and British Columbia Thus, the regional winds are strong and cyclonic and the precipitation rates are very high The positive wind-stress curl forces cyclonic circulation in the deep GOA while on the shelf these winds impel an onshore surface Ekman drift and establish a cross-shore pressure gradient that forces the ACC The high precipitation rates cause an enormous freshwater flux (~20 % larger than the average annual Mississippi River discharge) that feeds the shelf as a "coastal line source" extending from Southeast Alaska to Kodiak Island (Royer 1982) However, the seasonal variability in winds and freshwater discharge is large Cyclonic (or coastal downwelling favorable) winds are strongest from November through March and feeble or even weakly anticyclonic in summer when the Aleutian Low is displaced by the North Pacific High (Royer 1975), (Wilson and Overland 1986) The seasonal runoff cycle exhibits slightly different phasing from the winds it is maximum in early fall, decreases rapidly through winter when precipitation is stored as snow, and attains a secondary maximum in spring due to snowmelt (Royer 1982)

The shelf hydrography and circulation vary seasonally and are linked to the annual cycles of wind and freshwater discharge In late winter, the vertical stratification and the front bounding the ACC are relatively weak By contrast, in fall the water column is strongly stratified and the offshore front is strong Measurements by Royer et al (1979) and Johnson et al imply that near-surface waters converge from either side of the front This pattern of cross-shelf circulation would tend to accumulate plankton, which might then attract foraging fish Moreover, the front and the region inshore of it might be an area of enhanced productivity because entrainment (Royer et al 1979) and/or frontal instability could resupply the surface layer with nutrients from depth As shown by Xiong and Royer (1984), deep shelf waters attain maximum salinities in fall and minimum in spring The source of this high salinity water is the annual intrusion of slope water forced onshore and along the bottom of the shelf by the seasonal relaxation (or reversal) in downwelling (Royer 1975) Interannual variability in the onshore flux of slope water and/or differences in slope-water properties likely imply similar variability in the onshore flux of nutrients to the GOA shelf

Farther offshore, the Alaska Current forms the poleward-flowing eastern portion of the North Pacific subarctic gyre and generally follows the upper slope and shelf break It is broad in the east, but it narrows and strengthens into a western boundary current northeast of Kodiak Island (Figure 4) into the Alaska Stream, the westward flowing portion of the subarctic gyre (Reed and Schumacher 1986) This dominant current system often may have computed velocities in excess of 80 to 100 centimeters/second and net transport in excess of 6×10^6 m^3/s This is particularly so near the outer Alaska Peninsula and Aleutian Islands, where sharp salinity decreases inshore generate strong pressure gradients that force swift flows (Reed and Schumacher 1986) Waters from the shelf and basin of the GOA eventually enter the Bering Sea through Unimak Pass and then the Arctic Ocean through the Bering Strait Thus, the Bering and Chukchi seas are "downstream" ecosystems with respect to the GOA

With regard to the interannual variability of current flows, it is generally thought that more intense cyclonic activity in the atmosphere will result in stronger flows in the Alaska Gyre and more of the westwind drift will go to the south to the California Current system (Hollowed and Wooster 1992) The proposed decadal scale variation in currents of the northeastern Pacific are shown in

Figure 5 Weak flows of the Alaska Current in the eastern gulf have been associated with years of higher-than-normal salinity (Ingraham Jr et al 1991) Reed and Schumacher (1986) describe a summer 1981 collapse of wind stress in the eastern gulf, which was accompanied by the widespread distribution of warm and relatively fresh surface water At the same time, wind stress increased in the western gulf, diverting water flowing into the southern gulf more to the northwest They suggested that such changes, although neither frequently characterized nor well understood, may affect biological processes throughout the region For example, one would expect the persistence of such conditions to favor water-column stratification, and subsequent depletion of surface water nutrients during the later portion of the summer growing season

During periods when the winter Aleutian Low pressure system is more northerly and intense, winds in the eastern GOA are stronger (Emery and Hamilton 1985,Mantua et al 1997), precipitation is greater, and Ekman transport is greater, which might be expected to influence variability in mixed-layer depth and productivity However, in the central GOA, mixed layer depth variability in the winter is primarily a consequence of changes in upper-ocean salinity (Freeland et al 1998)

e Climatic Oscillations

The GOA has a variable and severe climate and is the incubator for the winter storms that sweep across the North America continent via the Aleutian storm track (Wilson and Overland 1986) Three semi-permanent atmospheric pressure regions dominate climate in the northern GOA–the Siberian and East Pacific high-pressure systems and the Aleutian Low-pressure system (Figure 6) These have variable, but characteristic, seasonal locations The Aleutian Low pressure system averages about 1002 millibars (Favorite et al 1976), is most intense in winter, and appears to cycle in its average position and intensity with about a 20-25 year period (Rogers 1981,Trenberth and Hurrel 1994) The North Pacific Oscillation (NPO), as this cycle is called, appears to be a major source of oceanographic and biological variability

Low-pressure systems or storms frequently arise from the GOA Although the storm track is well-known, the severe winter weather that comes from the northern GOA is unpredictable on a short-term basis, due to the interplay among the relatively warm air masses over the gulf, the cold continental air masses inland, and the dominating coastal mountains (Alaska, Chugach and Wrangell-St Elias ranges) in between These features support blocking high-pressure ridges, which deflect storm tracks to the north and south for periods as long as several weeks, but which have an average persistence of seven to ten days (Treidl et al) This interplay between eastward moving storm systems and blocking high pressure in winter is quite variable from year to year, but undergoes long-term cycles on or about the same period as the NPO (White and Clark 1975)

Mantua et al (1997) have calculated the Pacific Decadal Oscillation (PDO) index, which tracks the NPO and is discussed in more detail in Section IV D 2 The PDO index had strong positive values from 1900 to about 1912, during most of the 1930s and early 1940s, and then again during the late 1970s, 1980s and most of the 1990s From about 1948 through 1976, and then again for three years in the early 1990s, the PDO was negative (Hare et al 1999) Figure 7 shows wintertime examples from two climatic regimes a negative PDO regime example from 1972 and a positive PDO example from 1977 In addition, there is evidence that the Aleutian storm track has shifted to a more southerly position during the twentieth century (Richardson 1936), (Klein 1957), (Whittaker and Horn 1982), (Wilson and Overland 1986) There also is a low-frequency lunar nodal cycle of 18 6 years, possibly working through an enhancement of poleward geostrophic flow (due to differences in seawater density) or increased tidal mixing in its positive phase, as an attractive alternative or complementary hypothesis for external forcing factors (Parker et al 1995)

f Marine Nutrients and Fertility

The fertility of GOA waters depends on nutrient recycling from depth to the surface layer where plants grow The deep waters of the central GOA have some of the highest concentrations of nutrients and the oldest carbon in the world's oceans (Mantyla and Reid 1983), consistent with lack of deep-water formation in the north Pacific Ocean, slow turnover and trapping of significant amounts of nutrients at depth Intense low-pressure systems and cyclonic circulation in the GOA favor nutrient transport to the surface in the central GOA (Reid Jr 1965), ^{14}C depletion in surface waters (Reeburg and Kipphut 1987), and the presence of low-temperature, high-nutrient water (Sambratto and Lorenzen 1987)

One feature of the Alaska Gyre, also shared with the eastern Tropical Pacific and parts of the Southern Ocean, is that there is apparently no lack of the macronutrients (nitrates, phosphates and silicates) necessary to support phytoplankton growth (Beklemishev 1957,Heinrich 1957) The traditional view has been that grazing by zooplankters was sufficient to prevent phytoplankters from depleting macronutrients (Anderson and Munson 1972) More recent work has explained the surfeit of macronutrients differently in terms of micronutrient (iron) limitation and called lack of macronutrient limitation into question (Freeland et al 1998) Moreover, the question of the extent of limitations imposed on productivity by iron in the GOA is an important and open question (Pahlow and Riebsell 2000) Non-nitrogen and carbon limited growth allows phytoplankton to discriminate against the "heavy" stable isotopes, ^{15}N and ^{13}C, during synthesis of organic matter Organic nitrogen and carbon depleted in ^{15}N and ^{13}C are passed into food chains Thus, zooplankton and fishes from oceanic waters of the gulf are ^{15}N and ^{13}C depleted, compared to those from coastal waters such as PWS that are nutrient limited (Kline Jr 1999a)

Onshore movement of more dense offshore water by winds results in coastal downwelling most of the year Relaxation of these winds during the summer results in slightly favorable conditions for upwelling of deep nutrient-rich water onto the shelf, the supply of which undoubtedly varies from year to year For example, in Resurrection Bay transport of offshore water into the bay occurs mainly during periods of positive upwelling (Heggie and Burrell 1981) In this predominantly downwelling shelf and coastal regime, the extent to which deep-water nutrients reach the more biologically productive nearshore surface waters and the mechanisms that transport it there during most of the year are only sketchily understood Bottom water in coastal fjords appears to be renewed by water originating from shallower than 250 m in the central gulf (Muench and Heggie 1978) Renewal of bottom water in shallow-sill coastal fjords, like Aialik Bay on the outer Kenai Peninsula coast, occurs in spring From near-uniform density throughout the water column in winter, developing density gradients in the fjords in the spring allow denser (from winter cooling and reduced freshwater runoff) shelf water that enters as distinct masses on April tides to sink to the bottom of these fjords Deeper fjords, such as PWS, are renewed in late summer and early fall as relatively warm and saline water originating in the central gulf below 150 m moves onto the shelf under conditions of reduced downwelling and onshore convergence of surface water

Deep water renewal processes were speculated to explain the occurrence of GOA-origin copepods undergoing diapause within PWS (Kline Jr 1999a) Long-term shifts in the deepwater renewal process could thus affect variability in a source of zooplankton forage for juvenile salmon and other PWS consumers, since it is the offspring of diapausing copepods that form the bulk of subarctic Pacific zooplankton blooms (Miller et al 1984)

g Plankton and Productivity

Some of the basic conditions for phytoplankton growth in the central GOA, based on data from Ocean Station P, are outlined by Sambratto and Lorenzen (1987) The annual cycle starts in spring when the compensation depth for primary production increases to below 150 m with increasing insolation time and solar incident angle At the same time, the mean mixed-layer depth, constrained from below by a permanent halocline at 150 to 100 m, rises rapidly between April and May from below 100 m to about 50 m These changes result in a rapid increase in phytoplankton production in surface waters to between 200 and 800 mg C m^{2} d^{1} through the summer, but the actual data to support this estimate of production are limited (Miller et al 1991) The reported average annual rate of 170 g C m^{2}y^{1} is one of the highest in the world's oceans (Welschmeyer et al 1993) Historical data suggest that nitrate and other macronutrients are not limiting in the area reached by sunlight (photic zone) during the growing season (Dugdale 1967,Hattori and Wada 1972,Miller et al 1991) It is possible that the GOA may have undergone a change with respect to the role of macronutrient control, based on more recent data (Freeland et al 1998) The micronutrient iron has been suggested as a limiting factor, but it appears that iron may set the characteristics of the phytoplankton community but not be limiting *per se* to the dominant small phytoplankton cells that attain a high level of productivity (Miller et al 1991)

A great deal of uncertainty about primary production is due both to a sparsity of direct measurements and to the fact that chlorophyll-a does not increase much during the annual production cycle (Anderson et al 1977) Intense grazing during growth and sinking of cells are possible contributing causes (Booth et al 1993) Recently, Miller et al (1991) suggested that consideration of the grazing protozoans as an intermediate trophic step between phytoplankton and large copepods (Miller et al 1984) could well explain the lack of phytoplankton blooms in the presence of relatively low numbers of large copepods A further iteration of a model that explains productivity in the surface waters of the Alaska Gyre is presented by Miller (1993) Essentially, high productivity is maintained by a shallow mixed layer that persists throughout the year, thereby preventing loss of key organisms out of the photic zone, including the abundant protozoans, which have high enough rates of cellular division to keep up with the phytoplankton populations Ammonia recycled quickly from the micro- and macrozooplanknton to the phytoplankton (mainly flagellates) apparently explains the continuous high concentrations of dissolved nitrate With regard to long-term changes in phytoplankton, integrated measurements of chlorophyll-a over the central North Pacific indicate a general increase after 1977 (Venrick et al 1987)

Annual primary production rates rise from central gulf values of 100 g C m^{2} to values greater than 250 on the shelf and values between 150 and 200 g C m^{2} in bays, sounds and inlets (Sambratto and Lorenzen 1987) Unlike the oceanic regime offshore, nutrient depletion does occur inshore of the shelf in lower Cook Inlet during the growing season (Chester and Larrance 1981,Larrance and Chester 1979) Unfortunately, the situation with respect to macronutrient limitation of productivity on the GOA shelf is far from clear Results of the Trustee Council-sponsored Sound Ecosystem Assessment (SEA) project include a model of the water column in PWS that has successfully produced the duration and extent of both phytoplankton and zooplankton blooms for several years (Eslinger 1999) Atmosphere-sea-surface interactions in the early spring appear to set the conditions for the remainder of the spring-summer production period Two general outcomes are seen for production 1) warm, quiescent springs have intense but brief phytoplankton blooms and relatively low zooplankton biomass, and 2) colder stormy springs lead to longer phytoplankton blooms and higher zooplankton biomass These two outcomes affect dichotomous carbon isotope ratios in marine biota Quiescent springs result in ^{13}C enrichment while stormy springs result in ^{13}C depletion Primary production shifts thus characterized by $^{13}C/^{12}C$ permeate throughout food chains as evidenced by concomitant isotopic shifts among biota (Kline Jr 1999b)

It is generally thought that the more energetic physical environment on the shelf is responsible for sustaining these high rates of primary production, but coastal convergence and the predominantly downwelling nature of the hydrography limit opportunities for water renewal from the deep GOA Offshore fronts associated with the ACC have been proposed as possibly active in producing enhanced plankton biomass seen at the shelf break It appears that relaxation of coastal winds, local topography (e g , at the entrance to Cook Inlet) interacting with strong tidal currents, and wind events are important factors in within-season nutrient resupply to the photic zone in a system where high freshwater input and long days can produce extended periods of stratification The interplay of these factors throughout the growing season is undoubtedly critical to survival of the many juvenile forms of inshore life dependent on phytoplankton production

Zooplankton productivity in the GOA largely reflects patterns seen or inferred from phytoplankton productivity (Cooney 1987) Thus, productivity of oceanic zooplankton populations may be as high as 30 g C m^{-2} yr^{-1} and up to 50 g C m^{-2} yr^{-1} on the shelf and in inside waters This production occurs to a large extent in the spring bloom and follows an annual surge in phytoplankton production in the early spring One of the unique characteristics of North Pacific zooplankton populations is the apparent role of three species of very large copepods–*Neocalanus cristatus*, *N plumchris* and *Eucalanus bungi*–in transferring large amounts of energy from phytoplankton to higher trophic levels (Cooney 1987), Short unpubl) Available evidence led Cooney (1984) to propose that the oceanic copepods are carried by Ekman transport from the open ocean onto the shelf over a large part of the year and may be an important source of organic matter for inshore organisms He estimated that the advected biomass from March to November of each year was $10x10^6$ metric tons in the GOA, considerably higher than the $2x10^6$ metric tons estimated from production on the shelf in the ACC The discovery that stable isotope signatures diagnostic for offshore carbon are found and vary in juvenile fishes of PWS provided evidence that this process takes place and vary in effect from year to year (Kline Jr 1999a) With regard to interannual variability, Brodeur et al (1996) found long-term fluctuations in zooplankton biomass that displayed maximal values on a 10+ year frequency In Figure 8 biomass of plankton for the spring and summer period are contrasted for a negative PDO and a positive PDO, and it can be seen that zooplankton biomass was much greater during the positive PDO

Nonetheless, it is important to bear in mind that primary and secondary productivity measurements in the GOA are few (Reeburg and Kipphut 1987) A truly engaging enigma of the GOA shelf is how it can sustain its apparent high productivity in the face of physical features that should inhibit productivity Physical features that should limit productivity in the gulf include a deep shelf, input of a high volume of low-nutrient freshwater via coastal discharge onto the shelf, and a shelf that is subjected to downwelling winds throughout most of the year In the face of such apparent inconsistency between the physical circumstances of the gulf and reported high productivities, it is reasonable to be skeptical of how representative the reported values actually are It is possible that there are not enough values in time and space to resolve the nature of seasonal productivities on the GOA shelf

Even so, corroborating data on GOA nekton also indicate that this group of organisms was more abundant after about 1978 Both these observations are consistent with calculations by Polovinia et al (1995), indicating that the reduction of the mixed-layer depth and increase of surface temperatures in the GOA would allow a doubling of pelagic production With more to eat, it is not surprising that survival and catches of Pacific salmon in the Alaska Gyre have increased so strongly since the late 1970s (Hare et al 1999,Mantua et al 1997,Pearcy 1992) At the same time, there are indications that inshore production has been declining in many locations

There is little known about decadal-scale changes in inshore rates of primary production, but there are efforts underway to compile what data does exist (Mackas personal communcation) While the very favorable production regime for salmon in the central gulf was occurring, many, but not all, nearshore seabird and harbor seal colonies were in decline (Hatch et al 1993,Piatt and Anderson 1996) This was apparent in PWS, especially in data on black-legged kittiwakes from southern PWS (Irons 1996) One compelling contrast from adjacent Cook Inlet was the decline over the last 20 years in seabirds at Chisik Island, while seabirds at Gull Island in Kachemak Bay were increasing during this period (Figure 9) High rates of nutrient supply from deep water enabled by exceptionally strong, topographically focused, tidal-induced mixing in lower Cook Inlet and, at the same time, increased nutrient-poor freshwater inflows through upper Cook Inlet might explain these different regional 20-year trends in seabird abundance Other long-term trends that may impact biological productivity are the continuing increase of average surface-water temperatures in the North Pacific and an apparently greater frequency of strong *El Niño* events in recent years

h Benthos

The GOA sea bottom supports a diverse community of bacteria, fungi, algae, some higher plants, invertebrates and fishes It varies with changes in substrate characteristics, depth, temperature, light and food supply (Feder and Jewett 1987,O'Clair and Zimmerman 1987) Primary production occurs in intertidal and shallow subtidal communities Benthic algal production is locally important in inshore areas of the northeastern Pacific Productivity estimates for the northeastern GOA for large kelps *Nereocystis* and *Laminaria* species range as high as 37 4-71 9 kg/m^2/yr wet weight for PWS to 2 1 kg/m^2/yr wet weight for shallow intertidal *Fucus* and *Rhodymenia* spp in lower Cook Inlet, and 0-0 4 kg/m^2/yr for deep subtidal areas containing *Agarum* and *Callophyllis* Wherever physical conditions are suitable to permit benthic algae to flourish, benthic algal production is very important to maintaining nearshore communities Nonetheless, current information indicates the majority of primary production in the GOA occurs in phytoplankton

The communities of the shelf bottom and shallow subtidal and intertidal environments support thousands of different species that recycle nutrients and carbon and participate in important geochemical cycles for trace substances Climatic forcing may influence the nearshore-bottom communities in several ways, including through nutrients, larvae and food Long time series data necessary to address these questions are available primarily for commercially utilized species of fish, crabs and molluscs (Hollowed and Wooster 1995), (Zheng and Kruse In press) Data on the geology and biology of the benthos are also available from work preparatory to oil exploration in the Aleutian Islands, Alaska Peninsula, Kodiak Island, Cook Inlet, and northeastern GOA (OCSEAP 1990) The above references to climate-mediated changes in production regimes to changes in transport of organic matter apply to all these communities, whether they are at the bottom of the central GOA or in the intertidal zone of Cook Inlet In addition, terrestrially mediated changes wrought by climate change, such as differences in the amount, timing and volume of freshwater discharge, sediment loads, and winter temperatures, would be expected to affect intertidal and nearshore communities

For the offshore seabed and its associated resources (e g , epibenthic fish, crabs and shrimp), one might expect that changes in biological production in the surface-mixed layer, such as described earlier, might result in changes in the amount of organic matter reaching the sea floor Between 1989 and 1996, a decline in the supply of particulate organic carbon to the abyssal eastern North Pacific has been reported (Smith Jr and Kaufman 1999) Also, variations in cyclonic circulation in the GOA and, therefore, in surface Ekman divergence and the associated advection of plankton might change the amount of organic matter delivered to shelf communities Mechanisms underlying the radical changes in the biological composition of nearshore communities in the GOA in the late 1970s and early 1980s (Piatt and Anderson 1996) are not known It is possible, however, that the supply of organic matter to the shelf might have changed and this could have contributed to changes in seabed communities

Many inshore communities have populations that rely on only occasional recruitment of successful age classes The interplay of annually variable food supplies and currents may play significant roles in the success of larval production and their return to suitable habitats for the adult life stages It may be, for example, that offshore loss of propagules is constrained when the ACC stays close to the coast

Sediments are also a major repository for organic matter and contaminants from human activity and may capture the history of climatic and geochemical events in the overlying waters The intertidal zone, though very narrow, is a productive and unique component of the GOA ecosystem that feeds a variety of important populations, including people Unfortunately, there appears to be no long-term program among scientific agencies for collecting data on intertidal community composition in the northern GOA

2 Status and Changes in Fish and Shellfish, Birds and Mammals

a Fish and Shellfish

The fish and shellfish fisheries of the GOA have been among the world's richest in the second half of the 20th century Major fisheries include, or have included, numerous species of shrimp and crab, five species of Pacific salmon, Pacific cod, Pacific halibut, sablefish, herring, rockfish, pollock, flatfishes, scallops and other invertebrates Among the most important of the GOA groundfish species, exploitable pollock populations in 1999 were estimated at 738,000 metric tons (mt), down from a peak of about three million mt in 1982 (Witherell 1999) Annual numbers of two-year-old pollock entering the fishable population (recruitment) from 1981-1987 were erratic and usually lower than recruitments estimated in 1977-1980 Pacific cod of the GOA are also an economically and ecologically important species Pacific cod had an estimated fishable population of 648,000 mt in 1999, which is on the low end of the range of 600,000-950,000 mt estimated for 1978-1999 Annual recruitments of GOA Pacific cod have been relatively stable since 1978, with exceptionally large numbers of three-year old recruits appearing in 1980 and 1998 Biomass of the dominant flat fish in the GOA, the arrowtooth flounder, is approaching two million mt Arrowtooth flounder is not heavily harvested, and their biomass has been steadily increasing since 1977 By comparison, the exploitable biomass of another flatfish, the highly prized Pacific halibut, in 1999 was estimated at 258,000 mt, which is above average for 1974-1999 (Witherell 1999) Exploitable biomass of Pacific halibut was also increasing from 1974-1988, after which it declined slightly As a possible consequence of climate change and/or fishing, the status of crab populations (discussed below) is relatively poor in comparison to the groundfish populations

Both salmon and groundfish populations in the northeastern Pacific appear to vary in concert with features of climate, but the responses appear to be different (Francis et al 1998) Groundfish recruitments follow a cycle with a roughly ten-year period that is closely related to the *El Niño* Southern Oscillation (ENSO) (Hollowed and Wooster 1992), whereas salmon abundance changes sharply at intervals of 20-25 years in concert with the Pacific Decadal Oscillation (PDO) (Brodeur et al 1996) The ENSO and the PDO were shown to be independent of one another (Mantua et al 1997) The opposite responses of groundfish and salmon (positive) and crab (negative) recruitment to intensified Aleutian Lows may be because different species-specific mechanisms are invoked by the same weather pattern Since the groundfish species described by Hollowed and Wooster (1992, 1995) were mostly winter spawners, Zheng and Kruse (in press) hypothesize that strengthened Aleutian Lows increase advection of eggs and larvae of groundfish toward onshore nursery areas, improving survival Salmon, on the other hand, benefit from increased production of prey items under intense lows The possible links between Aleutian Lows, PDOs, and ENSO and populations of fish and other animals are discussed further below and in a recent review paper (Francis et al 1998)

Since the climatic regime shift in 1978, pollock and other cod-like fish have dramatically increased and maintained high population levels, replacing shrimp in nearshore waters as the dominant group of organisms caught in mid-water trawls on the shelf (Piatt and Anderson 1996) Pacific halibut appear to undergo decadal-scale changes in recruitment, which have been correlated with both the 18 6-year lunar nodal tide cycle (Parker et al 1995) and the PDO There also is a reported coincidence of size-at-age data for Pacific herring with this same cycle (Ware 1991) The patterns are not as clear with herring, but the populations tend to be dominated by the occasional strong year class and show considerable variability in landings over the years

In a recently completed study of time-series data on recruitment for 15 crab stocks in the Bering Sea, Aleutian Islands and GOA, time trends in seven of 15 crab stocks are significantly correlated with time series of the strength of Aleutian Low climate regimes (Zheng and Kruse In press) Time trends in recruitments among some king crab stocks were correlated over broad geographic regions, suggesting a significant role of environmental forcing in regulation of population numbers for these species The increased ocean productivity associated with the intense Aleutian Low and warmer temperatures was inversely related to recruitment for seven of the 15 crab stocks The seven significantly negative correlations between ocean productivity and crab recruitment were from Bristol Bay, Cook Inlet and the GOA Crab stocks declined as the Aleutian Low intensified A significant inverse relation between red king crab brood strength and Aleutian Low intensity was reported earlier for one of the stocks in this study, red king crab from Bristol Bay (Tyler and Kruse 1996)

Tyler and Kruse (1996, 1997) and Zheng and Kruse (in press) have articulated an explicit series of hypotheses linking features of physical and geological oceanography to the reproductive and developmental biology of red king and Tanner crab to explain observed relations between climate and recruitment Tanner and red king crab in the Bering Sea are thought to respond differently to the physical factors associated with the Aleutian Low due to the distribution of the different sea bottom types required by the post-planktonic stage of each species Suitable bottom habitat for red king crabs in the Bering Sea is more generally nearshore, whereas suitable bottom habitat for Tanner crab is offshore Intense Aleutian Low conditions favor surface currents that carry or hold planktonic crab larvae onshore, whereas weak Aleutian Low conditions favor surface currents that move larvae offshore The process may not be species specific, but stock specific, depending on the location of suitable settling habitat in relation to the prevailing currents In the case of red king crab, Zheng and Kruse (in press) explain the apparent paradox of lowered recruitment for red king crab during periods of increased primary productivity Red king crab eat diatoms, but show a preference for diatoms similar to *Thalassiosira* spp , which dominate in years of weak lows and stable water columns Strong lows contribute to well-mixed water columns and a diverse assemblage of primary producers, which may be unfavorable for red king crab larvae, but favorable for Tanner crab larvae Tanner crab larvae eat copepods, which are favored by the higher temperatures associated with intense lows

Recently completed modeling studies (Rosenkrantz 1999) support climatic variables as determinants of recruitment success in Tanner crab Predominant wind direction and temperature of bottom water were strongly related to strength of Tanner crab year classes in the Bering Sea Northeast winds are thought to set up ocean transport processes that promote year class strength by carrying the larvae toward suitable habitat Elevated bottom water temperatures were expected to augment the effect of northeast wind by increasing survival of newly hatched larvae (Rosenkrantz 1999)

Species not commercially harvested are less well studied than commercially harvested species, such as Tanner crab For example, since no commercial fisheries are allowed for such "forage" fishes as eulachon, sand lance, capelin, and lantern fish, the fluctuations of their populations are not well documented Some information on changes of forage fish comes from sampling the diets of colony nesting seabirds and the stomach contents of Pacific halibut, as well as from many years of mid-water trawls around Kodiak Island and on the Alaska Peninsula (Piatt and Anderson 1996) Data from the latter study indicated, for instance, that capelin nearly disappeared from the northern GOA shelf in the early 1980s The evidence that climate (i e , the PDO index) is significantly correlated with fisheries for Pacific salmon in the GOA is very strong (Hare et al 1999), with dramatic increases after the strong shift to a positive PDO index in the late 1970s In addition, analysis of the eastern GOA data on fishes showed that many flatfish stocks increased following the 1977 PDO shift, but several dominant groundfish stocks did not (e g , Atka mackerel, Pacific cod, Pacific hake and walleye pollock) (Francis et al 1998) With fisheries accounting for up to 25% of the energy produced by coastal shelf and upwelling systems on a worldwide basis (Pauly and Christensen 1995), the sustainability of gulf fisheries must be put in the context of climate change

b Seabirds

The GOA supports large aggregations of colony nesting seabirds 26 species contributed to an estimated total of eight million birds in 1987 in the GOA (DeGange and Sanger 1987) In addition, the large estuarine habitats in Cook Inlet and the Copper River Delta are critically important for migrating shorebirds in the spring (Senner 1999) During the summer breeding season, colonial sea birds aggregate at about 800 different colonies around the periphery of the GOA (DeGange and Sanger 1987) to feed on the plankton, nekton, and mainly the forage fishes living in the coastal and shelf environment It is well known that the general fertility of various marine systems is reflected in the abundance and productivity of seabirds that nest and reproduce nearby (Furness and Camphuysen 1997,Phillips et al 1996)

Seabirds also provide an easily accessible source of tissues (e g , eggs and feathers) that integrate changes in the availability of some contaminants and abundances of stable isotopes of carbon and nitrogen in the food web Gulf seabirds consume more than one million metric tons of marine organisms each breeding season Because different seabird species feed in different ways (e g , black-legged kittiwakes feed at the surface and common murres dive deeply), their distributions and productivity can give indications of the distribution and availability of their prey

While the very favorable production regime for salmon in the central gulf was occurring, many, but not all, nearshore seabird colonies were in decline (Hatch et al 1993,Piatt and Anderson 1996) (Figure 9) This was apparent in Price William Sound, especially in data on black-legged kittiwakes from the southern sound (Irons 1996) An exception to the widespread decline of nearshore seabirds is found at Gull Island in Kachemak Bay, lower Cook Inlet, where populations were apparently increasing during this period (Piatt unpublished) This exception to the widespread downward regional trend in lower Cook Inlet may point to an opportunity to identify the oceanographic conditions that support seabird productivity that are lacking in the other areas

c Marine Mammals

Three groups of marine mammals occur in the northern GOA, cetaceans (whales and dolphins), pinnipeds (seals, sea lions and walrus) and the mustelids (sea otter) One species, the Steller sea cow, was extirpated about 1768 (Hood and Zimmerman 1986) The loss of the sea cow is relevant to GEM in that it signals the beginning of the extensive alteration of trophic structure in the GOA as a result of human harvest of marine mammals (Scheffer 1972) As the largest recent herbivore to have grazed on nearshore macroalgae, the sea cow was undoubtedly an important component in the nearshore portion of the ecosystem Most species of marine mammals experienced some level of commercial harvest starting in 1741, when Vitus Bering explored the Bering Sea and northern GOA region and laid claim to it for Russia

Continuing concern about past alteration of trophic structure in the GOA and its consequences for contemporary trophic structure is well warranted Six species of large baleen whales inhabit the gulf blue, fin, sei, humpback, gray, and Pacific right (Calkins 1987) Numbers of each of the great baleen whale species have been radically reduced at some point between about 1845 and the imposition of protection by the International Whaling Commission in 1966 (Calkins 1987) Numbers of the blue whale and the Pacific right whale are now at the point where these species are unlikely to be factors in the trophic structure of the GOA Sei whales are notable in that their numbers were severely depleted relatively recently, between 1963 and 1966 Although sei whales eat mostly zooplankton, they are known to feed opportunistically on a wide range of forage and commercial fish species, including smelt, sand lance, capelin and pollock

Recovery of populations of large, potentially piscivorous (fish-eating) whale species leads to concern about future alteration of the trophic structure of the gulf in ways that could directly impact human harvests of salmon and herring Gray whale populations have recovered to what may be pre-exploitation levels Grays are piscivorous as they travel through the GOA, but consumption rates are unknown When feeding on a combination of benthic and pelagic invertebrates, the consumption rate of an adult gray whale is 1,200 kg per day (Calkins 1987) Recent growth in numbers of humpback whales, which were radically reduced in population size prior to 1966 (Scheffer 1972), has important implications for trophic structure and fisheries management Humpbacks at times feed heavily on fish including herring and juvenile salmon

Concern about future alteration of trophic structure is in part due to the fact that the harvest of many marine mammals, including the great baleen whales and sperm whale, has been sharply reduced in GOA waters during the last third of the 20th century, although some low levels of harvest for some species still occurs Some species of great whales, such as gray and sperm, have responded to the cessation of harvest by increasing their numbers, while others have not Given the diverse foraging strategies of cetaceans in general, the rates of recovery of these apex predators from heavy exploitation could offer insights into many different aspects of trophic structure and trophic dynamics of the GOA and North Pacific

Some species of pinnipeds, such as the northern elephant seals, have increased dramatically during recent decades Even with cessation of most harvests, however, such other pinniped species as fur seals, Steller sea lions, and harbor seals have undergone dramatic declines coincident with changes in oceanography, forage fish and seabird populations in the GOA over the past 20 years Harbor seals should be considered candidates for long-term monitoring since they have relatively small geographic ranges and do not appear to sharply limit composition of prey species within their range Harbor seal diet studies, including trophic status, may provide means of detecting changes in the trophic structure and dynamics of the nearshore marine environment

Sea otters, very nearly extirpated from the North Pacific by 1900, also have benefited from the near-cessation of human harvest Since that time the species has increased dramatically throughout most of Alaska, and has itself precipitated profound changes in the structure and function of coastal marine communities of less than 100 m depth During the past decade, large declines in sea otter abundance have been noted in the central Aleutian Islands, although the exact extent of the decline is unknown One hypothesis advanced to explain the decline involves killer whales using otters as a replacement for the now rare pinnipeds (seals and sea lions)

Northern fur seals have been in steep decline in the Bering Sea and their decline may be related to conditions in the GOA (Trites 1992) Although food limitations in the Bering Sea may not be limiting population growth, food limitations in the Aleutians and in the GOA may be creating a population growth bottleneck by causing high mortalities of juveniles during migrations The bottleneck hypothesis of fur seal abundance control (Trites 1992) illustrates one of many ecological connections between the Bering Sea and the GOA Steep declines in harbor seals in the GOA have been documented in and around Kodiak Island 1956-1976 (Pitcher 1990) and in PWS throughout the 1990s (Figure 10) (Frost et al 1998)

Concepts on control of marine mammal populations focus on food limitation and hunting or other human removals Steller sea lions, now listed under the federal Endangered Species Act, have declined steeply starting in the early 1970s, particularly in the Aleutian Islands (Trites 1992) Current hypotheses on limitation of Steller sea lion abundance center on food limitation, possibly due to competition with humans for prey species, but there is no conclusive information with respect to the role of fisheries in causing food limitation for Steller sea lions (Bowen et al 1999) The possibility remains that climate change and its effect on species composition of prey species plays an important role in regulating marine mammal populations

D Conceptual Foundation for the Gulf of Alaska Ecosystem

1 Rationale

A conceptual foundation of how biological production and diversity vary in the GOA in response to natural and anthropogenic forces is necessary to organize thinking about the ecosystem and how it functions As such, it is not a prescription for actions to be taken by the Trustee Council Rather, the conceptual foundation advises the Trustee Council regarding the ecological context for future decisions that set priorities for research and monitoring activities By use of the conceptual foundation, each specific project considered for implementation of the GEM program may be understood in relation to other projects and the functions and components of the ecosystem it addresses

Recent syntheses have advanced the understanding of processes upon which the production of marine birds, fish and marine mammals may depend, and with which the conceptual foundation is concerned As development of the GEM program progresses, we expect to advance understanding of the basis for production of representative species of birds, fish and mammals The remaining contexts for designing the plan relate to the human needs served by the Trustee Council through policy and management objectives In this way, the conceptual foundation provides a substantial part of the context for developing the research and monitoring plan by suggesting key processes and species for study

The conceptual foundation will change as more information accumulates, since it is a starting place for understanding the system Some parts of the conceptual foundation will stand the test of time as they are verified through further work in GEM and elsewhere Other portions will be rejected or modified based on reinterpretations of existing data or insights from new data The future states of the ecosystem might not be anticipated based on past experience, as happened following the regime shift in the late 1970s Therefore, using the principles of adaptive management, the conceptual foundation may be continually refined and revised to reflect our understanding of the ecosystem

Developing testable hypotheses based on the conceptual foundation is important to serve the purposes of GEM, but nonetheless, hypothesis-driven research is effective in direct proportion to the presence of long-term monitoring observations Capturing ecological change will necessitate yearly measures of the critical parameters to capture any superannual natural cycles and detect trends in anthropogenic influences

2 The Conceptual Foundation

The GEM program is concerned with both the productivity and population levels of birds, fish, shellfish and mammals in the watersheds and waters of the GOA Under the conceptual foundation, the direct effects of and interactions among related natural and human factors are thought to control the productivity of these species Their population levels are thought to be controlled primarily by food, habitat and removals

The conceptual foundation of the GOA ecosystem links or couples the variation in productivity of many of the birds, fish, shellfish and mammals in the gulf to the amount of food produced at the front associated with the continental shelf break and its subsequent distribution (Figures 11 and 12) There appear to be two major fronts one at the shelf break, that is, the transition between offshore and shelf water masses, and a second one that represents a transition from outer shelf water mass to the more shoreward and fresher waters of the Alaska Coastal Current These fronts are highly dynamic areas thought to be important for food production because of movement of nutrient-rich waters toward the surface (upwellings) or toward the bottom (downwellings) On the surface, long lines or "rips 'of debris or foam may identify some fronts Other fronts are marked by water of differing colors on either side Changes in production of break-coupled species may depend on primary production at the shelf break and on mechanisms that distribute the carbon and nutrients produced at the shelf break towards inshore areas

The factors that control populations—primarily food, habitat and removals—are also an important component of the conceptual foundation The amount of food available is greatly influenced by events at the shelf break, and the extent of inshore water stratification The amount of habitat available is determined by geophysical processes, such as climate, and by human activities that degrade habitat, such as pollution, and that destroy habitat, such as logging, road building and other aspects of urbanization Harvest removals include human harvests, as well as natural causes such as starvation and non-human predators Note that these key factors are interactive, since, for example, degraded habitat may produce less food or unsuitable food Key factors are also related, since removals can determine the amount of food available at a location

In general, the basic source of food, primary productivity, is thought to be controlled through the influence of climate and other geophysical processes on plant species composition, temperature, light and the availability of macronutrients, such as nitrate, phosphate, and silicate, and micronutrients, such as reduced iron In the GOA, four climatological cycles or trends may act alone or in combination to change annual primary productivity the ENSO (*El Niño-La Niña*) phenomena with 3- to 7-year oscillations, the PDO with a 20- to 30-year oscillation, the lunar tidal node with an 18 6-year period, and the long-term trend of global warming

Although the three other phenomena are also important, the conceptual foundation centers around the PDO as the primary force affecting changes in the productivity of the GOA The physical mechanisms through which the lunar tidal node on biological production may be expressed are not as apparent or extensively elaborated as are those of the PDO (Parker et al 1995), (Royer 1993) For purposes of this conceptual foundation, we assume confluence in the effects of the PDO and lunar cycle on production in order to avoid specifying which of these explanations (or both) are significantly affecting the ecosystem

The PDO is a set of atmospheric circumstances resulting from the location and intensity of the winter-time Aleutian Low pressure system The PDO changes, or oscillates, between positive and negative states (Figures 11 and 12) In decades of positive PDOs, below normal sea surface temperatures occur in the central and western North Pacific and above normal temperatures occur in the GOA An intense low pressure is centered over the Alaska Peninsula, resulting in the GOA being warm and windy with lots of precipitation Under these conditions, break-coupled species (primarily offshore grazers, such as salmon and some seabirds) do well Although influenced by the amount of removals by humans, the increases in adult salmon during a positive PDO generally return larger amounts of nitrogen to natal streams, resulting in increased production of break-coupled species of plants and animals in the watersheds

In decades of negative PDOs, the opposite sea surface temperature and pressure patterns occur The GOA is cooler and less windy with less precipitation As a consequence, non-break-coupled species (primarily inshore grazers, such as some seabirds, herring and seals) thrive

Figure 11 shows in detail the physics of the positive PDO, starting with the northerly movement and intensification of the winter-time Aleutian Low pressure system with the following interrelated changes

1 Acceleration of cyclonic motion in the Alaska subarctic gyre and increased shoreward surface water transport, specifically in the Alaska Current,

2 Increased mid-gyre upwelling of deep, nutrient-rich water to the ocean surface,

3 Entrainment of more of the west wind drift northward into the GOA Gyre via the Alaska Current, rather than into the California Current system to the south,

4 Deepened winter-time mixing of the surface layer in the central gulf,

5 Warmer surface water temperatures and increased heat flux to the atmosphere,

6 Increased precipitation and coastal runoff, increase in organic carbon and anthropogenic contaminants inputs,

7 Decreased surface water salinity, especially nearshore,

8 Increased winds and Ekman transport from the central gulf shoreward,

9 Increases in the intensity of the Alaska Coastal Current due to increased baroclinic and wind-driven transport,

10 Deepening of the Alaska Coastal Current nearshore, and

11 Increased downwelling of the shoreward-driven surface water from the central gulf

During the spring and summer a positive PDO period is characterized by the following biological differences

1 The mixed layer in the central gulf rises rapidly and is shallower due to greater warming and greater stratification of the surface water,

2 Phytoplankton production is greater in the gulf and at the shelf break,

3 There are greater production and standing crops of zooplankton and nekton, including salmon, in the gulf and at the shelf break,

4 More food is available on a year-round basis for pelagic-feeding fish, such as salmon, in the offshelf and in the central gyre and the effective habitat for salmon is expanded through a larger portion of the gulf,

5 Organic matter originating in the gulf is carried shoreward by Ekman transport in much greater quantities, and then is downwelled more strongly before reaching the coast,

6 There are increased supplies of organic matter to the benthic communities in the outer shelf and slope from downwelled saline surface water,

7 Changes in the distribution of organic matter and water temperature on the shelf and slope force changes in the abundance and species composition of the benthic, epibenthic and pelagic communities,

8 Deepening freshwater influence and greater density stratification of inshore waters limit opportunities for bottom water renewal in enclosed coastal water bodies and to the inner shelf, but may be modulated by patterns of in-season winds,

9 Offshore downwelling fronts, less nutrient replenishment and stronger surface water stratification result in a lower exogenous supply and lower endogenous plankton production in nearshore waters,

10 Forage fish dependent on endogenous inshore production have less to eat and decline, especially fat-rich species whose populations depend on high levels of inshore production,

11 Forage-fish predators, such as harbor seals, sea lions and many sea bird species decline to the extent to which they depend on inshore production and cannot trophically access downwelled offshore production,

12 Fish predators, such as resident killer whales, which depend on offshore production (e g , energy passed trophically through salmon) increase in abundance, and

13 Marine mammal predators, such as transient killer whales, undergo declines

The physics and biology of a negative PDO can generally be described as the inverse of a positive PDO

3 Discussion

The conceptual foundation is a mechanistic explanation of how the largest climate signal, the PDO, could cause positive and negative biological changes in the abundances and productivities of some species of birds, fish, shellfish and mammals, and why some species show no apparent relation to the climate signals so far described It is assumed that the effects of ENSO cycles and the long-term global warming evident throughout the Pacific will interact in potentially complex ways with PDO cycles to bring about change in biological systems It is also assumed that anthropogenic effects due to harvest levels and methods, degradation of water quality, growing concentrations of contaminants, and habitat loss and degradation will become increasingly important as agents of biological change Accordingly, the conceptual foundation will be changed to accommodate the circumstances created by these natural and anthropogenic agents of change As new insights accumulate, the current conceptual foundation will be expanded, modified or perhaps discarded

Much of the conceptual foundation already appears in the literature, as described in Section IV C , but it also contains a number of new ideas The proposed inshore-offshore inverse production regimes and the transport and fate of the organic matter produced in response to the PDO have not been proposed previously The production regimes are described in the context of a physically coherent ocean-climate model that generally agrees with population trends in higher trophic-level organisms (e g , salmon, seabirds and harbor seals) Specifically, bottom-up controlled food webs in the two regimes respond to climate in generally opposite ways, with positive PDO (e g 1978-1990) indices being associated with greater offshore production (i e , production offshore of the shelf break) and weaker inshore production and negative PDO indices (e g 1948-1977) being associated with greater inshore production (i e , production inshore of the shelf break and on land) and weaker offshore production

The fate of offshore production during the two regimes is key, with shoreward-transported organic production being downwelled more strongly onto the shelf break and outer shelf during the positive PDO index period During the negative PDO index period there is less offshore production transported shoreward, but more organic production can reach the inner shelf and enclosed water bodies due to less downwelling, less water stratification, and more frequent opportunities for shoaling of offshore water derived from the central gulf onto the inner shelf

The conceptional foundation proposes that the separation between onshore and offshore production regimes occurs between the fronts associated with the shelf break and the ACC (Figures 11 and 12) The "ring of plankton" often seen near the shelf break may be a manifestation, in part, of transported, downwelled organic matter from the gulf that accumulates near the shelf (Cooney 1987) The fate of this organic matter during different climate regimes is key to the oscillations in the concept being proposed here It is recognized that productivity of inshore plankton and nekton is generally higher than offshore productivity on an areal basis However, trapping and accumulation of organic matter produced near the shelf break over a very large area of the central gulf presents a potent source of nourishment for animals on the shelf and slope environments In fact, this source of nourishment is probably larger than the total inshore production of organic matter Cooney (1984, 1987) calculated that shoreward-advected zooplankton in the upper 50 m during the convergence season (October through April) was approximately $10x10^6$ metric tons This compares to $2x10^6$ metric tons produced in the ACC, a five-fold difference The fate of this material may have potent implications for seabirds and juvenile fish that can access it

Recently a mechanistic hypothesis has been advanced to explain the decadal scale variation in eastern North Pacific salmon stocks (Gargett 1997) Gargett proposes that increased precipitation in coastal areas during positive PDOs makes the water column more stable and that this increased stability promotes greater primary production -- the "optimal stability window " Polovina et al (1995) have proposed a similar hypothesis for the central GOA, and this ultimately results in more salmon production This hypothesis is based on the assumption that greater water column stability enhances retention of phytoplankton without sacrificing the nutrient supply necessary for the higher rate of primary production

The "optimal stability window" hypothesis is closely related to what is proposed here, with several differences First, because of the tendency for waters of the ACC to become nutrient limited, our model proposes that increased water column stability during positive PDOs will result in net production decreases inshore, in contrast to the increases expected in the central GOA Second, while Gargett proposes that greater salmon production results from favorable productivity in coastal waters, where many salmonids spend their first year at sea, our model would explain abundant food on the outer shelf either as a result of onshore transport of offshore production, i e Cooney's ring of zooplankton production or enhanced production at the shelf break Resolving which, if either, of these two models, the one presented here or Gargett's, is correct depends on knowing the origin of the carbon available to salmon on the shelf Offshore versus inshore carbon may be distinguished in juvenile salmon using natural stable isotope abundance measurements (Kline Jr 1999a) If the source of increased carbon during a positive PDO is due to onshore transport or shelf-break production rather than production within the ACC, then juvenile salmon would have access to the imported production before it is lost to downwelling near the shelf break Unfortunately it does not appear that there are enough data available to distinguish which model may be more accurate

In addition to biological production models based on water column stability and bottom-up control of higher trophic levels, there are the direct effects of water temperature on the physiology of the organism that could alter trophic dynamics, or the geographic range of important organisms For example, Welch (1998) has proposed that global climate warming could drastically restrict the range of sockeye salmon in the next several decades

E Tables and Figures

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Figure 9 Long-term decline of seabirds at Chisik Island, Cook Inlet (bottom) and increase at Gull Island, Outer Cook Inlet (top) (Piatt and Anderson, 1996)

Figure 10 Population trend of molting seals in Prince William Sound (Frost, 1998)

Figure 11 Schematic of physical processes during the winter in a positive PDO climatic regime in the Gulf of Alaska from offshore to nearshore areas showing the Alaska Current (AC) and the Alaska Coastal Current (ACC)

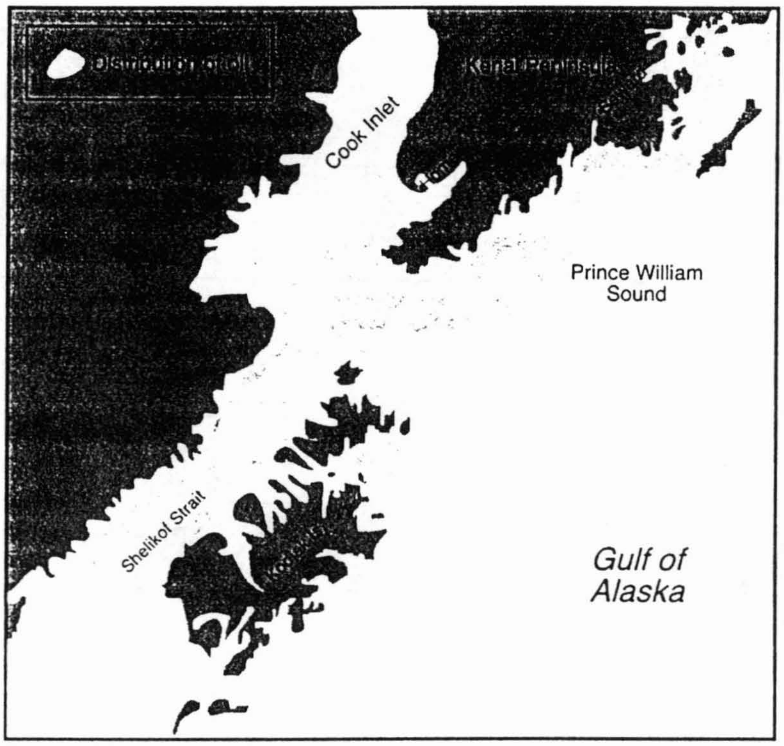
Figure 12 Schematic of physical processes during the winter in a negative PDO climatic regime in the Gulf of Alaska from offshore to nearshore areas showing the Alaska Current (AC) and the Alaska Coastal Current (ACC)

Table 1 Status of injured resources, *Exxon Valdez* oil spill as of March 1999

NOT RECOVERING	RECOVERING	RECOVERED	RECOVERY UNKNOWN
Common Loon	Archaeological resources	Bald Eagle	Cutthroat Trout
Cormorants (3 spp)	Black Oystercatcher	River Otter	Designated Wilderness Areas
Harbor Seal	Clams		Dolly Varden
Harlequin duck	Common Murre		Kittlitz's Murrelet
Killer Whale (AB pod)	Intertidal communities		Rockfish
Pigeon Guillemot	Marbled murrelet		
	Mussels		
	Pacific Herring		
	Pink Salmon		
	Sea Otter		
	Sediments		
	Sockeye Salmon		
	Subtidal communities		

Injured human services are considered to be recovering Commercial fishing, Passive use recreation and tourism, and Subsistence

Figure 2. Distribution of oil from the *Exxon Valdez* oil spill.



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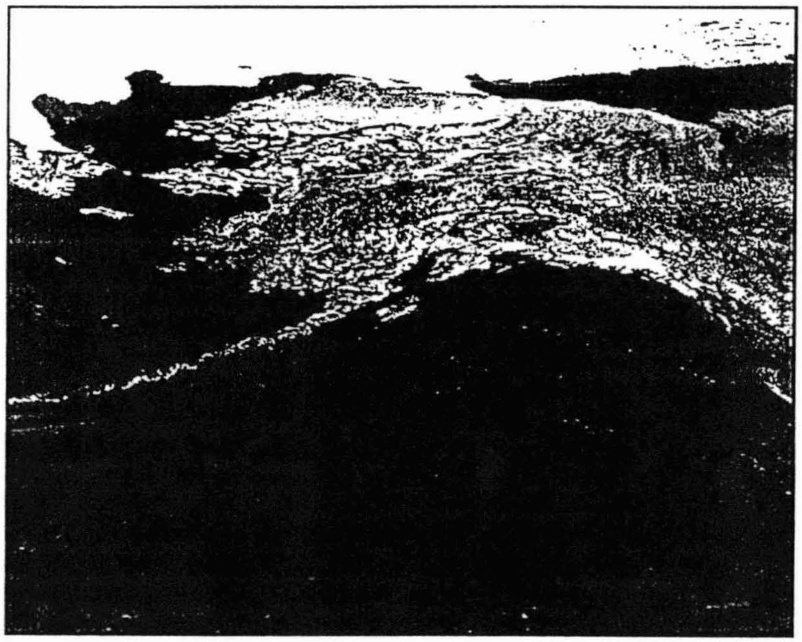

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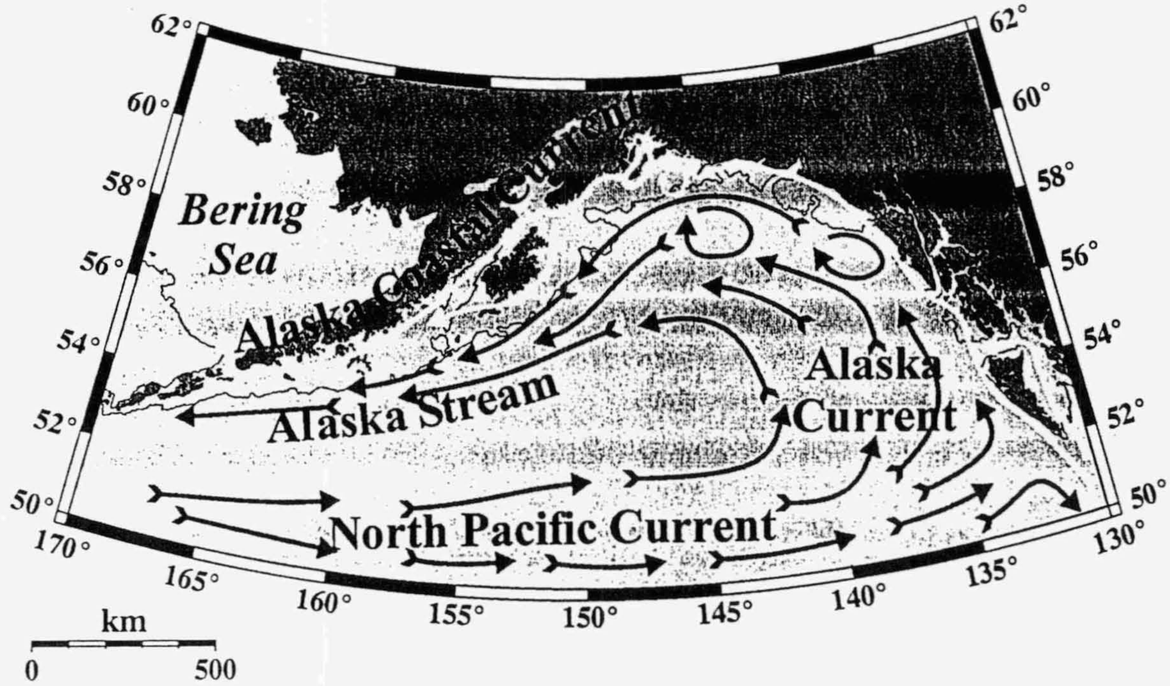

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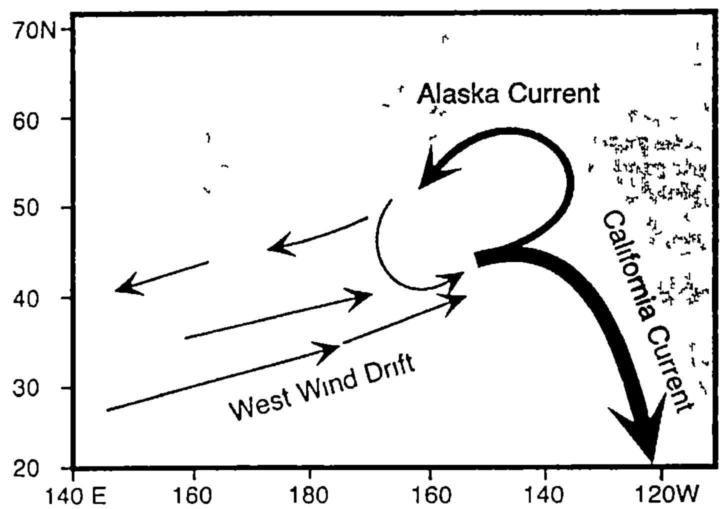

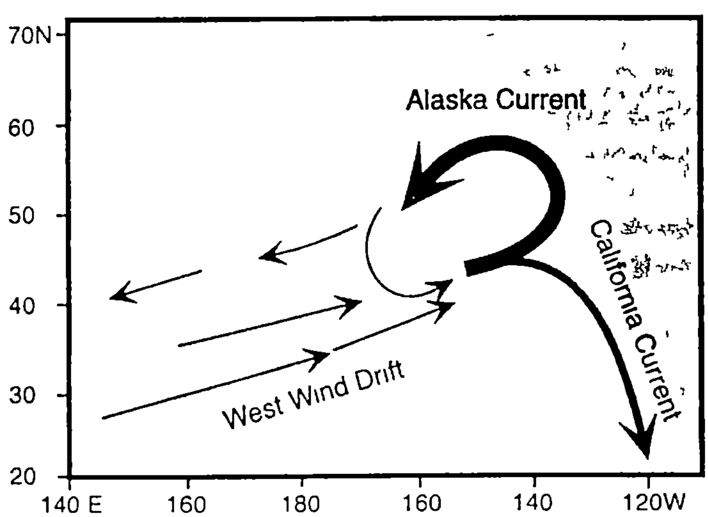

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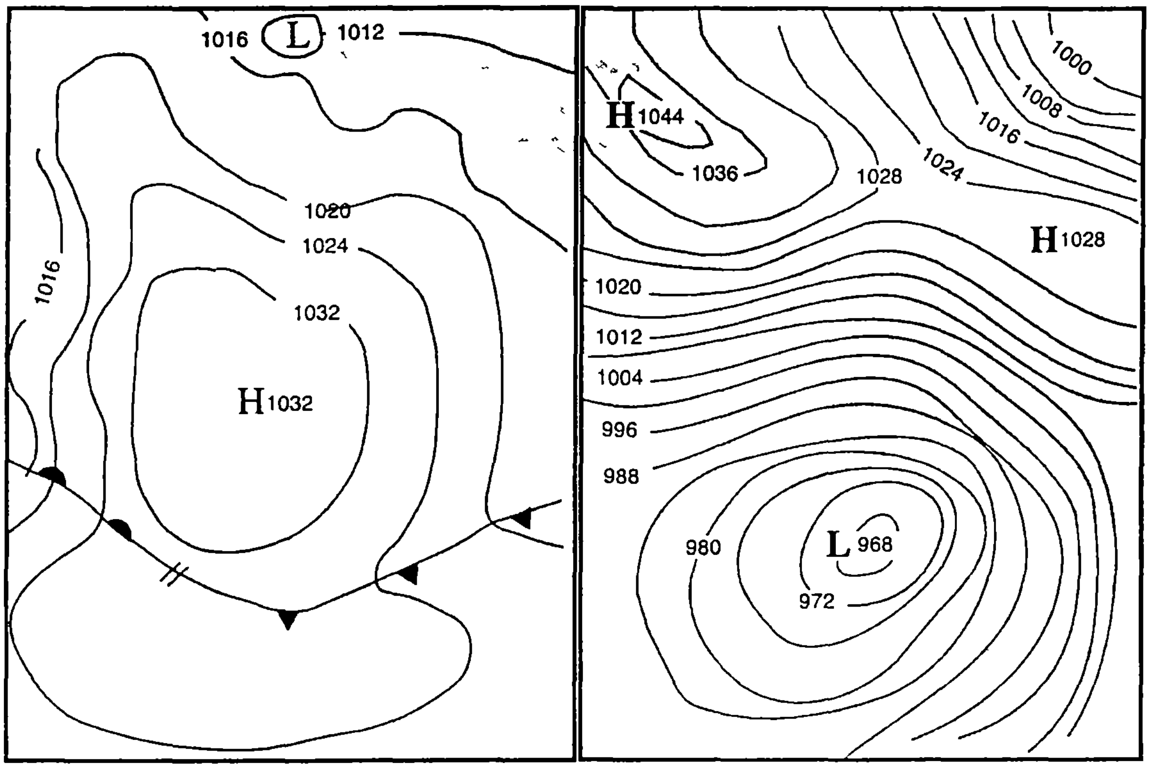

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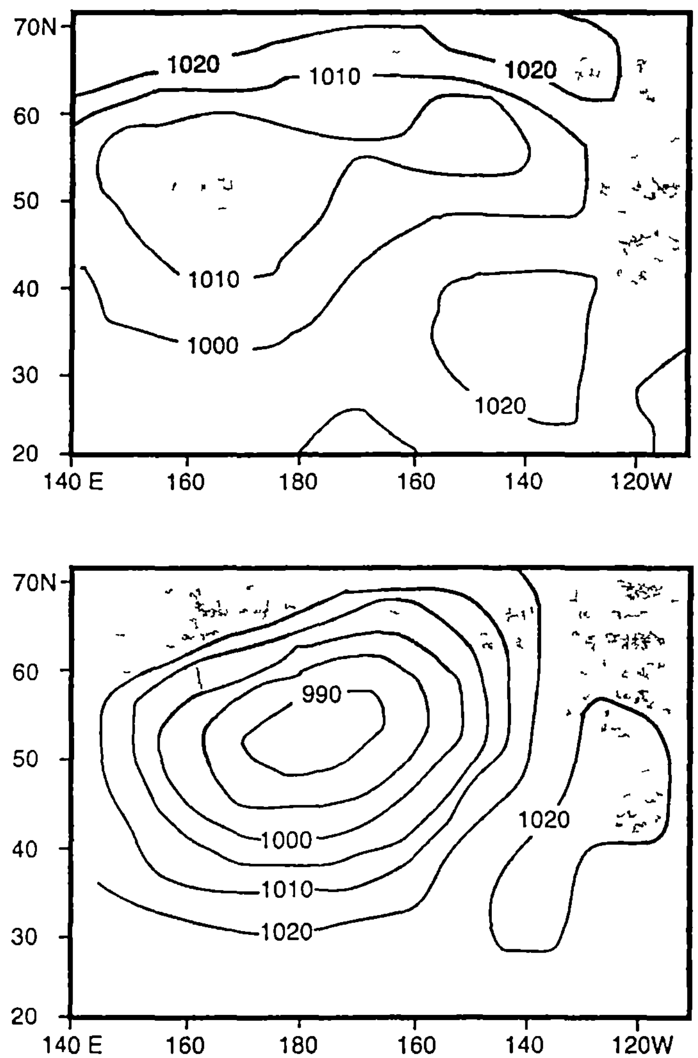

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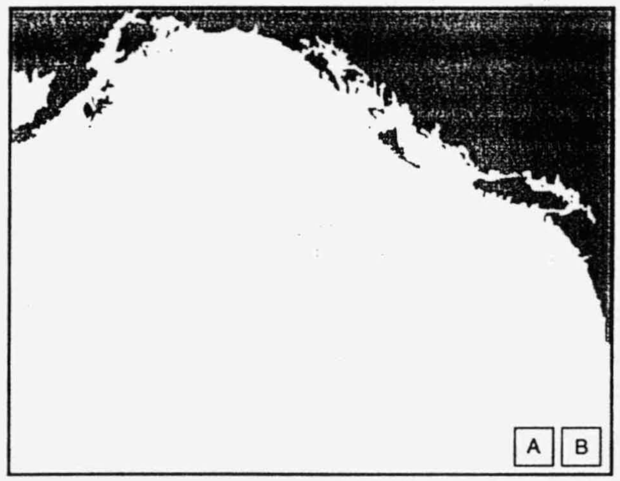

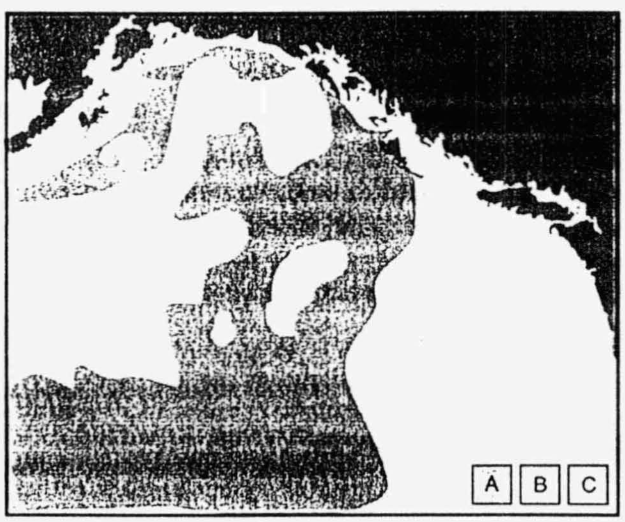

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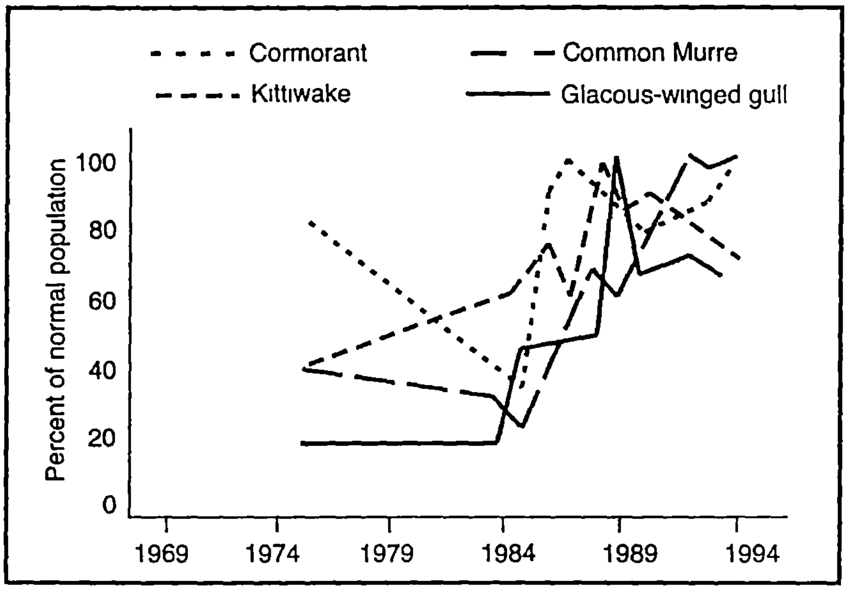

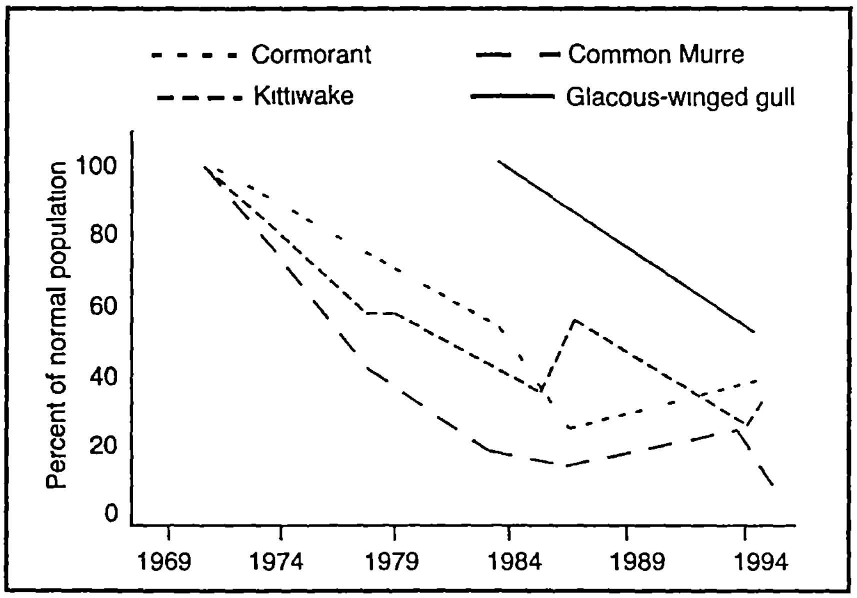

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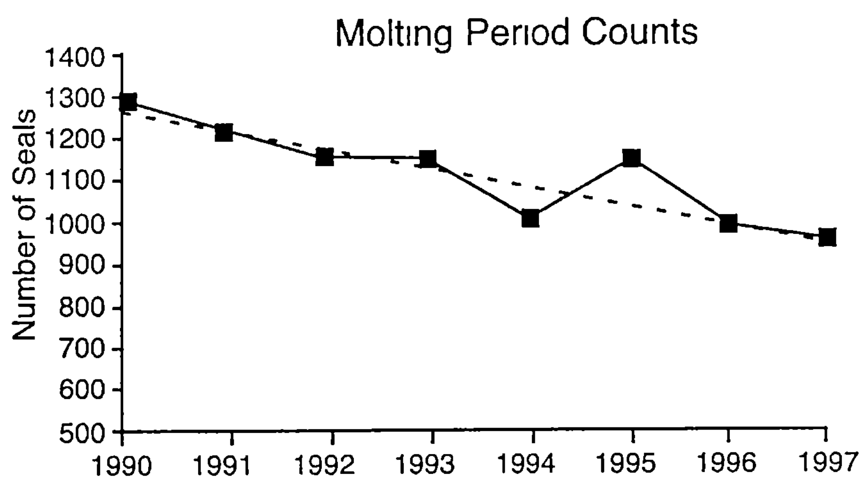

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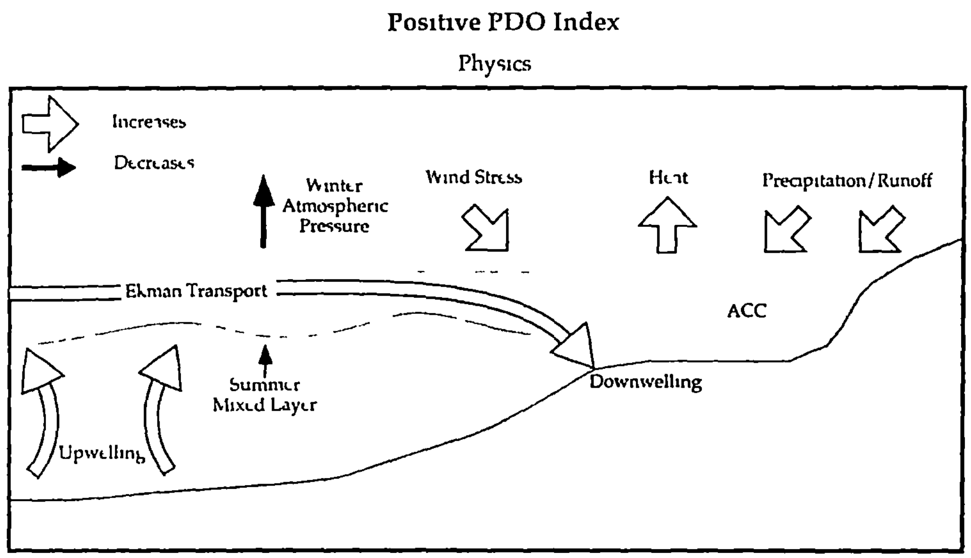

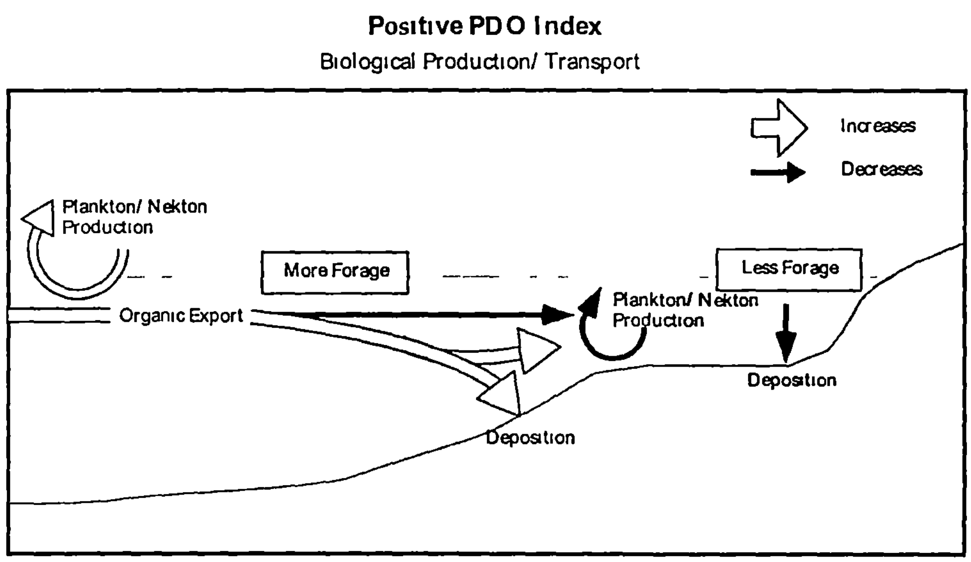

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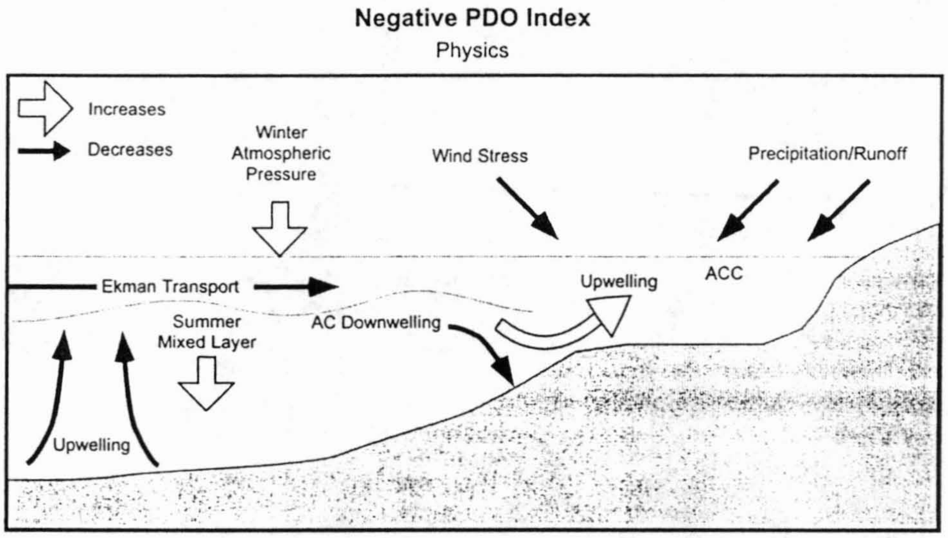

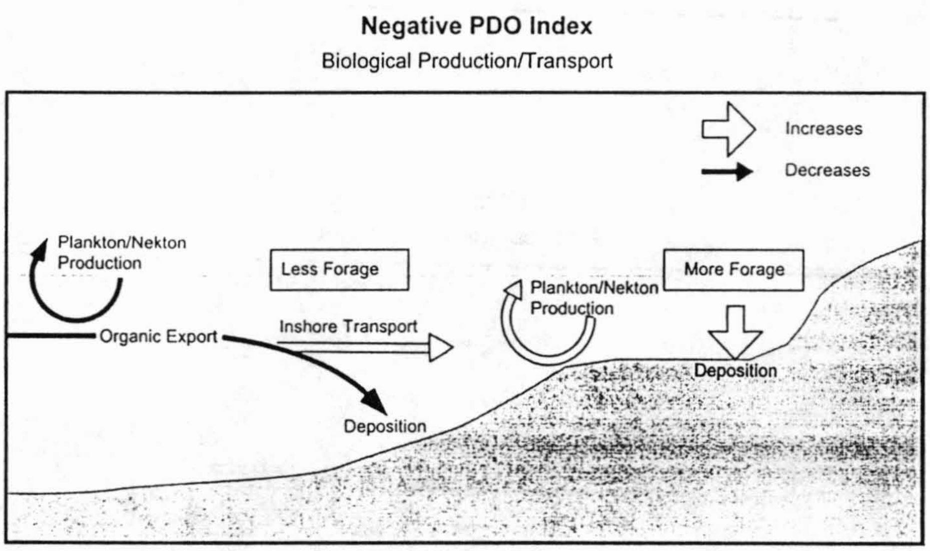

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G Summaries of Active Monitoring Projects in the Northern Gulf of Alaska

In June 1999, the Restoration Office began to develop a database of monitoring, research and retrospective projects in the northern Gulf of Alaska The purpose of the database is to identify major sources of data germane to the Gulf Ecosystem Monitoring (GEM) program

As of September 2000, the database has information on 243 projects Most of these projects have been funded or conducted by government agencies The database includes many projects that collect primary data Examples include meteorological and oceanographic data from satellites or buoys Other projects use this data or retrospective data to study an issue of interest to GEM Still other projects compile data into catalogues or databases Examples of such compilations are the Coded Wire Tag Database, the Pacific Seabird Monitoring Database, and the Beringian Seabird Catalogue

The following pages include descriptions of the most pertinent projects and programs to aid in identifying monitoring and research gaps Each record includes a description of the project and, if known, the geographic area of the project, the organization sponsoring the project, the name and contact information for the principal investigator, the type of data gathered, and the project's duration

This list may not be complete Your assistance is needed if there are any errors or omissions

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Discipline		Marine Mammals
ID#	011	Northern Sea Lion Counts
	013	Sea Otter Biomonitoring Program
	057	Annual Survey of Cook Inlet Beluga Whales
	058	Biennial Survey of Eastern North Pacific Ocean Gray Whales
	059	Aundance of Pelagic Delphinids and Harbor Porpoise off the Coast of Alaska
	060	Harbor Seals
	072	Marine Mammal Protection/Endangered Species Acts Compliance
	073	Cook Inlet Set and Drift Gillnet Marine Mammal Observer Project
	074	Marine Mammal Health and Stranding Response Program (MMHSRP) Data Base
	131	Marine Mammal Marking, Tagging and Reporting Program
	132	Sea Otter Stock Assessment
	157	Harbor Seal Survey
	195	Population Survey of Organochlorine Contaminants in Alaskan Steller Sea Lions
	206	Isotope Ratio Studies of Marine Mammals in Prince William Sound

Discipline		Marine & Fish Ecology
ID#	009	Winter Assessment of Shelikof Strait Spawning Pollock
	010	North Pacific Domestic Groundfish Observer Database
	012	Pacific Salmon Genetic Database Development
	018	NMFS Longline Survey of the Aleutian Region, Bering Sea, and Gulf of Alaska
	020	North Pacific Ocean Salmon Ecology
	022	Monitoring
	030	Pacific Halibut Stock Assessment
	055	Long Term Population Monitoring of Natural Populations of Seven Species of Salmonids
	061	Sablefish Longline Survey
	064	Gulf of Alaska Biennial Survey (formerly Gulf of Alaska Triennial Survey)
	067	Shellfish and Groundfish Pathogens
	118	Forage Fish Assessment of the Cook Inlet Oil and Gas Development-Affected Areas
	130	Pacific Coho Salmon Study
	139	Genetics Research for Characterizing Alaskan Salmonid Populations
	153	Sonar Enumeration of Returning Adult Salmon
	155	Groundfish Port Sampling
	158	Weirs and Counting Towers for Enumeration of Returning Adult Salmon, Escapement
	159	Aerial / Foot Surveys of Spawning Streams, Salmon Escapement
	160	Fry / Smolt Outmigration
	161	Salmon AWL (Age, Weight Length)
	162	Rockfish Assessments - Southeast Alaska

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

166	Catch Sampling - Southeast Alaska (Rockfish, Sablefish, Lingcod), Prince William Sound and Lower Cook Inlet (Rockfish, Sablefish, Pacific Cod, Pollock), Kodiak and Aleutian Islands (Rockfish)
167	Fish Tickets for Shoreside Landings
170	Herring Aerial Surveys - Statewide
171	Herring Catch Sampling - Statewide
173	Trawl Surveys - Prince William Sound, Lower Cook Inlet, and Alaska Peninsula for King and Tanner Crabs
174	Dive Surveys - Southeast Alaska Clams, and Sea Cucumbers
175	Shellfish Dockside Sampling - Statewide
176	Shellfish Catch Enumeration - Statewide
183	Subsistence Harvest
184	Monitoring Programs for Paralytic Shellfish Poison (PSP) in King Crab, Dungeness Crab and Tanner Crab
185	Scallop Dredge Survey - Prince William Sound and Cook Inlet
187	Fish Pathology Disease History Database
188	Coded Wire Tag Database
190	Sport Fish Weirs and Sonars
191	Coded Wire Tagging (CWT) of Hatchery and Selected Wild Salmonid Stocks
226	Rockfish Genetic Database Development

Discipline Seabird Ecology

ID#	003	Alaska Seabird Inventory and Monitoring Plan
	122	Monitoring and Evaluating Effects on Seabird Colonies in Potential Oil and Gas Development Areas
	127	Seabird Population Dynamics and Food Supply Assessing Long-Term Changes in Alaska Marine Ecosystem
	133	Alaska Seabird Inventory and Monitoring Plan - Annual Monitoring Sites
	135	Wintering Marine Bird and Mammal Surveys
	145	Population Status and Ecology of Shorebirds in Alaska
	223	Alaska Seabird Inventory and Monitoring Plan - Periodic Monitoring Sites
	227	Population Ecology of Seabirds on Middleton Island, Alaska

Discipline Nearshore, Benthic & Coastal Ecology

ID#	002	Age and Length Characteristics of Rainbow Trout in Selected Streams
	015	Bald Eagle Database
	016	Coastal Studies
	017	Hydrologic Data Collection and Investigations
	119	Kachemak Bay Experimental and Monitoring Studies
	152	Cook Inlet Basin Study Unit
	230	Process Structuring Coastal Marine Communties in Alaska DOI Trust Resources
	236	Certified Shellfish Beaches
	237	Lower Kenai Peninsula Watershed Health Project

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

	238	Citizens Environmental Monitoring Program (CEMP)
Discipline		Biological Oceanography
ID#	028	GLOBEC Northeast Pacific Program Remote Sensing of the Northeast Pacific Retrospective and Concurrent Time Series Analysis Using Multiple Sensors on Multiple Scales
	031	Sea-viewing Wide Field-of-view Sensor (SeaWiFS)
	032	Moderate Resolution Imaging Spectrometer (MODIS)
	068	Shelikof Strait FOCI
	229	A continuous plankton recorder monitoring program for the eastern North Pacific & southern Bering Sea
	235	Kitoi Bay Monitoring
Discipline		Physical, Geochemical & Chemical Oceanography
ID#	001	National Status and Trends Data Base
	004	Buoy Observations
	005	General Circulation and Tide Measurements / Model Output for the Coastal U S
	006	The Comprehensive Ocean-Atmosphere Data Set (COADS)
	036	Advanced Very High Resolution Radiometer (AVHRR)
	037	Advanced Earth Observing Satellite (ADEOS) II - Sea Winds 1B
	038	AIRS/AMSU/MHS
	039	EOS - ALT
	040	Quick Scatterometer (QuikSCAT) - SeaWinds Instrument
	041	TOPEX/Poseidon
	044	Sea Surface Temperature 14 Km Analysis (Local-Scale) from NOAA Series AVHRR Data
	091	Mussel Watch Project
	095	Coastal-Marine Automated Network (C-MAN)
	096	Moored Buoys
	117	Upper Ocean Circulation in the Subpolar and Northern Subtropical Pacific
	123	Sediment Quality in Depositional Areas of Shelikof Strait and Outermost Lower Cook Inlet
	124	Mapping of Cook Inlet Tide Rips Using Local Knowledge and Remote-Sensing Imagery Techniques
	177	Trident Basin Water Temperature
	207	GAK 1 TIME SERIES
	208	University of Miami TIROS-N/NOAA AVHRR Level 1b
	210	Permanent Service for Mean Sea Level (PSMSL) and Global Sea Level Observing System (GLOSS)
	211	Ships of Opportunity Program (SOOP) Low Density Expendable Bathythermograph Network (XBT)
	212	Array for Real-Time Geostrophy (ARGO)
	213	Pacific Basinwide Extended Climate Study (P-BECS)
	214	Repeat Hydrography and Special Analysis Centre
	216	Subsurface Floats
	217	Surface Drifting Buoys

Gulf Ecosystem Monitoring (GEM) Gap Analysis: Active Monitoring Projects in the Northern GOA (Non-EVOS)

218 Joint Archive for Shipboard Acoustic Doppler Current Profilers (ADCP)

219 Upper Ocean Thermal Data

220 Sea Surface Salinity

221 Surface Meteorological Data and Surface Fluxes

222 Tide Gauges

225 Line P / Station P

231 Sea Level Data, Wind Speed, and Significant Wave Height from Satellite Altimetry

241 Long-Term Environmental Monitoring Program

Gulf Ecosystem Monitoring (GEM) Gap Analysis.
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**National Status and Trends Data Base**	**ID# 00**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS)	
Description	Organic contaminants and trace metals in bivalves, fish and sediment	
Geographic Area	Coastal United States	
Measurements/ Data Obtained	Chemical concentrations Liver histopatholgy on fish biochemical markers of response to contamination	
Contact Info	Tom O'Connor NOS HQTR 1305 East West Hwy 10148 SSMC4 Silver Spring MD 20910-3281 301-713-3028 Tom Oconnor@noaa gov	
Duration	NS&T Program began in 1984 with collection of sediment and fish at about 100 sites That project ended in 1992 The Mussel watch project that collects sediments and mollusks at 250 sites began in 1986 and continues	
Future Plans	Continue Mussel Watch	
Discipline	Physical, Geochemical & Chemical Oceanography	

Gulf Ecosystem Monitoring (GEM) Gap Analysis: Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Age and Length Characteristics of Rainbow Trout in Selected Streams**	**ID#. 002**
Organization	U S Department of the Interior (DOI) Fish and Wildlife Service (FWS)	

Description

The Kodiak National Wildlife Refuge encompasses much of Kodiak Island and features many streams containing rich fishery resources These fish populations are important as a food base for many wildlife species, such as bald eagles and brown bears Many streams also provide for human subsistence needs, as well as excellent sport fishing opportunities

Because humans and wildlife depend on fish, the Alaska National Interest Lands Conservation Act (ANILCA) mandates that, within the Refuge, salmonid populations and their habitats be conserved in their natural diversity In order to meet such mandates, basic information is needed on each fisheries population

Our project on the Kodiak National Wildlife Refuge focuses specifically on rainbow trout, and is designed as a baseline survey of wild rainbow trout populations Data collected on the rainbow trout included length measurements, and scales for age determination Work began in 1995, when the Uganik, Little, and Dog Salmon rivers were surveyed A progress report is available for this portion of the project In 1996, the Akalura, Olga, and Spiridon drainages were surveyed A progress report should be available by June, 1997 Surveys scheduled for 1997 include the Ayakulik and Karluk drainages

Geographic Area Kodiak Island

Measurements/ Data Obtained Work began in 1995, when the Uganik, Little, and Dog Salmon rivers were surveyed A progress report is available for this portion of the project In 1996, the Akalura, Olga, and Spiridon drainages were surveyed A progress report should be available by June, 1997

Contact Info

Tony Chatto
Kodiak National Wildlife Refuge
1390 Buskin River Road
Kodiak AK 99615
(907) 487-2600 (907) 487-2144
Tony_Chatto@fws gov

Duration 1995-1997?

Future Plans Surveys scheduled for 1997 include the Ayakulik and Karluk drainages

Discipline Nearshore, Benthic & Coastal Ecology

Project	**Alaska Seabird Inventory and Monitoring Plan**	**ID# 00_**
Organization	U S Department of the Interior (DOI) Fish and Wildlife Service (FWS)	
Description	The inventory plan describes qualitative surveys of seabird abundance and distribution throughout the state The monitoring plan designates monitoring sites and indicator species for quantative evaluation of trends Both inventoring and monitoring are done at breeding colonies and on the water	
Geographic Area	All of Alaska	
Measurements/ Data Obtained		
Contact Info	Kent Wohl US Fish and Wildlife Service 1011 East Tudor Road Anchorage AK 99503-6199 907-786-3503 kent_wohl@fws gov	
Duration	Continuing	
Future Plans	Need to maintain a full-time manager's position for the seabird colony inventories Inventories of breeding murrelet abundance need to be extended beyond forested shorelines and associated feeding areas and breeding sites in Prince William Sound, particularly where perturbations such a logging are likely A GIS database should be developed to summarize studies of foraging areas Winter foraging areas should be defined A seabird-oriented wintering concentration survey to describe distributions of all species including *Brachyrhamphus* murrelets is a very high priority Statistically designed surveys to conduct inventories at sea are needed	
Discipline	Seabird Ecology	

Gulf Ecosystem Monitoring (GEM) Gap Analysis.
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Buoy Observations**	**ID# 004**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS)	
Description	File contains data from 1979 through the present including air and dew point, temperature, sea level pressure, wind direction and speed, current weather, significant wave height, average wave period, and wave spectra data (frequency, resolution and density)	
Geographic Area	Geographic coverage encompasses US coastal marine (BUOY) and headland Coastal-Marine Automated Network (C-MAN) stations for the northern Atlantic and Pacific Oceans, the Great Lakes, Gulf of Alaska, Gulf of Mexico and the Hawaiian Island areas	
Measurements/ Data Obtained	Air and dew point, temperature, sea level pressure, wind direction and speed, current weather, significant wave height, average wave period, and wave spectra data (frequency, resolution and density)	
Contact Info	Sam McCown National Climatic Data Center Research Customer Service Group Federal Building 151 Patton Ave Asheville NC 28801-5001 828 271-4800 ext 174 smccown@ncdc noaa gov	
Duration	File contains data from 1979 through the present	
Future Plans	Ongoing	
Discipline	Physical, Geochemical & Chemical Oceanography	

Project	**General Circulation and Tide Measurements / Model Output for the Coastal U S**	**ID# 00**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Environmental Satellite, Data and Information Service (NESDIS)	
Description	Project actually references Long Island Sound, but refers to measurements in Cook Inlet, AK Check with PI to see what long time series information is available	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Henry Frey NOAA/NESDIS/NODC 1315 East-West Hwy 11837 SSMC3 Silver Spring MD 20910-3282 301-713-3270 Hank R Frey@noaa gov	
Duration		
Future Plans		
Discipline	Physical, Geochemical & Chemical Oceanography	

Project	**The Comprehensive Ocean-Atmosphere Data Set (COADS)**	**ID#. 006**
Organization	National Oceanic and Atmospheric Administration (NOAA) Ocean and Atmospheric Research (OAR)	
Description	The most extensive collection of surface marine data available for the world oceans of the past century and a half (since 1854)	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	CDC Data Management Climate Diagnostics Center, NOAA 325 Broadway Boulder CO 80303 303-497-6640 cdcdata@cdc noaa gov	
Duration		
Future Plans		
Discipline	Physical, Geochemical & Chemical Oceanography	

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Winter Assessment of Shelikof Strait Spawning Pollock**	**ID# 009**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)	
Description	Winter survey using acoustic (echo location) technology and midwater trawls to develop time series of Shelikof Strait pollock abundance and distribution have been conducted annually since 1981	
Geographic Area		
Measurements/ Data Obtained		
Contact Info		
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Project	**North Pacific Domestic Groundfish Observer Database**	**ID#. 010**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)	
Description	Commercial catch and biomass parameters of groudfish species collected by observers aboard domestic (US) commercial fishing vessels operating in the EEZ of the Bering Sea and North Pacific ocean	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Martin Loefflad NMFS Route F/AKC3 7600 Sand Point Way NE Seattle WA 98115-0070 206-526-4195 Martin Loefflad@noaa gov	
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Project	**Northern Sea Lion Counts**	**ID# 01'.**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)	
Description	A compilation of counts of northern sea lions obvserved on land at sites along the north Pacific Rim rom 1958 to the present Annual summer counts (collected periodically since 1958) made at 151 locations in the Aleutians and the Gulf of Alaska are machine-readable format	
Geographic Area		
Measurements/ - Data Obtained		
Contact Info	Tom Loughlin National Marine Mammal Lab 7600 Sand Point Way NE Seattle WA 98115 206-526-4040 Tom Loughlin@noaa gov	
Duration		
Future Plans		
Discipline	Marine Mammals	

Project	**Pacific Salmon Genetic Database Development**	**ID# 012**
Organization	U S Department of the Interior (DOI) National Marine Fisheries Service (NMFS)	
Description	Develop allozyme and DNA databases for Pacific salmon throughout the North Pacific region	
Geographic Area	North Pacific Region	
Measurements/ Data Obtained	Allozyme and DNA data of Pacific salmon stocks	
Contact Info	Richard Wilmot NOAA-NMFS Auke Bay Laboratory 11305 Glacier Highway Juneau AK 99801-8626 (907)789-6079 Richard Wilmot@noaa gov	
Duration	On-going	
Future Plans		
Discipline	Marine & Fish Ecology	

Project **Sea Otter Biomonitoring Program** **ID# 013**

Organization U S Department of the Interior (DOI)

Fish and Wildlife Service (FWS)

Description The Marine Mammals Management Office (MMM) and the Alaska Sea Otter Commission (Commission) are conducting a sea otter monitoring program designed to give biologists additional information about the health, diet and life history of sea otters in Alaska The Commission is made up of native representatives from coastal areas in Alaska where sea otters are hunted This program provides training for villagers on biological sampling techniques used in wildlife management So far,approximately 30 Native Alaskans from 11 villages have been trained as sea otter "bio-monitors" to collect samples for the Fish and Wildlife Service from any sea otters that are brought in by local villagers

Through a special grant received by the Commission, bio-monitors collect samples from sea otters that are brought in by Native hunters They collect data on location and time that the otter was taken, its general health condition and collect samples of kidney, liver, muscle, bone,whiskers, and a tooth The tooth will be processed to determine the age of the animal All other samples will be frozen or preserved, sent to MMM and saved for further examination to look for contaminants, disease or to provide additional information about sea otter life history Some tissues will be used for genetic analysis to answer questions about how much genetic diversity exists within the state We hope that this program will give biologists information on differences between otters from all over Alaska and increase our knowledge about sea otters in Alaska

Geographic Area Coastal areas in Alaska where sea otters are hunted

Measurements/ Data Obtained

Contact Info

Duration ?

Future Plans

Discipline Marine Mammals

Project **Bald Eagle Database** **ID# 015**

Organization U S Department of the Interior (DOI)

Fish and Wildlife Service (FWS)

Description

Geographic Area

Measurements/ Data Obtained

Contact Info

Duration

Future Plans

Discipline Nearshore, Benthic & Coastal Ecology

Project	**Coastal Studies**	**ID# 01(**
Organization	U S Department of the Interior (DOI) National Park Service (NPS)	
Description	See USGS for more information	
Geographic Area		
Measurements/ Data Obtained		
Contact Info		
Duration		
Future Plans		
Discipline	Nearshore, Benthic & Coastal Ecology	

Project	**Hydrologic Data Collection and Investigations**	**ID# 017**
Organization	U S Department of the Interior (DOI) Fish and Wildlife Service (FWS)	
Description	Installs and maintains a stream discharge gaging network to collect water yield data on selected refuges within the Alaska Region Data is collected continously over a five-year period There are 14 stream discharge gaging stations in operation on the Kenai National Wildlife Refuge, 1 gaging station on the Becharof National Wildlife Refuge, 9 gaging stations on the Innoko National Wildlife Refuge, and 20 gaging stations on the Togiak National Wildlife Refuge	
Geographic Area	Statewide within National Wildlife Refuges (NWR) Two surveys are underway in the Gulf of Alaska region, one in the Kenai NWR and one in the Becharof NWR A survey is planned for the Kodiak Island NWR	
Measurements/ Data Obtained	Stream discharge average daily discharge (cubic feet per second), maximum and minimum discharge Surface water elevations height relative to mean sea level (feet)	
Contact Info	Steve Lyons Anchorage AK 99503 907-786-3515 steve_lyons@fws gov	
Duration	Ongoing Five continuous years on each refuge Eleven (11) gages were installed in the Kenai NWR in October 1994 Four additional gages were installed in August 1995 All gages will be discontinued October 2000 Only one gage was installed in the Becharof NWR That gage, on the Egegik River, was installed in September 1996 There are no plans to discontinue the Egegik River gage at this time	
Future Plans	When funding becomes available, a 5-year Water Resource Study is planned for Kodiak National Wildlife Refuge followed by a study on Koyukuk/Nowitna National Wildlife Refuge, then Selawik National Wildlife Refuge Proposed Kodiak NWR water resource inventory (10 stream discharge gages) would cost about $90,000 in its first, year, including start-uo equipment costs, and a total of $106,000 for the remaining 4 years	
Discipline	Nearshore, Benthic & Coastal Ecology	

Project	**NMFS Longline Survey of the Aleutian Region, Bering Sea, and Gulf of Alaska**	**ID#. 018**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)	
Description	Annual surveys of sablefish (*Anoplopoma fimbria*) Originally conducted as part of the Japan-US Cooperative Longline Survey (1979-1994), NMFS began independent parallel study in 1987 Annual study derives population size and structure Sufficient auxillary data collected to determine abundance and lenght composition of shortspine thorneyhead, *Sebastolobus alascanus*, rougheye rockfish, *Sebastes aleutianus*, and shortraker rockfish, *Sebastes borealis*	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Michael Sigler NMFS WASC Route F/AKC5 11305 Glacier Hwy Juneau AK 99801-8626 907-789-6051 Tom Rutecki@noaa gov	
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Gulf Ecosystem Monitoring (GEM) Gap Analysis. Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project **North Pacific Ocean Salmon Ecology** **ID# 02**

Organization National Oceanic and Atmospheric Administration (NOAA)

National Marine Fisheries Service (NMFS)

Description The Auke Bay Laboratory's Ocean Carrying Capacity program conducts field research in coastal waters and on the high seas of the Gulf of Alaska and North Pacific Ocean Major research effort focuses on 1) studies to document the ocean migrations of salmonids and their relative abundance and movement patterns by species and stock groups (Carlson et al 1996, 1997, and 1998, Wing et al 1998, McKinnell et al 1997) , 2) stock identity studies which show the incidence of hatchery fish and their origin (Farley and Munk 1998, Farley and Munk 1997, Ignell et al 1997), and genetic makeup of salmonids at specific sites on their migration path, 3) growth and condition studies to examine the general health and well-being of salmonids (Smoker and Ignell 1996), 4) diet studies of salmonids which explore potential for interspecific competition and compare diet of non-salmonid fishes (Sturdevant et al 1997), and 5) studies of the physical and biological environment of salmonids during their ocean migrations

Gulf of Alaska

Research cruises conducted from March to October have sampled salmonids and other marine life and documented their environment since 1995 Cruises have covered the entire North Pacific coastline of Alaska from Dixon Entrance to Attu Island in the western Aleutian Islands and parts of the Bering Sea The surveys have also extended far offshore into oceanic waters of the North Pacific Ocean Results show substantial proportions of hatchery marks and a broad mixture of stocks of varied genetic origins Analyses of growth and diet of salmonids are under way and results will be published in the near future

High-seas salmon studies

An integrated program of field and laboratory studies and computer modeling in cooperation with the Fisheries Research Institute is designed to address North Pacific Anadromous Fish Commission (NPAFC)-related scientific research issues in the international waters of the North Pacific Ocean and Bering Sea The current cooperative program includes 1) field research aboard salmon research vessels, 2) analyses of high-seas salmonid food habits data and development of ocean salmon bioenergetic models 3) various studies of ocean

Geographic Area

Measurements/ Data Obtained

Contact Info John Helle
NMFS WASC
Route F/AKC5
11305 Glacier Hwy
Juneau AK 99801-8626
907-789-6038
Jack Helle@noaa gov

Duration

Future Plans

Discipline Marine & Fish Ecology

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Monitoring**	**ID# 022**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)	
Description	Changes in age and size at maturity of salmon Long-term monitoring activities provide data for evaluating the influence of marine climate on the dynamics of salmon and marine fish populations Populations of chum salmon are sampled yearly for size and age at various locations in Alaska and Washington (Helle and Hoffman 1998, Bigler, Welch, and Helle 1996, and Helle and Hoffman 1995) Abundance and age and size at maturity of salmon are essential information for monitoring studies Chum salmon populations are of special interest because most of their growth occurs in the ocean and they mature at various ages Therefore, chum salmon could be indicators of ocean carrying capacity because they respond to ocean conditions and competition by changing their size and age of maturity Thermal otolith marking of pink and chum salmon stocks and studying the effects of climate forcing on hte physical and biological characteristics of salmon habitat Prediction of year class strength	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	John Helle NMFS WASC Route F/AKC5 11305 Glacier Hwy Juneau AK 99801-8626 907-789-6038 Jack Helle@noaa gov	
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project **GLOBEC Northeast Pacific Program Remote Sensing of the Northeast Pacific Retrospective and Concurrent Time Series Analysis Using Multiple Sensors on Multiple Scales** **ID# 02**

Organization National Oceanic and Atmospheric Administration (NOAA)

Coastal Ocean Program (COP)

Description

Types of data or derived indices being analyzed
Satellite SST - 1 km absolute temperature, cloud masked Approximately 19N--56N, from the coast out to 132W-138W 1-4 images per day
Satellite SST - Pathfinder 9 km absolute temperature, cloud masked
Satellite Altimeter Heights - TOPEX/POSEIDON, ERS-1, ERS-2 covering the NE Pacific from the equator to 61N, out to 170W
Satellite Color - Surface Pigment Concentrations, over the eastern basin during available periods (Oct 1997 - on)
SAR Imagery - selected scenes off Newport OR during cruises
Tide Gauge SLH From stations along the west coasts of N and S America, Hourly to daily

Types of analysis
Covariability of transports in the Subarctic and Subtropical Gyres and their connection to the interior N Pacific and wind forcing
Seasonal and mesoscale circulation variability in selected areas of the two gyres
Relationship between surface pigments, SST, wind and circulation (Thomas)
Small-scale circulation in regions next to the coast (Svejkovsky) using SAR data

Progress anticipated at the end of year 1
The 1-km AVHRR data will be processed and made available through ftp and a web site in an ongoing fashion Data from 1981-1997 will be processed similarly as quickly as possible (several past years should be available by the end of 1998)
A subset of the 9-km Pathfinder AVHRR data will be made for the Northeast Pacific from the available data set near the end of year 1 (approximately 1985-1996) SeaWiFS ocean color (and OCTS, when available) data will be collected over the NE Pacific and made available to those who are officially registered users with NASA The covariability of transports will be analyzed for the period October 1992 to November 1997 (or later, if available) to show the normal seasonal cycle of basin-scale tranports and the interannual variability during the onset of the 1997-1998 El Nino

Geographic Area The large-scale Northeast Pacific, with primary focus on the covariability of the Alaska Gyre, the California Current and the North Pacific Current Some studies related to El Niño variability will extend to the equator A supplemental grant from NSF has added a component comparing the NE Pacific to the SE Pacific (the Peru-Chile Current System)

Measurements/ Data Obtained

SST - 1985-1999
SSH - 1993-1999
Pigment - Oct 1997 - 1999
SAR scenes, several each year

Contact Info

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College of Oceanic and Atmospheric Sciences
Oregon State University
104 Ocean Administration Building
Corvallis OR 97331-5503
(541) 737-3015 (541) 737-2064
tstrub@oce orst edu

Duration August 1997 - July 2000 Possibly extended during the second phase of the GLOBEC NE Pacific program

Future Plans A proposal has been submitted to the next phase of the GLOBEC NE Pacific program to continue this work for the next 5 years (October 1994)

Discipline Biological Oceanography

Project **Pacific Halibut Stock Assessment** **ID# 030**

Organization International Pacific Halibut Commission (IPHC)

Description Each year, IPHC staff assess the abundance and potential yield of Pacific halibut using all available data from the commercial fishery and scientific surveys Stock assessments are supported by two projects operated by the IPHC fishery statistics and stock assessment surveys

Geographic Area All of Alaska, British Columbia, and Washington-Oregon-California within the Pacific halibut range

Measurements/ Data Obtained Age, length, catch, effort, sex, sexual maturity

Contact Info William Clark
International Pacific Halibut Commission
P O Box 95009
Seattle WA 98145-2009
206-634-1838 206-632-2983
bill@iphc washington edu

Duration "Current" data since 1974--collected more or less consistently, "Historical " data since 1935 -- some data gaps or irregular data collection

Future Plans Ongoing

Discipline Marine & Fish Ecology

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Sea-viewing Wide Field-of-view Sensor (SeaWiFS)**	**ID# 031**
Organization	National Aeronautics and Space Administration (NASA) Earth Science Enterprise (ESE)	
Description	An instrument on the SeaStar spacecraft that measures accurate ocean color to clarify magnitude and variability of chlorophyll and primary production by marine phytoplankton, and to determine the distribution and timing of spring blooms Launched August 1, 1997, it is a follow-up to the CZCS	
Geographic Area	Global	
Measurements/ Data Obtained	Top-of-the-atmosphere radiances at 412, 443, 490, 510, 555, 670, 765 and 865 nm, instrument and spacecraft telemetry from the OrbView-2 data stream, total column ozone from the TOMS project, meteorological fields (wind, humidity, pressure) from NCEP operational data products	
Contact Info	Charles McClain NASA Goddard Space Flight Center Mailstop 970 2 Greenbelt MD 20771 301-286-5377 301- mcclain@calval gsfc nasa gov or	
Duration	5 years	
Future Plans	Possible extension of spacecraft operations / data collection beyond 5-year nominal lifetime	
Discipline	Biological Oceanography	

Project **Moderate Resolution Imaging Spectrometer (MODIS)** **ID# 032**

Organization National Aeronautics and Space Administration (NASA)

Earth Science Enterprise (ESE)

Description Provides a comprehensive series of global observations of the Earth's land, oceans, and atmosphere in the visible and infrared regions of the spectrum in such a way as to view the entire surface of the Earth every two days Extends data sets started by AVHRR (sea surface temperature, sea ice), CZCS (oceanic biomass and ocean circulation patterns) Thus MODIS will measure several characteristics of phytoplankton (including primary productivity, coccolith concentrations, chlorophyll fluorescece, chlorophyll a concentration, phycoerythrin concentration) and sea surface temperature MODIS instruments will be on board the EOS-AM 1 (TERRA), EOS-PM 1, MISR, MERIS, and GLI satellites

Geographic Area Global

Measurements/ Data Obtained

Contact Info Wayne Esaias
Goddard Space Flight Center, Code 971

Greenbelt MD 20771
301-614-5709 301-614-5644
Wayne E Esaias@gsfc nasa gov

Duration

Future Plans

Discipline Biological Oceanography

Project **Advanced Very High Resolution Radiometer (AVHRR)** **ID#· 036**

Organization National Aeronautics and Space Administration (NASA)

Earth Science Enterprise (ESE)

Description Measures sea surface temperature Instruments are on board NOAA s-7, -9, -11, and -14 polar orbiting satellites since 1982 See NOAA, the lead agency, for more information

Geographic Area

Measurements/ Data Obtained

Contact Info

Duration

Future Plans

Discipline Physical, Geochemical & Chemical Oceanography

Gulf Ecosystem Monitoring (GEM) Gap Analysis·
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project **Advanced Earth Observing Satellite (ADEOS) II - Sea Winds 1B** **ID# 03.**

Organization National Aeronautics and Space Administration (NASA)

Earth Science Enterprise (ESE)

Description The Advanced Earth Observing Satellite II (ADEOS II), the successor to the Advanced Earth Observing Satellite (ADEOS) mission, is a joint mission with the National Space Development Agency (NASDA) of Japan The mission will take an active part in the research of global climate changes and their effect on weather phenomena It continues the data series begun in 1996 by the NSCAT Scheduled to be launched in 2000

Geographic Area Requirement 90% of the Earth surface in 48 hours The performance of SeaWinds on ADEOS II is expected to be 90% in 24 hours, 95 % in 48 hours and 100% in > 72 hours

Measurements/ Data Obtained Global, all-weather measurements of micowave radar back scatter cross-section over land, ice and oceans and 25 km resolution near-surface wind vector measurements over the ice-free oceans

Contact Info Carroll Winn

NASA, JPL
4800 Oak Grove Drive
M/S 264-626

Pasadena CA 91109-8099

818-354-9303

carroll f winn@jpl nasa gov

Duration Three years after launch with a 5 year goal

Future Plans To be determined

Discipline Physical, Geochemical & Chemical Oceanography

Project **AIRS/AMSU/MHS** **ID# 038**

Organization National Aeronautics and Space Administration (NASA)

Earth Science Enterprise (ESE)

Description Measurements of sea surface temperature Only referenece is Mission to Planet Earth - Scientific Reserach Plan, Section IV
(http //www earth nasa gov/visions/drafsciplan/section4 htm)

Geographic Area

Measurements/ Data Obtained

Contact Info

Duration

Future Plans

Discipline Physical, Geochemical & Chemical Oceanography

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project **EOS - ALT** **ID# 039**

Organization National Aeronautics and Space Administration (NASA)

Earth Science Enterprise (ESE)

Description Satellite instrument measuring absolute sea level Only referenece is Mission to Planet Earth - Scientific Reserach Plan, Section IV
(http //www earth nasa gov/visions/drafsciplan/section4 htm)
Same as the JASON?

Geographic Area

Measurements/ Data Obtained

Contact Info

Duration

Future Plans

Discipline Physical, Geochemical & Chemical Oceanography

Project **Quick Scatterometer (QuikSCAT) - SeaWinds Instrument** **ID#· 040**

Organization National Aeronautics and Space Administration (NASA)

Earth Science Enterprise (ESE)

Description Launched 6/19/99, QuikSCAT is a "quick recovery" mission to fill the data gap when the NASA Scatterometer (NSCAT) lost power in June 1997 The SeaWinds instrument is a specialized microwave radar that measures near-surface wind speed and direction under all weather and cloud conditions over the Earth's oceans Takes 400,000 measurements a day covering 90% of the Earth's surface/day Also studies daily/seasonal sea ice edge movement It will be followed by SeaWinds 1B on the ADEOS II in 2000

Geographic Area Requirement 90% of the Earth surface in 48 hours The performance of SeaWinds on QuikSCAT is 90% in 24 hours, 95 % in 48 hours and 100% in > 72 hours

Measurements/ Data Obtained Global, all-weather measurements of micowave radar back scatter cross-section over land, ice and oceans and 25 km resolution near-surface wind vector measurements over the ice-free oceans

Contact Info Carroll Winn
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Pasadena CA 91109-8099
818-354-9303
carroll f winn@jpl nasa gov

Duration QuikSCAT will produce data through at least August 2001

Future Plans SeaWinds on ADEOS II launch November 2000

Discipline Physical, Geochemical & Chemical Oceanography

Gulf Ecosystem Monitoring (GEM) Gap Analysis.
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**TOPEX/Poseidon**	**ID# 041**
Organization	National Aeronautics and Space Administration (NASA) Earth Science Enterprise (ESE)	

Description Measures sea level within 10 centimeters along the same path every 10 days, Launched August 1992 Jason-1 will be follow-on mission in 2000 Data is used for fisheries management and marine mammal habitat studies though it does not appear that this data has been used for this purpose in Alaska

Geographic Area

Measurements/ Data Obtained

Contact Info James Graf
4800 Oak Grove Drive
M/S 264-626

Pasadena CA 91109-8099
818-354-4765
James E Graf@jpl nasa gov or

Duration

Future Plans

Discipline Physical, Geochemical & Chemical Oceanography

Gulf Ecosystem Monitoring (GEM) Gap Analysis. Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Sea Surface Temperature 14 Km Analysis (Local-Scale) from NOAA Series AVHRR Data**	**ID# 044**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Environmental Satellite, Data and Information Service (NESDIS)	
Description	AVHRR records of 14-km scale sea surface temperatures from 1986 to the present For real-time data, see the NESDIS CoastWatch Program For archived data contact the National Climatic Data Center listed below	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	John Sapper Office of Satellite Data Processing and Distribution Suitland Federal Center FB#4, E/SP13, Room 20439 Suitland MD 20746 301 457-5195 john sapper@noaa gov	
Duration		
Future Plans		
Discipline	Physical, Geochemical & Chemical Oceanography	

Project	**Long Term Population Monitoring of Natural Populations of Seven Species of Salmonids**	**ID#. 055**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)	
Description		
Geographic Area		
Measurements/ Data Obtained		
Contact Info	William Heard NMFS WASC Route F/AKC5 11305 Glacier Hwy Juneau AK 99801-6094 907-789-6003 Bill Heard@noaa gov	
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Project **Annual Survey of Cook Inlet Beluga Whales** **ID# 057**

Organization National Oceanic and Atmospheric Administration (NOAA)
National Marine Fisheries Service (NMFS)

Description

Geographic Area

Measurements/ Data Obtained

Contact Info
Richard Ferrero
NMFS WASC
Route F/AKC4
7600 Sand Point Way NE
Seattle WA 98115-0070
206-526-6266
Rich Ferrero@noaa gov

Duration

Future Plans

Discipline Marine Mammals

Project **Biennial Survey of Eastern North Pacific Ocean Gray Whales** **ID# 058**

Organization National Oceanic and Atmospheric Administration (NOAA)
National Marine Fisheries Service (NMFS)

Description

Geographic Area

Measurements/ Data Obtained

Contact Info
Richard Ferrero
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206-526-6266
Rich Ferrero@noaa gov

Duration

Future Plans

Discipline Marine Mammals

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Aundance of Pelagic Delphinids and Harbor Porpoise off the Coast of Alaska**	**ID# 059**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)	
Description		
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Richard Ferrero NMFS Route AKC4 Sand Point Way NE Seattle WA 98115-0070 206-526-6266 Rich Ferrero@noaa gov	
Duration		
Future Plans		
Discipline	Marine Mammals	

Project	**Harbor Seals**	**ID#. 060**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)	
Description	Stock structure, abundance, mortality, net productivity	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	National Marine Mammal Lab 7600 Sand Point Way NE Seattle WA 98115	
Duration		
Future Plans		
Discipline	Marine Mammals	

Project	**Sablefish Longline Survey**	**ID# 06.**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)	
Description	See ABL	
Geographic Area		
Measurements/ Data Obtained		
Contact Info		
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Project	**Gulf of Alaska Biennial Survey (formerly Gulf of Alaska Triennial Survey)**	**ID# 064**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)	
Description	Using standardized RACE Division bottom trawls and a random-stratified survey design, the bottom trawl survey collects data to estimate the catch-per-unit-effort, biomass and size and age distribution of commercial and non-commercial fish and invertebrates The primary survey objectives are to (1) Delineate the distributions of the major groundfish and commercially important invertebrate species inhabiting the continental shelf and upper continental slope of the Gulf of Alaska and to (2) collect data to estimate the abundance and biological condition of the major groundfish species	
Geographic Area	Islands of Four Mountains (170W) to Dixon Entrance (U S -Canada border) nearshore of the 1,000 m isobath	
Measurements/ Data Obtained	Summer months of 1984, 1987, 1990, 1993, 1996 and 1999 from depths ranging from approximately 20-1,000 m over the continental shelf and upper slope waters Approximately 800 trawl stations completed/survey Beginning in 2001, the survey is scheduled to be conducted every two years	
Contact Info	Michael Martin NMFS Route F/AKC2 7600 Sand Point Way NE Seattle WA 98115-0070 206-526-4147 Michael Martin@noaa gov	
Duration	Biennially Three vessels @75 days each	
Future Plans		
Discipline	Marine & Fish Ecology	

Project	**Shellfish and Groundfish Pathogens**	**ID# 067**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)	
Description	Identify and track potential pathogens in the dominant shellfish and groundfish stocks in the north Pacific Ocean and Bering Sea Studies are in progress to describe the onset of parasitism in juvenile walleye pollock and identify specific parasites which are likely to present lethal risk to juvenile cohorts For those disease which may have high epizootic potential in the short term, fishery operations and management practices must be reviewed to insure that they are not contributing to the spread of the disease	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Frank Morado NMFS F/AKC2 7600 Sand Point Way NE Seattle WA 98115-0070 206-526-6572 Frank Morado@noaa gov	
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Project	**Shelikof Strait FOCI**	**ID#· 068**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)	
Description	An annual series of research cruises aboard NOAA ship Miller Freeman to census eggs and larvae, measure meterorological, physical, and biological oceanographic variables, and investigate larval transport and prey and predator densities Data is currently used to forecast annual recruitment for pollock in the Gulf of Alaska	
Geographic Area		
Measurements/ Data Obtained	The program is currently making annual forecasts of future recruitment levels for pollock in the Gulf of Alaska	
Contact Info		
Duration		
Future Plans		
Discipline	Biological Oceanography	

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Marine Mammal Protection/Endangered Species Acts Compliance** **ID# 07_**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)
Description	Observers collect information necessary to support maangement of marine mammals, seabirds, and other protected species Documents incidental takes and sightings Data from NPGOP provides this information to NMML and USFWS
Geographic Area	
Measurements/ Data Obtained	
Contact Info	Lowell Fritz NMFS Route F/AKC3 7600 Sand Point Way NE Seattle WA 98115-0070 206-526-4246 Lowell Fritz@noaa gov
Duration	
Future Plans	
Discipline	Marine Mammals

Project **Cook Inlet Set and Drift Gillnet Marine Mammal Observer Project** **ID# 073**

Organization National Oceanic and Atmospheric Administration (NOAA)

National Marine Fisheries Service (NMFS)

Description Assesses the extent of marine mammal interactions with the Cook Inlet salmon set and drift gillnet fisheries

Geographic Area Cook Inlet, Alaska Most of the set fishery, and all of the drift fishery effort (and hence observer effort) is focused in the Upper Cook Inlet, north of Anchor Point

Measurements/ Data Obtained Fishery characteristic data includes set duration, timing, location, gear type, net orientation, percent of net fishing, proximity to shore and other nets, and species and size of catch Environmental data describing sea and weather conditions includes sea state, estimates of wind speed, swell height and direction, tide stage, and habitat type (river mouth, embayment, point, etc) Numbers, species, and behavior of seabirds and marine mammals observed near nets are recorded, and if used the effectiveness of deterents If there is an interaction or entanglement with the net, then additional data to describe in detail the behavior of the animal, response/behavior of the fisherman, and out

Contact Info

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Duration Cook Inlet fisheries 1999 and 2000, additional fisheries through at least 2005

Future Plans The current plans (subject to change) are to observe Kodiak Island and Yakutat salmon set gillnet fisheries in 01/02, and Southeast Alaska salmon purse seine and drift gillnet fisheries in 03/04 If incidental mortality and serious injury levels are found to be high, additional periods of observation within a fishery may result

Discipline Marine Mammals

Gulf Ecosystem Monitoring (GEM) Gap Analysis.
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Marine Mammal Health and Stranding Response Program (MMHSRP) Data Base**	**ID# 074**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)	
Description	Contaminant data, as well as, life history parameters, pathology and serology for marine mammals	
Geographic Area	US coastal waters including Alaska	
Measurements/ Data Obtained		
Contact Info	Teri Rowles NMFS, Office of Protected Resources 1315 East-West Hwy 13752 SSMC3 Silver Spring MD 20910-3282 301-713-2322 Teri Rowles@noaa gov	
Duration		
Future Plans		
Discipline	Marine Mammals	

Gulf Ecosystem Monitoring (GEM) Gap Analysis. Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Mussel Watch Project**	**ID# 091**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Ocean Service (NOS)	
Description	Since 1986, monitored contaminants in sediments and bivalve mollusks (e g mussels and oysters) Bivalves are collected every other year and sediments every fifth year at a network of over 250 US coastal and estuarine sites Samples are analyzed for 24 PAHs, 18 PCB congeners, DDT and its breakdown products DDD and DDE, 16 other chlorinated pesticides, tributyl-tins, 3 major elements, and 11 trace metals This project was based on an earlier EPA Mussel Watch Program (1976-1978)	
Geographic Area	US coastal waters	
Measurements/ Data Obtained		
Contact Info	Tom O'Conner NOS HQTR 1305 East West Hwy 10148 SSMC4 Silver Spring MD 20910-3281 301-713-3028 Tom Oconnor@noaa gov	
Duration		
Future Plans		
Discipline	Physical, Geochemical & Chemical Oceanography	

Project	**Coastal-Marine Automated Network (C-MAN)**	**ID# 09**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS)	
Description	Established in the early 1980's in a response to a need to maintain meteorological observations in US coastal areas C-MAN stations have been installed on lighthouses, at a capes and beaches, on near shore islands, and on offshore platforms Typical data includes barometric pressure, wind direction, speed and gust, and air temperature, some also measure sea surface temperature (not the Alaskan ones), water level, waves, relative humidity, precipitation, and visibility Four C-MAN stations are located in the Gulf of Alaska	
Geographic Area	POTA2 (Potato Point, AK) is at 61 06N, 146 70W MRKA2 (Middle Rock Light, AK) is at 61 08N, 146 66W FFIA2 (Five Finger, AK) is at 57 27N, 133 63W BLIA2 (Bligh Reef Light, AK) is at 60 84N, 146 88W	
Measurements/ Data Obtained	Measures wind direction, wind speed, wind gust, atmospheric pressure, pressure tendency, and air temperature	
Contact Info	Eric Meindl National Buoy Data Center 353B Stennis Space Center SSC MS 39529-6000 228-688-1717 Eric Meindl@noaa gov	
Duration	C-MAN stations were established in the early 1980's and continue to operate The beginning date for which data is available varies with the station and the type of data	
Future Plans		
Discipline	Physical, Geochemical & Chemical Oceanography	

Gulf Ecosystem Monitoring (GEM) Gap Analysis.
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Moored Buoys**	**ID# 096**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS)	
Description	Moored buoys are deployed in the coastal and offshore waters from the western Atlantic to the Pacific Ocean around Hawaii, and from the Bering Sea to the South Pacific Moored bouys measure and transmit barometric pressure, wind direction, speed, and gust, air and sea temperature, and wave energy spectra from which significant wave height, dominant wave period, and average wave period are derived Direction of wave propagation is measured on many buoys Three buoy stations are located in the Gulf of Alaska	
Geographic Area	Buoy station 46001 (Gulf of Alaska) is moored at 56 30N, 148 17W Buoy station 46060 (North Prince William Sound) is moored at 60 58N, 146 83W Buoy station 46061 (South Prince William Sound) is moored at 60 22N, 146 83W	
Measurements/ Data Obtained	All three buoys deployed in the Gulf of Alaska measure wave height, dominant wave period, atmospheric pressure, pressure tendency, air temperature, and water temperature In addition, buoy stations 46060 (North Prince William Sound) and 46061 (South Prince William Sound) measure wind direction, wind speed and wind gust	
Contact Info	Eric Meindl National Buoy Data Center 353B Stennis Space Center SSC MS 39529-6000 228-688-1717 Eric Meindl@noaa gov	
Duration		
Future Plans		
Discipline	Physical, Geochemical & Chemical Oceanography	

Project	**Upper Ocean Circulation in the Subpolar and Northern Subtropical Pacific**	**ID#. 11**
Organization	National Science Foundation (NSF) Directorate for Geosciences	
Description	Investigators collaborate with Russian and Canadian scientists in a repeated survey of the upper 1500 meters of the subtropical and subpolar North Pacific The total program includes four surveys of the Oyashio/Kamchatka Current region, one geochemistry cruise in the western North Pacific, and spring and fall trans-Pacific cruises each year for four years that cover all the major circulation features north of the Subtropical Front US participation in the two trans-Pacific cruises, will allow the PI's to gain access to thet entire data set, allowing them to study a numbe rof major questions related to North Pacific circulation	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	David Musgrave Institute of Marine Science University of Alaska, Fairbanks 129 ONL Fairbanks AK 99775-0900 907-474-7837 musgrave@ims alaska edu	
Duration		
Future Plans		
Discipline	Physical, Geochemical & Chemical Oceanography	

Project	**Forage Fish Assessment of the Cook Inlet Oil and Gas Development-Affected Areas**	**ID# 118**
Organization	U S Department of the Interior (DOI) Minerals Management Service (MMS)	
Description	Determine forage fish abundance, composition, diet, biomass and nutient quality at key locations in nutrient-rich coastal areas, particularly for high-quality (high-lipid) forage fish, and exposure to hydrocarbons to establish a prespill baseline for forage fishes Inventory of capelin, eulachon, and herring which are the preferred prey of harbor seals, Steller sea lions, and seabirds	
Geographic Area		
Measurements/ Data Obtained		
Contact Info		
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Project	**Kachemak Bay Experimental and Monitoring Studies**	**ID# 119**
Organization	U S Department of the Interior (DOI) Minerals Management Service (MMS)	
Description	Obtains information throughout and between years on intertidal community structure, recruitment, and succession, and to relate these variables to several physical factors such as wave exposure and water-current movement	
Geographic Area		
Measurements/ Data Obtained		
Contact Info		
Duration		
Future Plans		
Discipline	Nearshore, Benthic & Coastal Ecology	

Project	**Monitoring and Evaluating Effects on Seabird Colonies in Potential Oil and Gas Development Areas**	**ID# 122**
Organization	U S Department of the Interior (DOI) Minerals Management Service (MMS)	
Description	Extend the records of regional population trends necessary for characterizing natural fluctuations in attendance and distinguishing between these and large or abrupt colongy changes that might occur coincidentally with an oil spill or local human disturbances Objectives are to determine the annual attendance of breeding and nonbreeding individuals at seclected colonies, annual breeding success and productivity at these colonies, adult dietary preferences, and chick diet and growth rates when feasible, and the location of pelagic-seabird concentration areas and relate this to the occurrence of prey populations and evironmental parameters	
Geographic Area		
Measurements/ Data Obtained		
Contact Info		
Duration		
Future Plans		
Discipline	Seabird Ecology	

Project **Sediment Quality in Depositional Areas of Shelikof Strait and Outermost Lower Cook Inlet** **ID# 12**

Organization U S Department of the Interior (DOI)

Minerals Management Service (MMS)

Description Examines whether there has been accumulation of biologically significant levels of pollutants in depositional areas down current of Cook Inlet oil and other develoment areas that could not be sampled with a small launch in the 1993 MMS-sponsored sediment- and water-quality study

Geographic Area

Measurements/ Data Obtained

Contact Info

Duration

Future Plans

Discipline Physical, Geochemical & Chemical Oceanography

Project **Mapping of Cook Inlet Tide Rips Using Local Knowledge and Remote-Sensing Imagery Techniques** **ID# 124**

Organization U S Department of the Interior (DOI)

Minerals Management Service (MMS)

Description Develop precise ground-truthed information on the location of tide rips Tide rips concentrate oil within or along their margins and may submerge at the convergences along the rips These areas may be excluded from oil lease sales or alternatives developed for rip-specific mitigation measures within lease blocks

Geographic Area

Measurements/ Data Obtained

Contact Info

Duration

Future Plans

Discipline Physical, Geochemical & Chemical Oceanography

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project — **Seabird Population Dynamics and Food Supply Assessing Long-Term Changes in Alaska Marine Ecosystem** — **ID# 127**

Organization U S Department of the Interior (DOI)

U S Geological Survey (USGS)

Description The most important factor influencing seabird populations is food supply In turn, seabird prey (mostly forage fish and macro-zooplankton) undergo fluctuations in abundance and distribution with changes in the marine environment This project examines relationships between seabird biology, behavior, and food availability in light of information on short- and long-term changes in prey populations and marine climate

Geographic Area Cook Inlet, Gulf of Alaska, Bering Sea Data on productivity, foraging behavior, and diets of seabirds from multiple sites in Gulf of Alaska (PWS, Cook Inlet, Kodiak, Alaska Peninsula, Semidis, Shumagins, Aleutians)

Measurements/ Data Obtained

Contact Info John Piatt
USGS
1011 E Tudor Rd
Anchorage AK 99503
(907) 786-3549 (907) 786-3636
john_piatt@usgs gov

Duration

Future Plans

Discipline Seabird Ecology

Project	**Pacific Coho Salmon Study**	**ID# 13(**
Organization	U S Department of the Interior (DOI) Fish and Wildlife Service (FWS)	
Description	Since 1994, inventoried coho salmon in streams of Chiginagak Bay and Wide Bay south to the Yantarni River on the south coast of the Alaska Peninsula National Wildlife Refuge Escapement enumeration, length, weight, sex and scales are collected Dolly varden were also inventoried in the Chiginagak Bay streams	
Geographic Area	Pacific drainages of the Alaska Peninsula and Becharof National Wildlife Refuges	
Measurements/ Data Obtained	Coho salmon age composition and length frequency Coho salmon abundance in Sandy and Clear creeks near Yantarni air strip during 1995 and 1996	
Contact Info	James Larson USFWS King Salmon Fishery Resources Office PO Box 277 King Salmon AK 99613 (907) 246-3442 (907) 487-2144 Jim_Larson@fws gov	
Duration	1994-1996	
Future Plans	Weather, remoteness, and protracted run timing make counting adult coho salmon extemely difficult Methods focusing on juvenile abundance hold more promise as a long term monitoring tool of coho salmon productivity and should be investigated	
Discipline	Marine & Fish Ecology	

Project	**Marine Mammal Marking, Tagging and Reporting Program**	**ID# 131**
Organization	U S Department of the Interior (DOI) Fish and Wildlife Service (FWS)	
Description	The Marine Mammal Protection Act of 1972 allows Alaska Natives to harvest marine mammals for subsistence uses It requires that all sea otter and polar bear hides and skulls, and all walrus tusks be tagged by a representative of the U S Fish and Wildlife Service This program is implemented through resident MTRP taggers located in coastal villages and communities throughout Alaska At present, there are 120 taggers located in 98 villages The information collected by the MTRP will help ensure the long-term survival of these species by monitoring the Native harvest and controlling the illegal take, trade, and transport of marine mammal parts	
Geographic Area	Coastal areas in Alaska where sea otters are hunted	
Measurements/ Data Obtained		
Contact Info	Wells Stephensen Alaska Regional Office US Fish and Wildlife Service 1011 E Tudor Road Anchorage AK 99503 907-786-3800 Wells_Stephensen@fws gov	
Duration	?	
Future Plans		
Discipline	Marine Mammals	

Project	**Sea Otter Stock Assessment**	**ID# 132**
Organization	U S Department of the Interior (DOI) Fish and Wildlife Service (FWS)	
Description	Assessment of sea otter population size, stock definition and geographic range,current and maximum net productivity rates, potential for biological removal, annual mortality, fisheries interactions and the status of the stock	
Geographic Area	Coastal areas in Alaska where sea otters are hunted	
Measurements/ Data Obtained		
Contact Info		
Duration	?	
Future Plans		
Discipline	Marine Mammals	

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Alaska Seabird Inventory and Monitoring Plan - Annual Monitoring Sites** **ID# 13**
Organization	U S Department of the Interior (DOI) Fish and Wildlife Service (FWS)
Description	Detects trends in seabird populations, or conditions that are expected to result in population trends, and ensures that managers have up-to-date information about the health of populations and ecosystems Objectives are to provide time-series to ensure that managers have up-to-date information for identifying conservation issues and for applying adaptive management Species and Parameters Parameters include reproductive success, timing of nesting events, prey, and population trends of species of seabirds representing different foraging guilds (e g , diving piscivores, diving planktivores, surface-feeding piscivores, etc) at 10 different sites annually on the Alaska Maritime NWR including St Lazaria, East Amatuli, Chowiet, and Aiktak islands in the GOA Other sites are in the Bering and Chukchi Sea Electronic Format All data from the monitoring program goes into the Pacific Seabird Monitoring Database
Geographic Area	10 different sites annually on the Alaska Maritime NWR including St Lazaria, East Amatuli, Chowiet, and Aiktak islands in the GOA Other sites are in the Bering and Chukchi Sea
Measurements/ Data Obtained	Population trends, interannual patterns in productivity and timing of nesting events, changes in prey use, chick growth rates, survival (for a few species), environmental variables (e g sea surface temperatures)
Contact Info	Vern Byrd Alaska Maritime National Wildlife Refuge 2355 Kachemak Drive, Suite 101 Homer AK 99603 907-235-6546 vernon_byrd@fws gov
Duration	Begin Date Mid-1970's for longest data sets, End date continuing long term
Future Plans	Continue long term/dependent on funding
Discipline	Seabird Ecology

Gulf Ecosystem Monitoring (GEM) Gap Analysis.
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Wintering Marine Bird and Mammal Surveys**	**ID# 135**
Organization	U S Department of the Interior (DOI) Fish and Wildlife Service (FWS)	
Description	Survey and monitor seabird, sea duck, and marine mammal populations found in ice-free sheltered waters of the Kodiak Archipelago Surveys note relative abundance, frequency of occurrence, and distribution within the study area bays	
Geographic Area	236 transects in selected bays of Kodiak Island Archipelago - Uyak Bay, Uganik Bay, Eastern Sitkalidak Straits, and Western Sitkalidak Straits areas Uyak Bay survey area is bounded approximately by North 57°43', South 57°17', East 153°36' and West 154°05' Uganik survey area is bounded approximately by North 57°55', South 57°38', East 153°12' and West 153°37' East Sitkalidak Straits survey area is bounded approximately by North 57°21', South 57°08', East 152°40' and West 153°16' West Sitkalidak Straits survey area is bounded approximately by North 57°13', South 56°59', East 153°16' and West 153°42'	
Measurements/ Data Obtained	A total of 236 boat based transects, 300 meters wide, conducted at 9 knots for 10 minutes duration are repeated annually Water depths are recorded for the transects Time, date, wind speed, cloud cover, sea and swell conditions, surface sea water temperatures and observer conditions are also recorded	
Contact Info	Denny Zwiefelhofer Kodiak National Wildlife Refuge 1390 Buskin River Road Kodiak AK 99615 907-487-2600 denny_zwiefelhofer@fws gov	
Duration	November 1979 to present Surveys were not conducted in 1998	
Future Plans	Survey is currently part of the Kodiak NWR's approved wildlife inventory plan The survey will continue to be funded at least until the refuge's next biological program review (approx 10 years)	
Discipline	Seabird Ecology	

Project	**Genetics Research for Characterizing Alaskan Salmonid Populations**	**ID# 139**
Organization	U S Department of the Interior (DOI) U S Geological Survey (USGS)	
Description	Population genetics analyses of Alaska salmonids	
Geographic Area	Alaska, eastern Pacific Ocean, Russia	
Measurements/ Data Obtained		
Contact Info	Jennifer Neitsen USGS/BRD, Alaska Biological Science Center 1011 East Tudor Road Anchorage AK 99503-6199 907-786-3670 jennifer_nielsen@usgs gov	
Duration	Indefinite	
Future Plans	Publication in peer reviewed literature	
Discipline	Marine & Fish Ecology	

Project	**Population Status and Ecology of Shorebirds in Alaska**	**ID# 145**
Organization	U S Department of the Interior (DOI) U S Geological Survey (USGS)	
Description	Collects data on as many taxa of arctic breeding shorebirds as possible to monitor the status and trends of populations, identify critical sites and habitat requirements throughout the annual cycle, provide basic ecological knowledge about poorly known species, and provide management agencies and conservation administrators with information Assessment areas include Cook Inlet and the Alaska Peninsula	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Robert Gill USGS/BRD, Alaska Biological Science Center 1011 East Tudor Road Anchorage AK 99503-6199 907-786-3514 robert_gill@usgs gov	
Duration		
Future Plans		
Discipline	Seabird Ecology	

Project	**Cook Inlet Basin Study Unit**	**ID# 152**

Organization U S Department of the Interior (DOI)

U S Geological Survey (USGS)

Description Surface and ground-water are collected intensively for 3 years A low-intensity phase follows for 6 years, during which water quality is monitored at a selected number of sites and areas that were assessed during the high-intensity phase This combination of high- and low-intensity monitoring phases allows the NAWQA Program to examine trends in water quality over time Measurements are made to determine water chemistry in streams and aquifers, the quantity of suspended sediment and the quality of bottom sediments in streams, the variety and number of fish, benthic invertebrates and algae in streams, and the presence of contaminants in fish tissues

Geographic Area Fresh waters of the Cook Inlet Basin

Measurements/ Data Obtained Surface water is sampled for concentrations of major ions, nutrients, organic carbon, suspended sediment and basic field parameters Ground water is sampled for concentrations of major ions, nutrients, organic carbon, trace elements, pesticides and VOC Ecological attributes measured at stream sites include instream and riparian habitat conditions, benthic algae, macroinvertebrate, and fish community composition

Contact Info Steven Frenzel

US Geological Survey
4230 University Dr , Suite 201

Anchorage AK 99508-4664

907-786-7100

sfrenzel@usgs gov

Duration 10-01-1997 to 09-30-2002

Future Plans Monitoring firm through 09-30-2001 Final report due by 09-30-2002

Discipline Nearshore, Benthic & Coastal Ecology

Project **Sonar Enumeration of Returning Adult Salmon** **ID# 15**

Organization Alaska Department of Fish and Game (ADFG)

Commercial Fisheries

Description Sonar stations located on Kenai and Yukon Rivers assess the returns of salmon to these systems and attempt to differentiate between species based on signal strength and location Ground truthed with gill nets

Geographic Area

Measurements/ Data Obtained

Contact Info Gordon Kruse
Alaska Dept of Fish and Game
Division of Commercial Fisheries
1255 W 8th Street

Juneau AK 99801

907-465-6106

gordonk@fishgame state ak us

Duration

Future Plans

Discipline Marine & Fish Ecology

Project **Groundfish Port Sampling** **ID# 155**

Organization Alaska Department of Fish and Game (ADFG)

Sport Fish

Description Determines the age, weight, lenght (AWL), sex, maturity of sport caught groundfish at docks Cooperative project with CF Division

Geographic Area North Gulf Coast, including fish landed at Valdez, Cordova, Whittier, Seward, Homer, Deep Creek, and Kodiak

Measurements/ Data Obtained Angler trips, number caught, number harvested by species Total length, age, sex, and maturity by species Data are obtained annually from May through September

Contact Info Bob Clark
Alaska Department of Fish and Game
Sport Fish Division
333 Raspberry Rd

Anchorage AK 99518-1599

907-267-2221

bob_clark@fishgame state ak us

Duration It is anticipated that this program will continue into the forseeable future

Future Plans Alternative ports will be added/removed as management questions and budgets dictate This proje will likely continue into the forseeable future

Discipline Marine & Fish Ecology

Project	**Harbor Seal Survey**	**ID# 157**
Organization	Alaska Department of Fish and Game (ADFG) Wildlife Conservation	
Description	(1) Ground counts of harbor seals at the southwest beach haulout on Tugidak Island, south of Kodiak Island, (2) Aerial population trend surveys (ADF&G) of selected haulouts in Prince William Sound (1984, 1988-present), near Ketchikan (1983-84, 88, 93-present), Sitka (1983-84, 93-present), and Kodiak (1992-present), and (3) Aerial population abudance surveys (NMFS), statewide coverage completed on a 5-year rotation	
Geographic Area	Latititudes and Longitudes of every haulout site in the state are available	
Measurements/ Data Obtained	Aerial surveys 4-7 replicate counts are obtained during each survey, with both visual estimates and counts from photographic slides Land-based surveys age and sex of all seals present on the haulouts	
Contact Info	Bob Small Alaska Dept of Fish and Game Wildlife Conservations Division 333 Raspberry Rd Anchorage AK 99518-1599 907-267-2188 bob_small@fishgame state ak us	
Duration	All programs will likely continue for the foreseeable future	
Future Plans	Both programs are likely to continue See EVOS project 00509 (FY 2000) for review/revision of both projects	
Discipline	Marine Mammals	

Project **Weirs and Counting Towers for Enumeration of Returning Adult Salmon, Escapement** **ID# 158**

Organization Alaska Department of Fish and Game (ADFG)

Commercial Fisheries

Description Returning adult salmon are counted by observers from towers and at weirs across streams to determine the escapement to the streams This is used to determine when escapement goals are met and is a factor in opening and closing fisheries Some data to early 1900's

Geographic Area

Measurements/ Data Obtained

Contact Info Gordon Kruse
Alaska Dept of Fish and Game
Division of Commercial Fisheries
1255 W 8th Street
Juneau AK 99801
907-465-6106
gordonk@fishgame state ak us

Duration

Future Plans

Discipline Marine & Fish Ecology

Project **Aerial / Foot Surveys of Spawning Streams, Salmon Escapement** **ID# 159**

Organization Alaska Department of Fish and Game (ADFG)

Commercial Fisheries

Description Returning adult salmon are counted visually from light aircraft to determine escapement to streams Ground-truthed by stream walks and weirs

Geographic Area

Measurements/ Data Obtained

Contact Info Gordon Kruse
Alaska Dept of Fish and Game
Division of Commercial Fisheries
1255 W 8th Street
Juneau AK 99801
907-465-6106
gordonk@fishgame state ak us

Duration

Future Plans

Discipline Marine & Fish Ecology

Project	**Fry / Smolt Outmigration**	**ID# 160**
Organization	Alaska Department of Fish and Game (ADFG) Commercial Fisheries	
Description	Outmigrating fry and smolt salmon are counted through downstream weirs or traps at various locations around Alaska to determine abundance, age, length and weight, to assess the general health of the stock and to predict later adult returns	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Gordon Kruse Alaska Dept of Fish and Game Division of Commercial Fisheries 1255 W 8th Street Juneau AK 99801 907-465-6106 gordonk@fishgame state ak us	
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Project	**Salmon AWL (Age, Weight Length)**	**ID#· 161**
Organization	Alaska Department of Fish and Game (ADFG) Commercial Fisheries	
Description	Returning adult salmon are sampled to detremine age, weight and length This information is used to determine ocean growth, survival and predict future run strength	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Gordon Kruse Alaska Dept of Fish and Game Division of Commercial Fisheries 1255 W 8th Street Juneau AK 99801 907-465-6106 gordonk@fishgame state ak us	
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Project	**Rockfish Assessments - Southeast Alaska**	**ID# 162**
Organization	Alaska Department of Fish and Game (ADFG) Commercial Fisheries	
Description	Determines fish counts, species, effort, catch, CPUE, age, sex and size of rockfish Longline surveys from 1984 Line sampling surveys from 1989	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Gordon Kruse Alaska Dept of Fish and Game Division of Commercial Fisheries 1255 W 8th Street Juneau AK 99801 907-465-6106 gordonk@fishgame state ak us	
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Project	**Catch Sampling - Southeast Alaska (Rockfish, Sablefish, Lingcod), Prince William Sound and Lower Cook Inlet (Rockfish, Sablefish, Pacific Cod, Pollock), Kodiak and Aleutian Islands (Rockfish)**	**ID# 166**
Organization	Alaska Department of Fish and Game (ADFG) Commercial Fisheries	
Description	Dockside catch sampling gathers information for age, weight, length, AWL, sex, maturity for rockfish, sablefish, lingcod, Pacific cod, and pollock with differnt species mixes in each area Most beginning in 1980's	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Gordon Kruse Alaska Dept of Fish and Game Division of Commercial Fisheries 1255 W 8th Street Juneau AK 99801 907-465-6106 gordonk@fishgame state ak us	
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Gulf Ecosystem Monitoring (GEM) Gap Analysis: Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Fish Tickets for Shoreside Landings**	**ID# 167**

Organization Alaska Department of Fish and Game (ADFG)

Commercial Fisheries

Description Fish ticket information from commercial fisheries details catch, value, species and permit types for groundfish statewide Data collected includes Salmon, Herring, Groundfish, and Shellfish Approx 250,000 tickets are collected and entered each year Data is used by multiple agencies for the management of fisheries in Alaska Data is also used to determine participants in limited license programs

Geographic Area All Alaska State Waters

Measurements/ Data Obtained

Contact Info Carmine DiCostanzo
Alaska Dept of Fish and Game
Division of Commercial Fisheries
1255 W 8th Street

Juneau AK 99801

907-465-6127

carmined@fishgame state ak us

Duration 1969 to Present

Future Plans The system is currently under conversion from a decentralized COBOL/ISAM based system to a client/server centralized RDMS (Oracle)
Completetion date June 2000

Discipline Marine & Fish Ecology

Project	**Herring Aerial Surveys - Statewide**	**ID# 17u**
Organization	Alaska Department of Fish and Game (ADFG) Commercial Fisheries	
Description	Aerial surveys to determine timing, location and extent of herring spawning Also compared with other methods to estimate biomass	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Gordon Kruse Alaska Dept of Fish and Game Division of Commercial Fisheries 1255 W 8th Street Juneau AK 99801 907-465-6106 gordonk@fishgame state ak us	
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Project	**Herring Catch Sampling - Statewide**	**ID# 171**
Organization	Alaska Department of Fish and Game (ADFG) Commercial Fisheries	
Description	Catch sampling provides age, weight, length, AWL information since 1980	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Gordon Kruse Alaska Dept of Fish and Game Division of Commercial Fisheries 1255 W 8th Street Juneau AK 99801 907-465-6106 gordonk@fishgame state ak us	
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Project Trawl Surveys - Prince William Sound, Lower Cook Inlet, and Alaska Peninsula for King and Tanner Crabs **ID# 173**

Organization Alaska Department of Fish and Game (ADFG)

Commercial Fisheries

Description Trawl surveys for king and tanner crabs Data includes age, weight, length, AWL, sex, maturity (gonad maturity), catch, bycatch, vessel log, and halibut lengths

Geographic Area

Measurements/ Data Obtained

Contact Info Gordon Kruse
Alaska Dept of Fish and Game
Division of Commercial Fisheries
1255 W 8th Street
Juneau AK 99801
907-465-6106
gordonk@fishgame state ak us

Duration

Future Plans

Discipline Marine & Fish Ecology

Project Dive Surveys - Southeast Alaska Clams, and Sea Cucumbers **ID#· 174**

Organization Alaska Department of Fish and Game (ADFG)

Commercial Fisheries

Description

Geographic Area

Measurements/ Data Obtained

Contact Info Gordon Kruse
Alaska Dept of Fish and Game
Division of Commercial Fisheries
1255 W 8th Street
Juneau AK 99801
907-465-6106
gordonk@fishgame state ak us

Duration

Future Plans

Discipline Marine & Fish Ecology

Project	**Shellfish Dockside Sampling - Statewide**	**ID# 175**
Organization	Alaska Department of Fish and Game (ADFG) Commercial Fisheries	
Description	Dockside sampling for scallops (age, weight, length, AWL), and crabs (size, sex, catch, bycatch, ,vessel log)	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Gordon Kruse Alaska Dept of Fish and Game Division of Commercial Fisheries 1255 W 8th Street Juneau AK 99801 907-465-6106 gordonk@fishgame state ak us	
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Project	**Shellfish Catch Enumeration - Statewide**	**ID# 176**
Organization	Alaska Department of Fish and Game (ADFG) Commercial Fisheries	
Description	Fish tickets provide information on catch, value, species, area, and permit type for king, tanner, and dungeness crabs, shrimp, scallops, clams, and sea cucumbers	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Gordon Kruse Alaska Dept of Fish and Game Division of Commercial Fisheries 1255 W 8th Street Juneau AK 99801 907-465-6106 gordonk@fishgame state ak us	
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Project	**Trident Basin Water Temperature**	**ID#· 177**
Organization	Alaska Department of Fish and Game (ADFG) Commercial Fisheries	
Description	Water temperatures in Trident Basin near Near Island in the City of Kodiak from 1971 to the present	
Geographic Area		
Measurements/ Data Obtained	Regional Information Report 4K95-36, temps updated every ~5years in an RIR	
Contact Info	Pete Probasco Alaska Dept of Fish and Game 211 Mission Road Kodiak AK 99615 907-486-1870 pete_probasco@fishgame state ak us	
Duration	1970 to present	
Future Plans		
Discipline	Physical, Geochemical & Chemical Oceanography	

Project	**Subsistence Harvest**	**ID# 183**
Organization	Alaska Department of Fish and Game (ADFG) Commercial Fisheries	
Description	Commercial Fisheries Division collects subsistence fish and shellfish harvest and provides this information to ADF&G Subsistence Division	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Gordon Kruse Alaska Dept of Fish and Game Division of Commercial Fisheries 1255 W 8th Street Juneau AK 99801 907-465-6106 gordonk@fishgame state ak us	
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Project	**Monitoring Programs for Paralytic Shellfish Poison (PSP) in King Crab, Dungeness Crab and Tanner Crab**	**ID#: 184**
Organization	Alaska Department of Environmental Conservation (ADEC) Environmental Health (DEH)	
Description	This project monitors the current level of paralytic shellfish poison (PSP) in kng crab, tanner crab and dungeness crab being harvested Some monitoring projects have a pre-season component	
Geographic Area	King crab, tanner crab and dungeness crab will be monitored in Prince William Sound Tanner crab and dungeness crab will also be monitored in Cook Inlet (including the eastern Kenai Peninsula to south of seward) and Kodiak Island	
Measurements/ Data Obtained	Micrograms of PSP present per 100 grams of viscera	
Contact Info	Manny Soares Seafood Processing and Development Alaska Dept of Environmental Conservation Division of Environmental Health 555 Cordova Street Anchorage AK 99501-2617 907-269-7640 907-269-7510 msoares@envircon state ak us	
Duration		
Future Plans		
Discipline	Marine & Fish Ecology	

Project	**Scallop Dredge Survey - Prince William Sound and Cook Inlet**	**ID# 185**

Organization Alaska Department of Fish and Game (ADFG)

Commercial Fisheries

Description Weathervane scallop dredge survey collects age, weight, and height (AWL), sex and gonad maturity data dating to 1984 in Cook Inlet and dating to 1995 in Prince William Sound Fishery-independent surveys are conducted biennially Scallop age and height data are collected annually from commercial fisheries

Geographic Area In Cook Inlet, scallops are surveyed in Kamishak Bay In Prince William Sound, scallops are surveyed east and west of Kayak Island

Measurements/ Data Obtained Surveys involved towing an 8-foot wide scallop dredge along a 1 0 nautical mile transect Catch weight and abundance of scallops and other species, and crab size, was recorded Shell height was measured on all scallops, and age, weight, and meat weight obtained on a subsample of the scallop catch An underwater video was used to record the mouth of the dredge on a subset of the tows to document dredge efficiency and habitat type An age-structured model was developed for the Kamishak Bay scallop population

Contact Info

William Bechtol

Alaska Dept of Fish and Game
Division of Commercial Fisheries
3298 Douglas Place

Homer AK 99603-8027

907-235-8191

bill_bechtol@fishgame state ak us

Duration Biennial survey schedule Surveys were conducted in 1984, 1996, and 1999

Future Plans The Kamishak Bay and Kayak Island scallop beds are currently surveyed biennially

Discipline Marine & Fish Ecology

Project **Fish Pathology Disease History Database** **ID# 18,**

Organization Alaska Department of Fish and Game (ADFG)

Commercial Fisheries

Description Disease histories of salmon, steelhead, trout, char, grayling, herring, oysters, clams, crabs and miscellaneous other fish and shellfish have been recorded since 1973, primarily to support hatcheries Records include diagnostic and periodic brooodstock screening for pathogens Disease histories are required for each proposal to transport or release an stage of a fish or shellfish life history

Geographic Area

Measurements/ Data Obtained

Contact Info Ted Meyers
Alaska Dept of Fish and Game
Capital Office Park
1255 W 8th Street
PO Box 25526
Juneau AK 99801
907-465-3577
fishpath@fishgame state ak us

Duration

Future Plans

Discipline Marine & Fish Ecology

Project **Coded Wire Tag Database** **ID#. 188**

Organization Alaska Department of Fish and Game (ADFG)

Commercial Fisheries

Description The program maintains a database of all releases of coded wire tagged salmonids in Alaska It also has a database of all anadromous releases of salmon Associated with these release files are species, numbers, size, agency, date of release, stock of fish, release site, agency, project leader, and a number of other fields,

It also maintains a record of all recoveries of tags, the date, year, location, gear used, who sampled the fish and other fields

It has a database of sampling information, e g how many fish were sampled for the presence of coded wire tags and how many were found to have tags, when and where they were sampled

Steelhead and salmon from many hatchery and a few wild fish programs have been coded wire tagged (CWT) since the early 1970's Tags have binary codes that uniquely identify a particular stock or experimental unit of fish from a particular year These tags are inserted into fish noses as fry or smolt and recovered when the adults return For the most part, the Coded Wire Tag Lab just reads the tags and provides the data to project leaders Many different researchers and managers use the database for a diversity of purposes In many cases the Tag Lab does not know specifically what the data will be used for

Geographic Area Alaska

Measurements/ Data Obtained In some cases length measurements for recovered salmon is available

Contact Info Ron Josephson
Alaska Dept of Fish and Game
Mark Tag and Age Lab
PO Box 25526 / 10017 Bentwood Place
Juneau AK 99802
907-465-4088
ron_josephson@fishgame state ak us or

Duration 1978 to present and ongoing

Future Plans ongoing

Discipline Marine & Fish Ecology

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Sport Fish Weirs and Sonars**	**ID#. 190**
Organization	Alaska Department of Fish and Game (ADFG) Sport Fish	
Description	Weir and sonar (Kenai River only) counts of returning anadromous salmonid sportfish (salmon, steelhead, dolly varden, cutthroat trout) to streams Determines population size Weir-caught fish may also provide age, weight, length (AWL), and stage of maturity data	
Geographic Area	This project occurs in Cook Inlet (Kenai River, Russian River, Cooper Creek, Deep Creek, Ninilchik River, Deshka River, Wasilla Creek, Cottonwood Creek, Little Susitna River, Fish Creek) and Kodiak (Karluk, Ayakulik, Chignik)	
Measurements/ Data Obtained	Counts of salmonids by species by date, length from mid-eye to fork in tail, sex (male/female), age (freshwater and ocean ages in years) These data are collected by day through each run on an annual basis	
Contact Info	Bob Clark Alaska Department of Fish and Game Sport Fish Division 333 Raspberry Rd Anchorage AK 99518-1599 907-267-2221 bob_clark@fishgame state ak us	
Duration	It is anticipated that these programs will continue into the forseeable future	
Future Plans	Alternative stocks will be added/removed as management questions and budgets dictate This project will likely continue into the forseeable future	
Discipline	Marine & Fish Ecology	

Project	**Coded Wire Tagging (CWT) of Hatchery and Selected Wild Salmonid Stocks**	**ID# 191**
Organization	Alaska Department of Fish and Game (ADFG) Sport Fish	
Description	Coded wire tagging (CWT) inserts a binary tag into the snouts of salmonids before release This project places and recovers these tags from hatchery chinook and coho salmon and selected wild stocks to determine size of returning population and straying rates	
Geographic Area	This project occurs in Prince William Sound (Valdez, Wittier, Cordova), Cook Inlet (various sites), and Kodiak (Buskin River)	
Measurements/ Data Obtained	Estimates of contribution, smolt abundance, and straying rate are obtained annually	
Contact Info	Bob Clark Alaska Department of Fish and Game Sport Fish Division 333 Raspberry Rd Anchorage AK 99518-1599 907-267-2222 bob_clark@fishgame state ak us	
Duration	It is anticipated that these programs will continue into the forseeable future	
Future Plans	Alternative stocks and hatchery plants will be added/removed as management questions and budgets dictate This project will likely continue into the forseeable future	
Discipline	Marine & Fish Ecology	

Project **Population Survey of Organochlorine Contaminants in Alaskan Steller Sea Lions** **ID# 19**

Organization Alaska Department of Fish and Game (ADFG)

Wildlife Conservation

Description Uses composite fecal samples collected at rookeries to compare relative organochlorine contaminant levels between the thriving population in Southeast Alaska and the depleted population in Western Alaska Samples of blood, feces, and blubber will be routinely collected from Steller sea lions at the Alaska SeaLife Center to evaluate relationships of contaminant levels and composition in the three mediums This project is funded by the Fish and Wildlife Foundation

Geographic Area

Measurements/ Data Obtained

Contact Info Kenneth Pitcher

Alaska Dept of Fish and Game
Wildlife Conservations Division
333 Raspberry Rd

Anchorage AK 99518-1599

907-267-2363

ken_pitcher@fishgame state ak us

Duration

Future Plans

Discipline Marine Mammals

Gulf Ecosystem Monitoring (GEM) Gap Analysis.
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Isotope Ratio Studies of Marine Mammals in Prince William Sound ID#· 206**
Organization	University of Alaska Fairbanks (UAF) School of Fisheries and Ocean Sciences (SFOS)
Description	Harbor seal whiskers and prey items from Prince William Sound and the adjacent Gulf of Alaska are sampled and then analyzed using stable isotope methods to measure carbon and nitrogen stable isotope ratios which are in turn used as tracers of nutrient transfer The resulting stable isotope data is used to determine physiology of nutrient assimilation in seals and provide information on the seasonal feeding areas of seals and the food web structure of those areas
Geographic Area	Prince William Sound and the surrounding Gulf of Alaska
Measurements/ Data Obtained	Variable Laboratory studies were conducted with captive animals and samples from the Gulf of Alaska were obtained opportunistically from native subsistence hunts or collection programs All stable isotope analyses were conducted in replicate at the University of Alaska Fairbanks
Contact Info	Donald Schell Institute of Marine Science Univeristy of Alaska Fairbanks PO Box 757220 Fairbanks AK 99775-7220 907-474-7989 schell@ims uaf edu
Duration	Three years (FY 99-01)
Future Plans	Work is continuing at the Alaska SeaLife Center in Seward The focus is on isolating amino acids with a goal of identifying conservative biomarkers useful in allocating critical feeding habitats We are now (Aug 1999) completing year 1 of a projected three-year study
Discipline	Marine Mammals

Gulf Ecosystem Monitoring (GEM) Gap Analysis·
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project GAK 1 TIME SERIES **ID# 20/**

Organization University of Alaska Fairbanks (UAF)

School of Fisheries and Ocean Sciences (SFOS)

Description Temperature and salinity versus depth profiles have been taken at the mouth of Resurrection Bay near Seward, Alaska since December, 1970 For the first 20 years the sampling was accomplished by ships-of-opportunity, primarily research vessels as they left or entered the port, thus the time interval varied from several times per month to several times per year Since September 1990, the sampling has been sponsored by NOAA's Office of Global Programs (Office of Ocean and Earth Sciences, Ocean Observing Division, Observing Networks Branch) and is accomplished monthly, usually as a single CTD (conductivity-temperature-depth) profile to within 10 meters of the bottom,that is, 263 m Until about 1975, the profiling was accomplished with discrete samples using Nansen bottles Since that time STDs (salinity-temperature-depth) or CTDs have been used The accuracies of the temperature and salinity are plus/minus 0 02 in degrees C and ppt

Geographic Area The location is 59 50 7 N, 149 28 0 W within the Alaska Coastal Current, so it is well "connected" with the shelf circulation

Measurements/ Data Obtained Temperature and salinity versus depth to 250 m

Contact Info Thomas Royer
Institute of Marine Science
University of Alaska

Fairbanks AK 99775

(907) 474-7835 (907) 474-4204

royer@ims uaf edu

Duration

Future Plans Continued sampling is being picked up by NOAA/NSF GLOBEC Program for the present time but the long term prognosis is uncertain This data set are the only long term subsurface coastal data in the northern North Pacific They are the only continuing salinity measurements

Discipline Physical, Geochemical & Chemical Oceanography

Project	**University of Miami TIROS-N/NOAA AVHRR Level 1b**	**ID# 208**
Organization	University of Miami Rosenstiel School of Marine and Atmospheric Science (RSMAS)	
Description	Cloud top and sea surface temperatures through passively measured visible, near infrared and infrared spectral radiation bands from NOAA-6, 7, 8 and 9 AVHRR (Advanced Very High Resolution Radiometer) instruments Level 1b format corresponds to quality controlled raw AVHRR data, that is assembled into discrete data sets withsensor calibration and earth location informatoin appended to the incoming radiation (video) data (NOAA Polar Orbiter Data Users Guide) The data tapes originate at NESDIS/SDSD in Suitland, Maryland	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Joanie Splain University of Miami Rosentiel School of Marine and Atmospheric Science 4600 Rickenbacker Cswy Miami FL 33149-1098 305-361-4622 joanie@miami rsmas miami edu or	
Duration		
Future Plans		
Discipline	Physical, Geochemical & Chemical Oceanography	

Project	**Permanent Service for Mean Sea Level (PSMSL) and Global Sea Level Observing System (GLOSS)**	**ID# 210**
Organization	United Nations (UN) United Nations Educational, Scientific and Cultural Organization (UNESCO)	
Description	The PSMSL is the global data bank for long term sea level change data GLOSS is an international programme coordinated by the Intergovernmental Oceanographic Commission (IOC) for the establishment of high quality global and regional sea level networks for application to climate, oceanographic and coastal sea level research Since 1933, the Permanent Service for Mean Sea Level (PSMSL) has been responsible for the collection, publication, analysis and interpretation of sea level data from the global network of tide gauges The PSMSL is a member of the Federation of Astronomical and Geophysical Data Analysis Services (FAGS) established by the International Council of Scientific Unions (ICSU) It is based at the Proudman Oceanographic Laboratory (POL), Bidston Observatory which is a component of the UK Natural Environment Research Council (NERC)	
Geographic Area	Global There are 21 sites in the PSMSL data base for Alaska Five of these are GLOSS stations There are stations at Womens Bay (Kodiak), Anchorage, Nikiski, Seldovia, Seward, Valdez, Cordova, Yakutat and Sitka There are more sites in Canada	
Measurements/ Data Obtained	Sea level measurements typically every low tide or fractions of low tide	
Contact Info	Dr P L Woodworth Permanent Service for Mean Sea Level Proudman Oceanographic Laboratory Birdston Observatory, Birkenhead Merseyside UK CH43 7RA 144-151-653-8633 psmsl@pol ac uk	
Duration	Ongoing The PSMSL data bank includes long time series data There are 518 stations for which at least 20 years of data are stored and 115 stations have data from before 1900 Data for Seward dates back to 1925, data for the other sites in the Gulf of Alaska date from the 1930s through the 1970s	
Future Plans	Ongoing	
Discipline	Physical, Geochemical & Chemical Oceanography	

Gulf Ecosystem Monitoring (GEM) Gap Analysis·
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Ships of Opportunity Program (SOOP) Low Density Expendable Bathythermograph Network (XBT)**	**ID#· 211**

Organization United Nations (UN)

United Nations Educational, Scientific and Cultural Organization (UNESCO)

Description To collect and transmit real-time sea surface meteorological and sub-surface oceanographic data in support of marine weather forecasting and El Nino Southern Oscillation studies including seasonal, interannual to decadel climatic changes

Geographic Area Global

Measurements/ Data Obtained Subsurface temperature data down to 760 meters data stored at 2 meter resolution

Contact Info Steve Cook
NOAA/AOML
GOOS Center Operations
4301 Rickenbacker Causeway

Miami FL 33149

305-361-4366

skcook@ucsd edu or cook@aoml noaa gov

Duration Started about 30 years ago and is considered a national NOAA asset Therefore expected to survive

Future Plans Continue to improve sensor, transmission and software to improve data throughput and accuracy

Discipline Physical, Geochemical & Chemical Oceanography

Project **Array for Real-Time Geostrophy (ARGO)** **ID#. 212**

Organization United Nations (UN)

United Nations Educational, Scientific and Cultural Organization (UNESCO)

Description A joint GODAE / CLIVAR project Initial deployment of ARGO floats should begin in the year 2000 and in 3-4 years comprise around 3,300 floating temperature, salinity, and current velocity (at the parking depth around 1500 m) profilers

Geographic Area

Measurements/ Data Obtained

Contact Info Dean Roemmich
Scripps Institution of Oceanography
UC San Diego
9500 Gilman Drive

La Jolla CA 92093-0230
858-534-2307
droemmich@uscd edu

Duration

Future Plans

Discipline Physical, Geochemical & Chemical Oceanography

Project	**Pacific Basinwide Extended Climate Study (P-BECS)**	**ID# 213**
Organization	United Nations (UN) World Meteorological Organization (WMO)	

Description Measures the oceanic variability, tests existing models of it, and from this testing improve the models and our understanding of the processes This requires identifying the primcipal three-dimensional space-temi patterns of temperature and salinity anomalies and their circualtion pathways, assessing the cont5rolling dynamical processes, comparing existing models of thes processes with improved models, both independently from the observations as well as through data assimilaion and forecasts, and to detemine the Pacific Ocean's coupling and feedbakc with the atmosphere and thus its role in climate variability

Geographic Area

Measurements/ Data Obtained

Contact Info

Roger Lucas
OCE/JIMAR, MSB 418/400
School of Ocean and Earth Science and Technology
University of Hawaii
1680 East-West Road, POST 802
Honolulu HI 96822
808-956-5875
rlukas@soest hawaii edu

Duration

Future Plans

Discipline Physical, Geochemical & Chemical Oceanography

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Repeat Hydrography and Special Analysis Centre**	**ID#. 214**

Organization U S Global Change Research Program (USGCRG)

World Ocean Circulation Experiment (WOCE)

Description The repeated sections and time series stations provide information on the temporal variability of the ocean from several occupations in different seasons and years The data from each occupation are considered separately in the data management system, thus early data from a section may be available before all the planned occupations have occurred The Special Analysis Center is the final stage in the hydrographic data management process, it provides a globally consistent data set and generates dynamical products for use in models and other analyses Specialized visualization programs and historical (pre-WOCE) hydrographic data are also available from the SAC

Geographic Area

Measurements/ Data Obtained

Contact Info Kai Jancke

Bundesamt fuer Seeschiffahrt und Hydrographie (BSH)

Hamburg Germany

Fax 49-40-3190-5000

Kai Jancke@m5 hamburg bsh d400 de

Duration

Future Plans

Discipline Physical, Geochemical & Chemical Oceanography

Project	**Subsurface Floats**	**ID# 216**
Organization	U S Global Change Research Program (USGCRG) World Ocean Circulation Experiment (WOCE)	
Description	A variety of acoustically- or satellite-tracked, neutrally buoyant subsurface floats have been released during WOCE The Subsurface Float DAC is assembling these (and historical data) to form a consolidated float data set for incorporation into ocean models and climatology	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Philip Richardson Woods Hole Oceanographic Institution Woods Hole MA 02543 508-457-2000 prichardson@whoi edu	
Duration		
Future Plans		
Discipline	Physical, Geochemical & Chemical Oceanography	

Project	**Surface Drifting Buoys**	**ID#: 217**
Organization	U S Global Change Research Program (USGCRG) World Ocean Circulation Experiment (WOCE)	
Description	Since 1990, drifting buoys have provided surface velocity measurements for validation of models and ground truth sea surface temperature data to initialize the ocean component of climate prediction models Some buoys also measure atmospheric pressure	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Mark Swenson NOAA / AOML 4301 Rickenbacker Cswy Miami FL 33149-1026 305-361-4364 Mark Swenson@noaa gov	
Duration		
Future Plans		
Discipline	Physical, Geochemical & Chemical Oceanography	

Project	**Joint Archive for Shipboard Acoustic Doppler Current Profilers (ADCP)**	**ID#· 216**

Organization U S Global Change Research Program (USGCRG)

World Ocean Circulation Experiment (WOCE)

Description Shipboard acoustic Doppler current profilers (ADCPs) when used in conjunction with reliable heading and navigation data can determine absolute currents in the upper ocean For the past decade, acoustic Doppler current profilers (ADCPs) have become steadily more common aboard the UNOLS, NOAA, and Navy fleets During the late 1980s, the data quality was limited by lack of continuous Global Positioning System (GPS) coverage and uncertainties in the ship's heading information However, the quality has improved significantly in recent years With the sharp increase in installation and attention to the shipboard ADCP in the early 1990s, it became clear that a data management system was needed The National Oceanographic Data Center (NODC) has established the Joint Archive for Shipboard ADCP (JASADCP) at UH for the acquisition, review, documentation, archival, and distribution of shipboard ADCP data sets The growing database allows a fresh view of upper ocean velocity structure on a variety of temporal and spatial scales

Geographic Area Global

Measurements/ Data Obtained Presently data from 334 unique cruises The Common Oceanographic Data Analysis System (CODAS) files include current velocities and all ancillary data (date-time- group, transducer temperature and salinity, a variety of diagnostic values, heading information, and navigational data) while the subset includes only the absolute current velocities, transducer temperature, and ship velocity For analysis purposes, the standard subset is best suited for synoptic and climatological research and the high-density set is valuable for fine-scale studies

Contact Info Patrick Caldwell

National Oceanographic Data Center / E Firing ADCP Lab
University of Hawaii
Joint Archive for Shipboard ADCP
1000 Pope Rd MSB 307

Honolulu HI 96822

808-956-4105 808-956-2352

caldwell@soest hawaii edu

Duration Indefinite

Future Plans Continue to populate the database

Discipline Physical, Geochemical & Chemical Oceanography

Project	**Upper Ocean Thermal Data**	**ID# 219**
Organization	U S Global Change Research Program (USGCRG) World Ocean Circulation Experiment (WOCE)	
Description	A global network of commercial ships takes voluntary upper ocean thermal measurement using Expendable Bathythermographs (XBTs) which are launched every few hours while the ship is steaming XBTs are also deployed by fishing and research vessels, and together these observations from a global data set of temperature (and sometimes salinity) profiles in the top 750 m	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Charles Sun National Oceanographic Data Center 1315 East-West Hwy 4837 SSMC3 Silver Spring MD 20910-3282 301-713-3267 x151 Douglas Hamilton@noaa gov	
Duration		
Future Plans		
Discipline	Physical, Geochemical & Chemical Oceanography	

Project	**Sea Surface Salinity**	**ID#· 220**
Organization	U S Global Change Research Program (USGCRG) World Ocean Circulation Experiment (WOCE)	
Description	Underway sea surface salinity data are collected on WHP cruises and voluntary observing ships using thermosalinographs and buckets Processed and calibrted data are assembled and made available by the DAC	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Alain Dessier IFREMER Bretagne ? France Fax 33-98-22-45-14 dessier@orstom fr	
Duration		
Future Plans		
Discipline	Physical, Geochemical & Chemical Oceanography	

Project	**Surface Meteorological Data and Surface Fluxes**	**ID# 22.**
Organization	U S Global Change Research Program (USGCRG) World Ocean Circulation Experiment (WOCE)	
Description	Surface meteorological data are collected on many WOCE cruises, and range from high quality near-continuous recording systems, to ship bridge observations These data are collected, checked, archived and distributed by the Surface Meteorological DAC Associated with the DAC is the WOCE SAC for surface fluxes The SAC produces regularly gridded fields of ocean surface forcing fields (e g winds, temperatures, humidity, turbulent fluxes of momentum, moisture, and heat) suitable for use by ocean models and intensive diagnostic studies	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	David Legler Florida State University 234 Johnson Building Meteorology Mail Code2840 Tallahassee FL 32306 850-644-3797 legler@coaps fsu edu	
Duration		
Future Plans		
Discipline	Physical, Geochemical & Chemical Oceanography	

Gulf Ecosystem Monitoring (GEM) Gap Analysis.
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Tide Gauges**	**ID# 222**
Organization	U S Global Change Research Program (USGCRG) World Ocean Circulation Experiment (WOCE)	
Description	WOCE tide gauges make hourly or more frequent observations to provide *in situ* data to support altimetry, and to estimate geostrophic currents across straits Many stations transmit data by satellite in real time (delay of 1-3 months) and these are assembled and distributed by the Fast Delivery DAC The Delayed Mmode Sea Level DAC assembles, quality controls, distributes and archives all available sea level data (18-24 months)	
Geographic Area		
Measurements/ Data Obtained		
Contact Info	Mark Merrifield OCE, MSB 317A School of Ocean and Earth Science and Technology University of Hawaii 1680 East-West Road, POST 802 Honolulu HI 96822 808-956-6161 MSB 317A markm@soest hwaii edu	
Duration		
Future Plans		
Discipline	Physical, Geochemical & Chemical Oceanography	

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Alaska Seabird Inventory and Monitoring Plan - Periodic Monitoring Sites** **ID# 22**
Organization	U S Department of the Interior (DOI) Fish and Wildlife Service (FWS)
Description	Detects trends in seabird populations, or conditions that are expected to result in population trends, and ensures that managers have up-to-date information about the health of populations and ecosystems Begin Date Mid-1970's, End Date Continuing, long term, Species and Parameters Parameters include reproductive success, timing of nesting events, prey, and population trends of species of seabirds representing different foraging guilds (e g , diving piscivores, diving planktivores, surface-feeding piscivores, etc), but this project includes only short visits to sites so, not all parameters are obtained for all species Electronic Format All data from the monitoring program goes into the Pacific Seabird Monitoring Database
Geographic Area	In the GOA the periodic sites are Forrester/Lowrie (surveyed opportunistically 2 of last 5 years), Chiswells (surveyed with EVOS funding 2 of last 5 years), Pye Islands (surveyed opportunistically with NPS boat once in last 5 years), Chisik/Duck (surveyed annually the last 5 years with MMS and EVOS funding), Shumagins (several different islands surveyed once in last 5 years with EVOS funding)
Measurements/ Data Obtained	population trends, indices to productivity and timing of nesting events, prey
Contact Info	Vern Byrd Alaska Maritime National Wildlife Refuge 2355 Kachemak Drive, Suite 101 Homer AK 99603 907-235-6546 vernon_byrd@fws gov
Duration	Begin Date mid-1970's, End date Continuing long term
Future Plans	long term/depending on funding
Discipline	Seabird Ecology

Gulf Ecosystem Monitoring (GEM) Gap Analysis.
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Line P / Station P**	**ID# 225**
Organization	Fisheries & Oceans Canada	

Description The maintenance of the long term sampling at Station P and along Line P is a high priority as the time series is unique in providing a continual view of the interannual variability of the NE Pacific Ocean The value of a long time series is in the ability to define mean conditions In recent years we have seen some dramatic changes in conditions along Line-P, in particular, a shallowing of the mid-winter mixed layer and a decline in dissolved nutrients During the 1990s we have seen late summer nitrates decline to zero along much of Line-P These changing conditions need to be monitored

Geographic Area Nominally from the mouth of the Juan de Fuca Strait, south of Vancouver Island, to Ocean Station Papa at 50N 145W, but at least once per year we extend the survey either north to the coast of Alaska or south to 45N and thence to the Oregon/Washington coast

Measurements/ Data Obtained Temperature and salinity, major nutrients sampled versus depth on a rosette cast, also sampled continuously from sea-water loop Primary productivity, ID of zooplankton species, carbon chemistry, dimethyl suplhide, iron, currents from Doppler profiler and other sampling as required

Contact Info

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P O Box 6000
Sidney B C , Canada V8L 4B2
(250)-363-6590
FreelandHj@pac dfo-mpo gc ca

Duration Ongoing

Future Plans We have recently had to downgrade the Line-P trips from 3 per year to 2 per year and a partial trip We hope to revive the program to three trips/year very soon

Discipline Physical, Geochemical & Chemical Oceanography

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Rockfish Genetic Database Development**	**ID#: 22(**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)	
Description	Develop allozyme and DNA databases for rougheye and shortraker rockfish throughout the North Pacific region	
Geographic Area	North Pacific Region	
Measurements/ Data Obtained	Allozyme and DNA data of rougheye and shortraker rockfish stocks	
Contact Info	Richard Wilmot NOAA-NMFS Auke Bay Laboratory 11305 Glacier Highway Juneau AK 99801-8626 907/789-6079 Richard Wilmot@noaa gov	
Duration	On-going	
Future Plans		
Discipline	Marine & Fish Ecology	

Gulf Ecosystem Monitoring (GEM) Gap Analysis· Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project **Population Ecology of Seabirds on Middleton Island, Alaska** **ID#· 227**

Organization U S Department of the Interior (DOI)

U S Geological Survey (USGS)

Description Current research and monitoring of seabirds on Middleton Island is a continuation of work initiated at this location in 1956 by Robert Rausch and resumed in the mid 1970s by the U S Fish and Wildlife Service Work of varying intensity has been conducted in 22 years since 1974 and annually since 1981 Current emphasis is on the population dynamics and feeding ecology of black-legged kittiwakes and pelagic cormorants nesting on an abandoned radar tower, which has been modified to facilitate close observation and experimental manipulation of those species Capabilities include supplemental feeding of breeding adults and evaluation of food availability as a factor affecting breeding performance, colony structure, and survival Annual censuses of several species (kittiwakes, cormorants, murres) are conducted Long-term population trend data are also available for glaucous-winged gulls, rhinoceros auklets, and black oystercatchers Productivity of gulls, auklets, and tufted puffins is monitored using standard protocols Sampling of chick diets in several species, especially puffins and auklets, is used to montitor the species composition of forage fish available to seabirds on Middleton

Geographic Area Middleton Island, north-central Gulf of Alaska

Measurements/ Data Obtained Middleton Island seabird monitoring comprises about 880 observations in the Pacific Seabird Monitoring Database These are annual measures of population parameters (numbers, productivity, and/or other variables from the above list) in one or more of the focal species during most years since 1974 Middleton studies include the earliest (1988) and longest running observations on adult survival of black-legged kittiwakes in the North Pacific Auklet and puffin diet composition has been quantified in 10 years since 1978 Supplemental feeding experiments with black-legged kittiwakes have now been conducted in 4 years (annually since 1996)

Contact Info Scott Hatch
USGS/BRD
Alaska Biological Science Center
1011 East Tudor Road

Anchorage AK 99503-6199

907-786-3529

scott_hatch@usgs gov

Duration Ongoing, currently planned for continuation by USGS through FY 2003

Future Plans In 1998, USGS personnel wrote a prospectus for a permanent marine biological station on Middleton Island Partnerships are sought in support of continued research and monitoring of the island's seabirds and other wildlife, land acquisition and protection, and public education in this uniquely accessible and biologically dynamic area

Discipline Seabird Ecology

Project **A continuous plankton recorder monitoring program for the eastern North Pacific & southern Bering Sea** **ID#· 22**

Organization Fisheries & Oceans Canada

Description (See http //www2 sfos uaf edu 8080/projects/projects html for a version including graphics)

Our objective is to put in place a monitoring program for the eastern North Pacific and southern Bering Sea region Large scale changes in Pacific salmon populations in all regions of North America have been related to climate change in this century The likely initial cause is changes in the structure of the ocean and atmosphere These changes are known to affect the abundance, productivity, and community structure of continental shelf and open ocean plankton communities The changes in plankton abundance have been related to the changes in salmon abundance, and reduced ocean productivity is probably the causal link leading to poor ocean survival for salmon The climate changes experienced in recent years are consistent with expectations from models for the early stages of global warming In all regions of the West Coast of North America there have been extremely sudden changes in the productivity of salmon populations These changes have not been expected from the standard fisheries management theories, nor could they be forecast from available data However, the changes have had devastating economic impacts on coastal communities from Oregon to (most recently) Alaska The pattern of failure in year-class strength of Bristol Bay sockeye salmon and other stocks and species demonstrates that the cause of the sudden downturn has in large part a marine origin However, salmon spend part of their life history in both coastal and oceanic marine environments, and are therefore subject to environmental changes occurring in both regions We seek to put in place a monitoring framework using Hardy Continuous Plankton Recorder (CPR) This is an established technology widely used in the North Atlantic The changes that the Atlantic CPR program have documented in the 1990s are now being linked to the decline in Atlantic salmon populations, which are also experiencing substantially increased ocean mortality

Proposed CPR plankton monitoring lines (A and B, in red), and existing NE Pacific ocean monitoring locations (blue) The continental shelf edge is shown in black Our project involves sampling of the plankton in multiple regions of the offshore and coastal regions of the eastern North Pacific and southern Bering Sea The monitoring lines will (a) sample the plankton along the coastal migration routes of the juvenile salmon in four locations, (b) quantify the distribution and abundance of shelf plankton populations in the Atlantic (Steele

Geographic Area Plankton monitoring transects extending from Prince William Sound to Long Beach California, and from Vancouver west to the southern Bering Sea

Measurements/ Data Obtained Relative index of chlorophyll concentration
Abundance by taxa of zooplankton

Contact Info Sonia Batten

Dr Sonia D Batten
Sir Alister Hardy Foundation for Ocean Science
1, Walker Terrace, The Hoe,
Plymouth United Kingdom PL1 3BN
+44 1752 221-112
soba@wpo nerc ac uk

Duration 1991-2001

Future Plans We intend to put a proposal in to EVOS (which will have the support of PICES) to initiate a multi-decadal plankton monitoring program for the Eastern North Pacific

Discipline Biological Oceanography

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Process Structuring Coastal Marine Communties in Alaska DOI Trust Resources**	**ID#: 230**
Organization	U S Department of the Interior (DOI) U S Geological Survey (USGS)	
Description		
Geographic Area		
Measurements/ Data Obtained		
Contact Info	James Bodkin	
Duration		
Future Plans		
Discipline	Nearshore, Benthic & Coastal Ecology	

Project	**Sea Level Data, Wind Speed, and Significant Wave Height from Satellite Altimetry** **ID# 23**
Organization	National Oceanic and Atmospheric Administration (NOAA) National Environmental Satellite, Data and Information Service (NESDIS)
Description	Radar altimeters measure sea level with an accuracy of 3 cm over a footprint of about 2 km They also measure significant wave height and wind speed (but not direction)
Geographic Area	Global
Measurements/ Data Obtained	Sea level, wind speed, wave height
Contact Info	Robert Cheney NOAA E/OC2, SSMC3 Room 3620 1315 East West Hwy Silver Spring MD 20910-3282 301-713-2857 x118 rcheney@nodc noaa gov
Duration	The series began in 1991 Global altimeter data are available from 1985-89 and 1991-present The Geosat altimeter operated for 4 5 years during 1985-89, and was the only satellite to capture the sea level changes associated with the 1987 El Nino A significantly improved version of the Geosat dat was released by NOAA in June 1997 ERS-1 and ERS-2 are missions of the European Space Agency ERS-1 collected global altimeter data from November 1991 to June 1996 It was then put in standby mode ERS-2 began collecting data in June 1995, providing a 1-year overlap with ERS-1 The joint NASA/CNES satellite altimeter, Topex/Poseidon, has been operating since September 1992 Geosat Follow-On is a U S Navy altimeter mission that was launched on Feb 10, 1998 NOAA will work together with the Naval Oceanographic Office to process the altimeter data
Future Plans	Indefinite It is expected that satellite altimeters will fly continuously
Discipline	Physical, Geochemical & Chemical Oceanography

Gulf Ecosystem Monitoring (GEM) Gap Analysis·
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Kitoi Bay Monitoring**	**ID# 235**

Organization Alaska Department of Fish and Game (ADFG)

Commercial Fisheries

Description ADF&G personnel, funded by Kodiak Regional Aquaculture Association (KRAA), monitor several sites in Kitoi Bay for plankton, salinity, and temperature data The project is part of the Kitoi Bay Hatchery Evaluation program which monitors enhanced salmon production from the facility The oceanography data has been collected annually since 1990

Geographic Area Kitoi Bay, located on Afognak Island (58o11'N, 152o21'W)

Measurements/ Data Obtained Plankton tows collected weekly from May through July by replicate vertical tows - 24 hour settlement volume in graduated cylinders Salinity and temperature data are collected weekly from May through July at three stations within Kitoi Bay from the surface to the bottom

Contact Info
Steven Honnold
211 Mission Road
Kodiak AK 99615
907-486-1873
Steve_Honnold@fishgame state ak us

Duration 1990-present

Future Plans Continue annual monitoring

Discipline Biological Oceanography

Gulf Ecosystem Monitoring (GEM) Gap Analysis
Active Monitoring Projects in the Northern GOA (Non-EVOS)

Project	**Certified Shellfish Beaches**	**ID# 23L**
Organization	Alaska Department of Environmental Conservation (ADEC) Environmental Health (DEH)	
Description	The State of Alaska certifies shellfish beaches Approved areas are those waters where water sampling, marine toxin sampling and shoreline work have taken place and that fecal material, pathogens, microorganisms, poisonous and deleterious substances are not present in dangerous concentrations	
Geographic Area	Certified beaches include Polly Creek - Cresent River, Jakolof Bay, Kasitsna Bay, Tutka Bay, Halibut Cove Lagoon, Chugachik Island, Sadie Cove, Peterson Bay, and Little Jakolof Bay	
Measurements/ Data Obtained		
Contact Info	Manny Soares Seafood Processing and Development Alaska Dept of Environmental Conservation Division of Environmental Health 555 Cordova Street Anchorage AK 99501-2617 907-269-7640 907-269-7510 msoares@envircon state ak us	
Duration		
Future Plans		
Discipline	Nearshore, Benthic & Coastal Ecology	

Project **Lower Kenai Peninsula Watershed Health Project** **ID# 237**

Organization Cook Inlet Keeper

Description Cook Inlet Keeper has teamed up with the Homer Soil and Water Conservation District to develop the Lower Kenai Peninsula Watershed Health Project The goal of the project is to collect professional-level water quality data on the four rivers of concern Keeper uses aerial photography, macroinvertebrate (insect) data and Geographic Information Systems (GIS) technology to supplement field water quality data collection The Anchor River, Stariski Creek, Ninilchik River and Deep Creek boast healthy, world-class salmon and dolly varden populations Yet these rivers are under threat from human activities Logging, development and road building are all taking place in these watersheds As populations on the lower Kenai Peninsula increases, so will the pressure on these streams Each month, Keeper's stream ecologist visits a total of twelve sites on the four streams At each site the ecologist and her assistant make measurements, describe the environment and collect water samples

Geographic Area

Measurements/ Data Obtained

Contact Info

Duration

Future Plans

Discipline Nearshore, Benthic & Coastal Ecology

Project **Citizens Environmental Monitoring Program (CEMP)** **ID#. 238**

Organization Cook Inlet Keeper

Description Cook Inlet Keeper trains citizens to monitor water quality at many sites in the Cook Inlet watershed Currently sites are established around Kenai, Homer and Anchor Point The data collected are entered into a relational database, and compared to federal and state water quality standards

Geographic Area

Measurements/ Data Obtained

Contact Info

Duration

Future Plans

Discipline Nearshore, Benthic & Coastal Ecology

Project	**Long-Term Environmental Monitoring Program**	**ID#. 24**
Organization	Prince William Sound Regional Citizens' Advisory Council (PWSRCAC)	

Description The Long-Term Environmental Monitoring Program provides measurements of hydrocarbon concentrations and sources at program sites within areas of Prince William Sound and the Gulf of Alaska under the auspices of the Prince William Sound Regional Citizens' Advisory Council These measurements provide a basis for the examination of spatial and temporal changes in hydrocarbon levels that are the result of both natural and man-induced inputs to the environment The program focuses on sampling of intertidal mussels and nearby sediments to provide information on hydrocarbon levels that exist in the study area

Geographic Area Sample sites Aialik Bay, Alyeska Marine Terminal, Disk Island, Gold Creek, Knowles Head, Sheep Bay, Shuyak Harbor, Sleepy Bay and Windy Bay

Measurements/ Data Obtained

Contact Info

907-277-7222

Duration

Future Plans

Discipline Physical, Geochemical & Chemical Oceanography

H Acronyms and Links

ABC Acceptable Biological Catch

AC Alaska Current

ACC Alaska Coastal Current

ACCE Atlantic Climate and Circulation Experiment

ACIA Arctic Climate Impact Assessment

http //www acia uaf edu

http //www iarc uaf edu/structure_of_IARC html

ADCED Alaska Department of Community and Economic Development

ADEC Alaska Department of Environmental Conservation

ADF&G Alaska Department of Fish and Game

Division of Commercial Fisheries http //www cf adfg state ak us/cf_home htm

Division of Habitat http //www state ak us/adfg/habitat/hab_home htm

Division of Subsistence http //www state ak us/local/akpages/FISH GAME/subsist/subhome htm

Division of Subsistence Whiskers Database

http //www state ak us/local/akpages/FISH GAME/subsist/subhome htm

Division of Sport Fish http //www state ak us/local/akpages/FISH GAME/sportf/sf_home htm

ADHSS Alaska Department of Health & Social Services

ADNR Alaska Department of Natural Resources http //www dnr state ak us/

Division of Parks and Outdoor Recreation http //www dnr state ak us/parks

Division of Mining, Land and Water http //www dnr state ak us/mlw

ADEOS-II Advanced Earth Observing Satellite-II

ADOT Alaska Department of Transportation

AEPS Arctic Environmental Protection Strategy

http //arcticcircle uconn edu/NatResources/aeps html

AMAP Arctic Monitoring and Assessment Programme

http //www amap no

AMHS Alaska Marine Highway System

AMMTAP Alaska Marine Mammals Tissue Archival Project

AMNWR Alaska Maritime National Wildlife Refuge

AMSR Advance Microwave Scanning Radiometer

ANHSC Alaska Native Harbor Seal Commission

APEX Alaska Predator Ecosystem Experiment

ARCUS Arctic Research Consortium of the United States

http //www arcus org

ARGO Array for Real-time Geostrophic Oceanography

ARLIS Alaska Resources Library and Information Service

ARMRB Alaska Regional Marine Research Board

ARMRP Alaska Regional Marine Research Plan

ASP Amnesiac Shellfish Poisoning

ASTF Alaska Science and Technology Foundation

http //www astf org

ATV All Terrain Vehicle

AUV Autonomous Underwater Vehicle

AVHRR Advanced Very High Resolution Radiometer

AVSP Alaska Visitor Statistics Program

AWC Anchorage Waterway Council

http //www anchwaterwayscouncil org

AWQ Division of Air and Water Quality, ADEC

BRD Biological Resources Division

CARIACO Carbon Retention in a Colored Ocean Program

CARICOMP Caribbean Coastal Marine Productivity

CCAMLR Commission for the Conservation of Antarctic Marine Living Resources

http //www ccamlr org

CCF One hundred cubic feet

CDFO Canadian Department of Fisheries and Oceans

CDQ Community Development Quota

CEMP CCAMLR Ecosystem Monitoring Program

http //www ccamlr org/English/e_scientific_committee/e_ecosystem_monitoring/e_ecosys_monitoring_intro htm

CENR Committee on Environment and Natural Resources

CIFAR Cooperative Institute for Arctic Research

http //www cifar uaf edu

http //www cifar uaf edu/fisheries html

CIIMMS Cook Inlet Information Management and Monitoring System

http //www dnr state ak us/ssd/ciimms/ciimms_sum2 html

CIK Cook Inlet Keepers

CIRCAC Cook Inlet Regional Citizens Advisory Council

CISNet Coastal Intensive Site Network

CLIC Climate and Cryosphere

CLIVAR Climate Variability and Predictability Program

C-MAN Coastal Marine Automated Network

CMED/GMNET Consortium for Marine and Estuarine Disease/Gulf of Mexico Network

CNES Centre National d'Etudes Spatiales (France)

COADS Comprehensive Ocean-Atmosphere Data Set

http //www cdc noaa gov/coads

CoML Census of Marine Life

http //core ssc erc msstate edu/censhome html

COP Coastal Ocean Program

CORE Consortium for Oceanographic Research and Education

http //core ssc erc msstate edu/corehmpg1 html

CPR Continuous plankton recorder

CRIS Court Registry Investment System

CRP Comprehensive Rationalization Program

CSCOR Center for Sponsored Coastal Ocean Research

CTD Conductivity temperature versus depth

CVOA Catcher Vessel Operational Area

DARPA Defense Advanced Research Projects Agency

DDE Dichlorodiphenyldichloroethylene

DDT Dichlorodiphenyltrichloroethane

DEOS Deep Earth Observatories on the Seafloor

DFO Department of Fisheries and Oceans, Canada

DoD U S Department of Defense

DODS Distributed Oceanographic Data System

http //rs gso uri edu/DODS/home/home html

DOE U S Department of Energy

DOI U S Department of the Interior

EA/RIR Environmental Assessment/Regulatory Impact Review

ECDIS Electronic Chart and Display Information Systems

EEZ Exclusive Economic Zone

EFH Essential Fish Habitat

EMAP Environmental Monitoring and Assessment Program

http //www epa gov emap/

ENSO El Niño Southern Oscillation

EOSDIS EOS Data and Information System

http //spsosun gsfc nasa gov/NewEOSDIS_Over html

EPA U S Environmental Protection Agency

ERS-1 European Remote Sensing satellite-1

ERS-2 European Remote Sensing satallite-2

EUMETSAT European Organization for the Exploitation of Meteorological Satellites

EVOS *Exxon Valdez* Oil Spill http //www oilspill state ak us/

Bibliography http //www oilspill state ak us/Biblio/biblio htm

Final and Annual Reports http //www oilspill state ak us/reports/clusters htm

FCCC Framework Convention on Climate Change

Federal Geographic Data Committee metadata requirements
http //www fgdc gov/metadata/metadata html

Federal Subsistence Fishery Monitoring Program, Federal Subsistence Management Program

http //www r7 fws gov/asm/home html

FGDC Federal Geographic Data Committee

FMP Fishery Management Plan

FOCI Fisheries Oceanography Investigations

http //rho pmel noaa gov/card/long/home_page html

FY Fiscal Year

GAK Gulf of Alaska

GCOS Global Climate Observing System

http //193 135 216 2/web/gcos/pub/dim_v1_1 html

GEM Gulf Ecosystem Monitoring

GEO Global Eulerian Observations

GHL Guideline Harvest Level

GLOBE Global Learning and Observations to Benefit the Environment

GLOBEC Global Climate Change

http //www ccpo odu edu/Research/globec_menu html

GLORIA Geological Long-Range Inclined Asdic

GNP Gross National Product

GOA Gulf of Alaska

GODAE Global Ocean Data Assimilation Experiment

GOES Geostationary Operational Environmental Satellite

GIS Geographic Information System

GOOS Global Ocean Observing System

http //www gos udel edu

GPS Global Positioning System

GTOS Global Terrestrial Observing System

HAB harmful algal bloom

http //www redtide whoi edu/hab

HABSOS Harmful Algal Bloom Observing System

http //www habhrca noaa gov

HAPC Habitat Areas of Particular Concern

IARC International Arctic Research Center, University of Alaska

http //www iarc uaf edu/

IBQ Individual Bycatch Quota

IFQ Individual Fishing Quota

IGBP International Geosphere-Biosphere Programme

http //www igbp kva se/

IGOS Integrated Global Observing System

IIP International Ice Patrol

IMS Institute of Marine Science, University of Alaska

INPFC International North Pacific Fisheries Commission

http //www npafc org/inpfc/inpfc html

IOC Intergovernmental Oceanographic Commission

http //ioc unesco org/iyo/

IODE International Oceanographic Data and Information Exchange

http //ioc unesco org/iode/index htm

IOOS Integrated Ocean Observing System

http //core ssc erc msstate edu/oceanobs html

IPCC Intergovernmental Panel on Climate Change

IPHC International Pacific Halibut Commission

http //www iphc washington edu/)

IPSFC International Pacific Salmon Fishing Commission

IRFA Initial Regulatory Flexibility Analysis

IRIU Improved Retention/Improved Utilization

ITAC Initial Total Allowable Catch

Japanese ADEOS-2 satellite http //seawinds jpl nasa gov

JGOFS Joint Global Ocean Flux Study
http //ads smr uib no/jgofs/jgofs htm

KBNERR Kachemak Bay Ecological Characterization study
http //www state ak us/adfg/habitat/geninfo/nerr/kbec/index htm

KRSA Kenai River Sportfishing Association

LAMP Local Area Management Plan

LATEX Louisiana-Texas shelf study

LEO Long-term Ecosystem Observatory

LEO-15 Long-term Ecosystem Observatory at 15-m depth

List of oceanographic data servers http //gcmd gsfc nasa gov/pointers/ocean html

LLP License Limitation Program

LTER Long-term Ecological Research

MAROB Marine Observation

MBF One thousand board feet

MBNMS Monterey Bay National Marine Sanctuary
http //bonita mbnms nos noaa gov/research/mb_workshop/index html

MEL Master Environmental Library
http //www-mel nrlmry navy mil/

MetOp Meteorological Operational

MMPA Marine Mammal Protection Act

MMRC The North Pacific Universities Marine Mammal Research Consortium
consortium@zoology ubc ca

MMS Minerals Management Service

MMS OCSES Outer Continental Shelf Environmental Studies

NPS National Park Service

MSFCMA Magnuson-Stevens Fishery Conservation and Management Act

MRB Maximum Retainable Bycatch

MSY Maximum Sustainable Yield

mt Metric tons

NAML National Association of Marine Laboratories

NASA National Aeronautics and Space Administration

NASA/AMSR Advance Microwave Scanning Radiometer

http //wwwghcc msfc nasa gov/AMSR/

Earth Science Enterprise http //www earth nasa gov

TOPEX/Poseiden http //topex-www jpl nasa gov

NASA/NASDA Tropical Rainfall Measurement Mission
http //ltpwww gsfc nasa gov/MODIS/MODIS html

NASA/SeaWiFS http //seawifs gsfc nasa gov

NASA/GRACE Gravity Recovery and Climate Experiment
http //essp gsfc nasa gov/esspmissions html

NASA/Salinity and Sea Ice Working Group http //www esr org/lagerloef/ssiwg/ssiwgrep1 v2 html

Naval Oceanographic Office

http //128 160 23 51/noframe/select products htm

NAWQA National Water Quality Assessment Program

NCAR National Center for Atmospheric Research

NCDC National Climate Data Center

http //www ncdc noaa gov/

NDBC National Data Buoy Center

NEP National Estuarary Program

NERR National Estuarine Research Reserve

NESDIS National Environmental Satellite, Data, and Information Service

NGO Non-governmental organization

NGOA Northern Gulf of Alaska

NIST National Institute of Standards and Technology

http //www nist gov/

NMFS National Marine Fisheries Service

http //www nmfs gov/

National Marine Mammal Health and Stranding Response Program

http //www nmfs gov/prot res/overview/mmhealth html

NOAA National Oceanic and Atmospheric Administration

NOAA HAZMAT Hazardous Materials Program

NOAA NOS National Ocean Service

NODC National Oceanographic Data Center

http //www nodc noaa gov

NOLS National Outdoor Leadership School

NOPP National Ocean Partnership Program

http //core ssc erc msstate edu/NOPPpg1 html

NOPPO National Oceanographic Partnership Program Office

NORLC National Ocean Research Leadership Council

NOS National Ocean Service

http //www nos noaa gov/

NPAFC North Pacific Anadromous Fish Commission

http //www npafc org

http //www pac dfo-mpo gc ca/sci/pbs/pages/NPAFC htm

NPFMC North Pacific Fishery Management Council

NPDES National Pollution Discharge Elimination System

NPO North Pacific Oscillation

NPOESS National Polar-Orbiting Environmental Satellite System

NRC National Research Council

NS&T National Status and Trends Program

http //ccmaserver nos noaa gov/NSandT/New_NSandT html

NSF National Science Foundation

NURP National Undersea Research Program

NVODS National Virtual Ocean Data System

NVP Nearshore Vertebrate Predator project

NWP numerical weather prediction

NWS National Weather Service

http //www nws noaa gov/

OAR Oceanic and Atmospheric Research

http //oar noaa gov/

OCC Ocean Carrying Capacity

OCSEAP Outer Continental Shelf Environmental Assessment Program

OFP Ocean Flux Program

OMB Office of Management and Budget

OOPC Ocean Observations Panel for Climate

OOSDP Ocean Observing System Development Panel

OPA 90 Oil Pollution Act of 1990

http //www pwssc-osri org/docs/opa90 html

OPR Office of Protected Resources

http //www nmfs gov/prot_res/prot_res html

ORAP Ocean Research Advisory Panel

OSRI Prince William Sound Oil Spill Recovery Institute

http //www pwssc-osri org/mission/mission fr html

OSTP Office of Science and Technology Policy

OY Optimum yield

PAG Public Advisory Group

PAH Polyaromatic hydrocarbons

PCB Polychlorinated biphenyls

PCC Pollock Conservation Cooperative

PDO Pacific Decadal Oscillation

PICES North Pacific Marine Science Organization (not an acronym)

http //pices ios bc ca/

PICES Technical Committee on Data Exchange http //pices ios bc ca/data/dataf htm

PICES Data Bases http //pices ios bc ca/data/weblist/weblist htm

PIRATA Pilot Research Array in the Tropical Atlantic

PISCO Partnership for the Interdisciplinary Study of Coastal Oceans

http //www piscoweb org/

PMEL Pacific Marine Environmental Laboratory

http //www pmel noaa gov/

PMEL Bering Sea and North Pacific Ocean Theme Page www pmel noaa gov/bering

PORTS Physical Oceanographic Real-Time System

PORTS/VTS PORTS/Vessel Traffic Services

PSC Pacific Salmon Commission

http //www psc org/Index htm

PSMFC Pacific States Marine Fisheries Commission

http //www psmfc org/

PSMFC Regional Mark Processing Center http //www rmis org/index html

PSP Paralytic Shellfish Poisoning

PWS Prince William Sound

PWSAC PWS Aquaculture Corporation

PWSRCAC PWS Regional Citizens Advisory Council

PWSSC Prince William Sound Science Center

http //www pwssc-osri org/

QC quality control

R&D Research and Development

RACE Resource Assessment and Community Ecology

RCAC Regional Citizens Advisory Council

RCRA Resource Conservation and Recovery Act

SAFE Stock Assessment and Fishery Evaluation Document

SEA Sound Ecosystem Assessment

SEARCH Study of Environmental Arctic Change

SeaWIFS Sea-viewing Wide Field-of-view Sensor

SFOS School of Fisheries and Ocean Sciences

SG Sea Grant

http //www nsgo seagrant org/

SGI State of the Gulf Index

SOLAS International Convention for Safety of Life at Sea

Specimen Banking Project

http //www nwfsc noaa gov/pubs/tm/tm16/tm16 htm

SSC Scientific and Statistical Committee

SSH Sea Surface Height

SSM/I Special Sensor Microwave/Imager

SST Sea Surface Temperature

STAMP Seabird Tissue Archival Monitoring Project

STD Salinity Temperature Depth recorder

STORET System (EPA)

http //www epa gov/owow/STORET

TAC Total allowable catch

TAO Tropical Atmosphere-Ocean

http //www pmel noaa gov/toga0tao/review98/data html

T/P TOPEX/Poseidon

UAA University of Alaska, Anchorage

UAF University of Alaska, Fairbanks

UN United Nations

UNCLOS United National Convention on the Law of the Sea (Montego Bay, 1982)

UNESCO United Nations Educational Social and Cultural Organization

http //ioc unesco org/iocweb/

USCG U S Coast Guard

USDA U S Department of Agriculture

USFS U S Forest Service

USGS U S Geological Survey

http //www usgs gov/

US GLOBEC U S Global Ocean Ecosystems Dynamics

http //cbl umces edu/fogarty/usglobec/

VBA Vessel Bycatch Accounting

VIP Vessel Incentive Program

VOS Volunteer Observing Ships

WCRP World Climate Research Program

WES Waterways Experimental Station

WHOI Woods Hole Oceanographic Institution

WOCE World Ocean Circulation Experiment

http //www soc soton ac uk/OTHERS/woceipo/ipo html

http //www cms udel edu woce/

XBT expendable bathythermograph

XCDT expendable conductivity, depth and salinity devices

Workshop Draft:
GEM Monitoring & Research Plan

September 25, 2000

Table of Contents

Introduction

What is This Document?

The *Exxon Valdez* Oil Spill Trustee Council has taken action to devote the majority of the remaining oil spill settlement funds to endowment of a long-term monitoring and research program for the region in the northern Gulf of Alaska impacted by the 1989 oil spill That program is called the Gulf Ecosystem Monitoring and Research Program – or GEM

A document describing the program, "The Gulf Ecosystem Monitoring (GEM) Science Program NRC Review Draft" (commonly referred to as the GEM Program document), was released in April 2000 and is now under review by the National Research Council It describes the mission and goals, overall framework and scientific conceptual foundation of the future GEM program It does not contain an actual plan for monitoring and research

This document is a "straw dog" draft of a GEM monitoring and research plan and should be viewed as a companion to the GEM Program document It provides the basis for the next step in program development by organizing the program into themes, identifying hypotheses for each theme that relate to the conceptual foundation, proposing strategies to test those hypotheses, and presenting draft "components", which are activities that could be undertaken to implement the strategies Together, these pieces constitute the beginnings of a GEM monitoring and research plan

The GEM Program document and the monitoring and research components presented here reflect the ideas and suggestions received from many people over the course of the last year and a half (see Acknowledgments) These collaborative efforts began with input from an informal group of scientists in the summer of 1999, followed by numerous presentations to groups and communities throughout Alaska over the past winter Most recently, in July and August 2000, regional focus groups were held for Prince William Sound, Cook Inlet, and Kodiak-Alaska Peninsula These groups helped enormously in defining the types of components presented here

What Does This Document Contain?

The Draft GEM Monitoring and Research Plan builds on our current understanding of the northern Gulf of Alaska and a conceptual foundation that describes how we think that ecosystem works Concepts in the plan are organized around themes, for which preliminary hypotheses, strategies to address hypotheses, and components to implement the strategies have been identified As a way of examining the draft plan from different viewpoints, we have also grouped the components by scientific discipline and question Specifically, the draft plan contains

- Following this introduction
A map showing the locations of proposed components

- "By theme "
A summary write-up about each theme, including the rationale for the theme, preliminary hypotheses, strategies, and components, questions for group discussion, a map showing the component locations, and a summary spreadsheet with rough estimated costs for that theme

- "By discipline "
A summary spreadsheet of these same components organized by scientific discipline with a brief explanation and questions for group discussion

- "By question "
A summary spreadsheet of these same components organized by ecological question with a brief explanation and questions for group discussion

- "By issue "
Questions to be addressed by the work groups on overarching issues

- "By component "
One-page descriptions of each component, preceded by an explanation of "How to Read" the component descriptions

How Does This Document Relate to the GEM Program Document?

The primary purpose of the Draft GEM Monitoring and Research Plan is to describe a comprehensive program that meets the mission and goals outlined in the GEM Program document The GEM mission is

> *"To sustain a healthy and biologically diverse marine ecosystem in the northern Gulf of Alaska and the human use of the marine resources in that ecosystem through greater understanding of how its productivity is influenced by natural changes and human activities "*

The five major goals of GEM are to

Detect change,
Understand the causes of change,
Predict future status and trends of resources,
Inform the public, resource managers and policy makers by providing integrated and synthesized information, and
Solve problems faced by resource managers and regulators by developing tools, technologies and information

The Draft Monitoring & Research Plan includes both monitoring and research components Monitoring provides observations that can be used to detect change in the populations of select marine animals and plants, ecological processes and geophysical mechanisms Research provides the key to understanding how these observations explain what is happening in the Gulf of Alaska ecosystem and how the system works Research converts monitoring into information that can be used for a wide variety of purposes, including the ability to predict future status and trends over time Monitoring and research must be used together so that the information obtained can be used to help solve various management problems, such as explaining why changes may be occurring in populations of species that are economically or culturally important and whether human activities should be modified in response

The GEM program also has six institutional goals
Identify research and monitoring gaps,
Leverage funds from other programs,
Prioritize research and monitoring needs,
Synthesize research and monitoring,
Track work relevant to understanding the Gulf of Alaska, and
Involve others in achieving the mission and goals of GEM

These goals permeate the Draft Monitoring and Research Plan For example, each individual component identifies potential partnerships and sources of funds to leverage An entire theme is devoted to synthesis Tracking others' work is key to understanding gaps in knowledge of the northern Gulf of Alaska and to understanding the state of the system from a larger perspective Because GEM does not have sufficient funds to do all of the work that could be done, it needs to focus on priorities and work with other entities to help address gaps

For more than two years, an informal "gap analysis" has been in progress through discussions with scientists, policy makers and stakeholders concerning what efforts are currently underway in the northern Gulf of Alaska A database of these efforts has been compiled, and the most relevant programs have been included behind the "Active Projects" tab in the Scientific Background section of this binder

Why Was the Theme Approach Selected?

There are numerous ways in which to organize a monitoring and research plan Two approaches that were considered and dismissed are the "potluck" approach —identifying very broad concepts and inviting anyone to submit project proposals (you may get all desserts!)—and the "Christmas tree" approach—including every conceivable proposal without thought for integration, prioritization, or cost The approach taken in this document, which we believe is preferable, uses themes to coordinate and integrate high priority hypotheses and strategies that attempt to refine the current scientific understanding of the northern Gulf of Alaska ecosystem

The theme approach is not new in the EVOS science program, or to the broader scientific community in the northern Pacific For example, in the Trustee Council-funded Sound Ecosystem Assessment (SEA) program, the entry points for understanding the Prince William Sound ecosystem were pink salmon and Pacific herring In the GLOBEC program, increasing our understanding about climate change in the north Pacific is organized around processes affecting juvenile salmon We have found the use of themes to be both necessary and acceptable for sustaining a long-term monitoring program The use of themes is also inclusive of a large number of scientific specialties, as can be seen in the spreadsheet (later in this binder) classifying proposed components by scientific discipline

Three of the proposed GEM themes address plant and animal species seabirds, forage fish and nearshore plants and animals Two others, terrestrial linkages and coastal processes, focus on ecological processes important to all of these species The final two themes, synthesis and support services, provide a critical foundation for the program

The seabird, forage fish, and nearshore themes use specific species as conceptual focal points around which to organize studies of factors controlling changes in the marine ecosystems They are seen as ecological "crossroads" where geophysical and biological agents of change come together The agents of change have been identified in the GEM conceptual foundation as food, habitat, removals by harvest and predators, and related geophysical forcing factors, such as the Pacific Decadal Oscillation

The selection of these themes and species was based in part on the state of knowledge of their biology and life histories, the convenience of their study and the availability of local expertise For example, harbor seals are a key species in the forage fish theme We have a relatively long history of data related to harbor seal population counts, food, juvenile survival and movement from 11 years of study in Prince William Sound In addition, harbor seals are an important subsistence resource and there are well-accepted methods for their capture and handling Unlike another species, such as the

Steller sea lion, there is very little work being done outside the oil spill restoration program

Although particular species may be the focus of a theme, this does not mean that other plant and animal species are excluded in that theme, nor are geophysical processes or factors such as contaminants overlooked The selection of a focus species also does not mean that GEM will fund data acquisition for all factors necessary to understand changes in that species through time Our goal is to describe as completely as possible what is necessary to understand change in a particular species, and in the process, address the many other species and geophysical and chemical processes that contribute to changes in that species through time

Why Is GEM a Salmon and Pollock Program, Even if There Is No Salmon or Pollock Theme?

One of the biggest debates in organizing this draft plan was whether or not to include a pelagic fish theme with a focus on adult salmon, pollock and herring In this draft, we have chosen not to use such a theme, instead addressing these species in an ecosystem fashion throughout the entire plan For example, these three fish are considered important components of the forage fish base during spring in nearshore habitats Adult salmon are important to terrestrial linkages In order to predict how many adult salmon will return in a year, managers need to understand how oceanographic conditions may influence the production of zooplankton and how predation by pollock populations may change the number of salmon available to fishers

The theme concept is designed to be inclusive However, the need to know more about a particular species in isolation from the environment is not adequate justification for its study under GEM A proposed component must be connected to the preliminary hypotheses and strategies for a particular theme, addressing the GEM Program's mission and goals and relating to the scientific conceptual foundation In this sense, GEM may be a "salmon and pollock" program, a "sea otter and crab" program or "other species" program, depending on how components are linked to the preliminary hypotheses and strategies

Why Also Look at the Draft Plan by Discipline, Question and Issue?

Even though the organizational approach used in this draft plan is by theme, it is useful to look at the proposed components from other perspectives, asking different questions to see if the draft plan is cohesive For this reason, three additional work sessions are planned at the workshop These give the opportunity for participants to review the plan by scientific discipline, ecological question and overarching issue In the discipline work sessions, oceanographers, bird biologists and fish ecologists will get together to look at the components and determine if there are errors or omissions Discipline work sessions will also provide opportunities to discuss data acquisition technologies and survey methods In the ecological question work sessions, the components will be viewed from the perspective of the major questions identified in the GEM Program related to food, habitat, removals, and their interactions The sessions addressing overarching issues provide an opportunity for those interested in issues that transcend individual components to view the entire program You will find specific questions to use as a starting point for each of these sessions behind the tabs labeled "by discipline", "by question" and "by issue "

How Close is This to a Final Plan?

This is the starting point for a draft plan to be written during and after the workshop Substantial effort has been expended to give workshop participants a "running start", so we are counting on your contributions as a participant at the workshop Much work is needed to prepare the draft plan, especially on the research side of the program In addition, ideas are needed on ways to integrate local involvement and community-based monitoring, contaminants monitoring, and data and information transfer throughout the entire GEM program The "Dear Workshop Participant" letter at the front of this binder describes where we are in the planning schedule

Do We Want You to Consider Developing a Monitoring and Research Plan for the Entire Northern Gulf of Alaska, or Just a Plan for What Will be Funded by GEM?

Both The Trustee Council directed us to develop GEM activities in view of all ongoing research and monitoring in the region The GEM Program document includes a goal of leveraging and developing partnerships as fundamental to the program To this end, we have proposed GEM components as part of ongoing agency activities where possible This plan is not intended to fully explain what each agency or research entity is now doing in the Gulf of Alaska However, we have used what existing agencies are currently doing to identify components for GEM to fund in order to meet the GEM mission

How Much Funding Will Be Available for GEM?

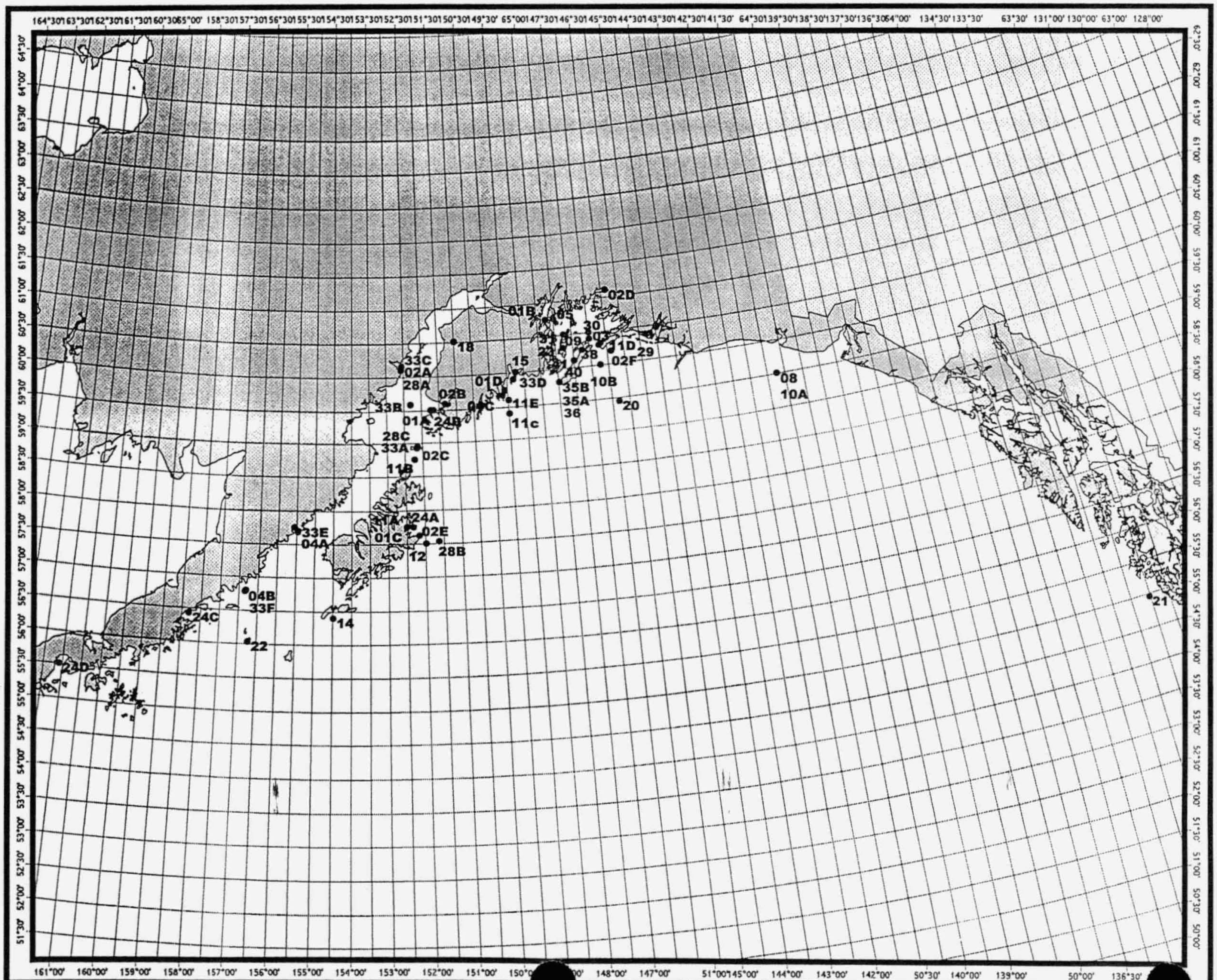
The Trustee Council is investing its funds with a plan for both inflation proofing and some real growth Depending on the outcome of various investments, the Trustee Council is anticipating that the following amounts will be available to the GEM program for the period FY 2003- 2007

FY 2003	$6 0 million fixed
FY 2004	$6 0 million fixed
FY 2005	$5 6 million estimated*
FY 2006	$5 7 million estimated*
FY 2007	$5 8 million estimated*
	** depending on investments*

This amount must fund the entire program, including any continuing oil spill restoration work and all administrative and support costs To put this in perspective, the EVOS Restoration Program cost more than $20 million in FY 96 For FY 2001, the current fiscal year, the total cost of the EVOS Restoration Program is $7 5 million

We were very hesitant about putting down cost estimates for each of the components in the draft plan Some of these estimates are very solid and truly indicative of the costs of these components Others are merely guesses and have not been verified Assumptions about partnerships and potential contributions from other sources are just that – assumptions They are not based on any definite commitments, and in fact, some entities identified as potential partners may be surprised to see themselves listed as such However, although the cost estimates are extremely rough, they do provide a starting point for looking at the program by estimated costs of components and hopefully start the discussion of what GEM can actually accomplish given the amount of funds available

All GEM Components



Seabird Theme Summary Page

Seabirds are highly visible indicators of the status of marine environments whose life cycles are part of a tightly interwoven food web composed of many other marine and some terrestrial species Implementing ecosystem-based management of animals in coastal marine environments depends on an understanding of the relations among species in those food webs in which seabirds are the most numerous and readily observed species Perhaps because seabirds do not have a history of intentional commercial harvest, the continuous time series of observations necessary to understand seabird abundance and productivity in relation to climate and other species are relatively short and uncommon

The basic strategy of the seabird monitoring components is to undertake boat surveys and land based observations at existing monitoring sites where seabird diversity and abundance are representative of regional variation in oceanographic conditions and availability of food resources and seabird habitats of the northern Gulf of Alaska Forage fish sampling sites (see Forage Fish Theme) would be nearby seabird monitoring sites

Monitoring of seabirds and their prey base of forage fishes would be organized around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska Sampling locations would be arrayed on the NE-SW axis of the cross from waters of Prince William Sound and Middleton Island down the Shelikof Strait to the vicinity of King Cove The NW-SE axis runs from central Cook Inlet through the Barren Islands, southeast of Kodiak and across the northern Gulf to Forrester Island This "Northern Cross" pattern straddles the most productive area of the northern gulf, runs both perpendicular and parallel to the Alaska Coastal Current, covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the northern gulf

Preliminary Hypotheses

Colonial seabirds that are linked to shelf break production increase in concert with available forage at the shelf break Increases in primary and secondary productivity at and beyond the shelf break are associated with lower mean winter-time atmospheric pressure Inner-shelf colonies decrease due to decreases in primary and secondary productivity associated with lower mean winter-time atmospheric pressure Fisheries removals impact seabird abundance through removals of food

Preliminary Strategies for FY 2003-2007

Comp No		Annual Cost	GEM Share
• Monitor seabirds at a variety of shelf-break, middle-shelf, and inner-shelf locations			
02	Establish field stations to collect data on murre and kittiwake biology, physiology, and diet		
	A - Chisik Island, Cook Inlet	$110 0	$73 7
	B - Gull Island, Cook Inlet	$110 0	$73 7
	C - East Amatuli Island, Cook Inlet	$75 0	$50 3
	D -Shoup Bay, Prince William Sound	$60 0	$30 0
	E - Kodiak Island	$75 0	$50 3
	F - Porpoise Rocks, Prince William Sound	$60 0	$30 0
04	Conduct boat-based surveys to collect data on murre and kittiwake biology and diet		
	A - Puale Bay, Alaska Peninsula	$18 3	$15 6
	B - Ugaiushak Island, Alaska Peninsula	$18 3	$15 6
	C - Chiswell Islands, Resurrection Bay	$18 3	$15 6
12	Collect data on murre and kittiwake biology in Chiniak Bay, Kodiak	$10 0	$5 0
09	Collect data on kittiwake biology at 27 colonies in Prince William Sound	$10 0	$5 0
20	Collect data on murre, kittiwake, puffin, gull, cormorant, and auklet biology--and diet information on all but murres-- at Middleton Island	$180 0	$45 0
21	Collect data on puffin, auklet, and murrelet biology and diet at Forrester Island	$60 0	$30 0
22	Collect data on murre, kittiwake, fulmar, puffin, and storm-petrel biology and diet at Semidi Islands	$80 0	$40 0

Preliminary Strategies for FY 2003-2007

Comp No		Annual Cost	GEM Share
• Manage data			
16	Update/maintain Alaska Seabird Colony Catalog Database and Pacific Seabird Monitoring Database	$120 0	$12 0
• Conduct research to answer questions derived from monitoring and to inform management decisions			
27	Synthesize data on seabird distribution, foraging range, and diet with fisheries allocation and bycatch records in order to assist allocation decisions and predict effects of fisheries allocations on seabird populations	$15 0	$7 5
	Other To be developed		
	Funding total [NOTE All costs are rough estimates]	*$1,019 9*	*$499 1*

Questions for Workshop Group to Consider

Questions for all themes

1 Are the preliminary hypotheses, strategies, and components correctly related to the draft GEM Program document in terms of goals (i e , detect, understand, predict, inform, solve) and products?

2 Are the preliminary hypotheses the right ones for this theme? Are the preliminary strategies likely to result in collection of the information needed to address the hypotheses?

3 Is the mix of components the right set of activities to be undertaken to implement the strategies?

4 Looking at the individual component descriptions (see "by component" tab later in this binder), are the proposed components appropriate as part of an answer to the ecological questions indicated (i e , food, habitat, removals, interactions)? Consider the types of measurements and locations and timing of samples in the answer, if applicable

5 Have the connections to other agencies and partners been adequately identified (i e , potential cost partners and other partners) ?

6 Have the connections to related but non-GEM funded activities at other agencies and partners been adequately identified?

7 All cost estimates shown are very rough and are not intended to be the focus of the group discussion However, do the cost estimates shown seem to be at least "in the ballpark" for the type of work described?

Questions for seabird theme

8 Do the sites identified correspond to the range of oceanographic conditions necessary to understand possible geographic effects on productivity? (Are the sites in the right place to address ecological questions?) Is the "Northern Cross" an appropriate pattern for selecting sampling locations?

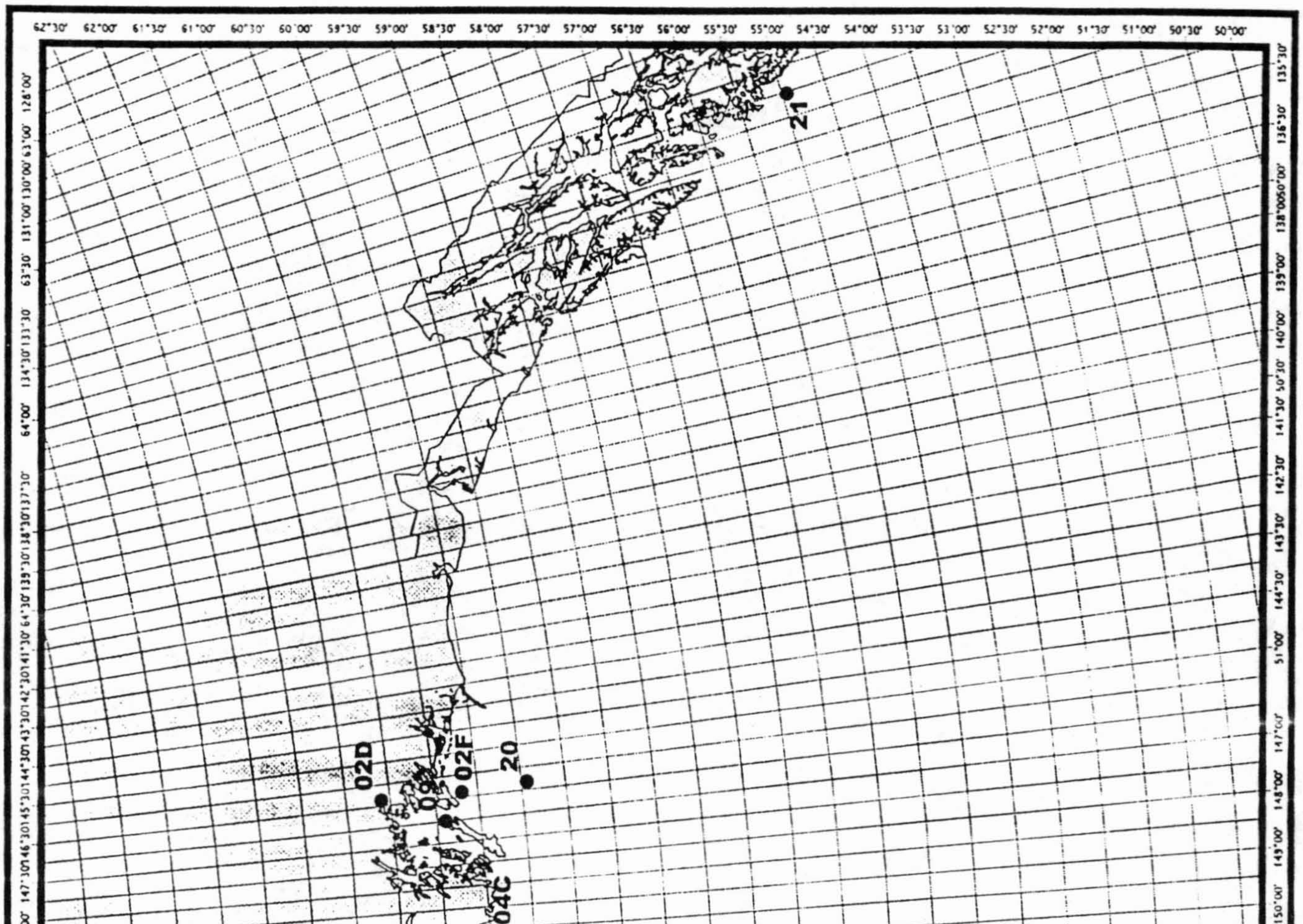
9 At which sites are the effects of other variables on productivity and abundance, such as amount of nesting habitat, amount of habitat, and population trends of predators, best understood?

10 Are there too many sites? Which could be eliminated? Are the sites located outside of the GEM geographic region essential to understanding events inside that region? The GEM Program document defines the focus of the program as "within the oil-spill area, which is generally the northern Gulf of Alaska including Prince William Sound, Cook Inlet, Kodiak Island, and the Alaska Peninsula "

11 What kinds of seabirds need to be included in the surveys in order to have the best chance of detecting change (for example planktivores, piscivores, deep divers, surface feeders)?

12 Do the Coastal Processes, Forage Fish, and Terrestrial Linkages themes include the right components to support seabird information needs?

Seabird Theme



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Forage Fish Theme Summary Page

Forage fish species are a principal pathway through which production of the northern Gulf of Alaska reaches other vertebrate species such as pollock and other groundfish, salmon, seabirds, sea lions, and harbor seals Production of these commercially and culturally important species depends heavily on forage species such as sand lance, capelin, eulachon, and juvenile salmon, herring, cod, and pollock However, very little is known about abundance, distribution and marine habitat requirements of these species

Forage fish components have been selected according to three principle criteria oceanographic features, relation to other food web species, and methods to fairly sample species composition and relative abundance Oceanographically, localities for sampling have been selected to coincide with the most highly productive region of the northern gulf, incorporating established survey localities for fish and seabirds to display food web relationships Because no single method works for all species of fish that can be classified as " forage," combinations of sampling methods -- benthic trawl, mid-water trawl, and shoreline seining -- as well as analyses of diets of predatory groundfish and seabirds have been identified

Forage fish work directly supports work on the Seabird Theme and is designed in concert with its sampling components As is the case with the Seabird Theme, the geographic organization follows the "Northern Cross" approach that organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska

The fate of the harbor seal is closely allied to that of the forage fish species, because harbor seals eat forage fish and related species Monitoring approaches to understanding why harbor seals undergo long-term fluctuations in abundance cannot be fielded without further research as reflected in the studies identified to supplement harbor seal monitoring programs conducted by other agencies The nature of the nearshore habitats utilized by harbor seals would be explored under a research component to define the geophysical and biologic extent of marine conservation areas More detailed understanding of habitat requirements of other species in the nearshore marine habitats frequented by harbor seals would be investigated by focusing on rockfish and lingcod Response of harbor seals to certain factors, such as removals (predation and harvest) and food availability (including competition from fisheries and with other species for food), is currently poorly understood Studying the role of potentially fluctuating food items, such as forage fish species, and removals, such as subsistence harvest, would supplement regular agency monitoring of harbor seals

Preliminary Hypotheses

Lower mean winter-time atmospheric pressures create conditions conducive to higher primary and secondary productivity at and beyond the shelf break and lower primary and secondary productivity inside the shelf break These changes in primary and secondary productivity control abundance of forage fish Physical conditions for predators and prey limit suitable habitat for forage fish Forage fish species and populations that are linked to shelf-break production increase during periods with lower mean winter-time atmospheric pressures, and species and populations that are not linked may increase or decrease due to food availability Harbor seals decline during periods with lower mean winter-time atmospheric pressures due to lower availability of food Positive upwelling anomalies are associated with increased inshore forage fish populations due to increased availability of food Most sources of carbon for forage fish originate in microalgae, such as diatoms and other phytoplankton

Preliminary Strategies for FY 2003-2007

Comp No		Annual Cost	GEM Share
• Sample forage fish species composition and relative abundance in the vicinity of monitored seabird colonies			
24	Conduct small-meshed bottom trawls		
	A - Chiniak Bay, Kodiak	$80 0	$53 6
	B - Kachemak Bay, Cook Inlet	$80 0	$53 6
	C - Chignik Bay, Kodiak	$80 0	$53 6
	D - Pavlof Bay, Alaska Peninsula	$80 0	$53 6
28	Conduct mid-water trawls		
	A - Chisik Island, Cook Inlet	$80 0	$53 6
	B - Chiniak Gully, Kodiak	$80 0	$53 6
	C - Barren Islands	$80 0	$53 6
33	Conduct beach seine collections		
	A - Barren Islands	$80 0	$53 6
	B - Gull Island, Cook Inlet	$80 0	$53 6
	C - Chisik Island, Cook Inlet	$20 0	$15 0

Preliminary Strategies for FY 2003-2007

Comp No		Annual Cost	GEM Share
	D - Resurrection Bay	$80 0	$53 6
	E - Puale Bay, Alaska Peninsula	$20 0	$15 0
	F - Ugaiushak Island, Alaska Peninsula	$80 0	$53 6
03	Analyze diets of predatory seabirds (tufted puffins)	$120 0	$60 0
39	Analyze diets of predatory fish through community monitoring	$115 0	$86 3
• Evaluate role of forage fish in harbor seal abundance			
23	Measure harbor seal abundance	$200 0	$20 0
• Conduct research to answer questions derived from monitoring and to inform management decisions			
14	Define the geophysical and biologic extent of nearshore marine conservation areas ("marine reserves")	$100 0	$33 0
15	Improve understanding of habitat requirements of nearshore ecosystem species by studying two long-lived species, rockfish and lingcod	$100 0	$50 0
40	Develop deterministic model of juvenile pink salmon survival	$300 0	$201 0
41	Develop deterministic model of juvenile Pacific herring survival	$300 0	$201 0
	Other To be developed		
	Funding total [NOTE All costs are rough estimates]	*$2,155 0*	*$1,270 9*

Questions for Workshop Group to Consider

Questions for all themes

1 Are the preliminary hypotheses, strategies, and components correctly related to the draft GEM Program document in terms of goals (i e , detect, understand, predict, inform, solve) and products?

2 Are the preliminary hypotheses the right ones for this theme? Are the preliminary strategies likely to result in collection of the information needed to address the hypotheses?

3 Is the mix of components the right set of activities to be undertaken to implement the strategies?

4 Looking at the individual component descriptions (see "by component" tab later in this binder), are the proposed components appropriate as part of an answer to the ecological questions indicated (i e , food, habitat, removals, interactions)? Consider the types of measurements and locations and timing of samples in the answer, if applicable

5 Have the connections to other agencies and partners been adequately identified (i e , potential cost partners and other partners) ?

6 Have the connections to related but non-GEM funded activities at other agencies and partners been adequately identified?

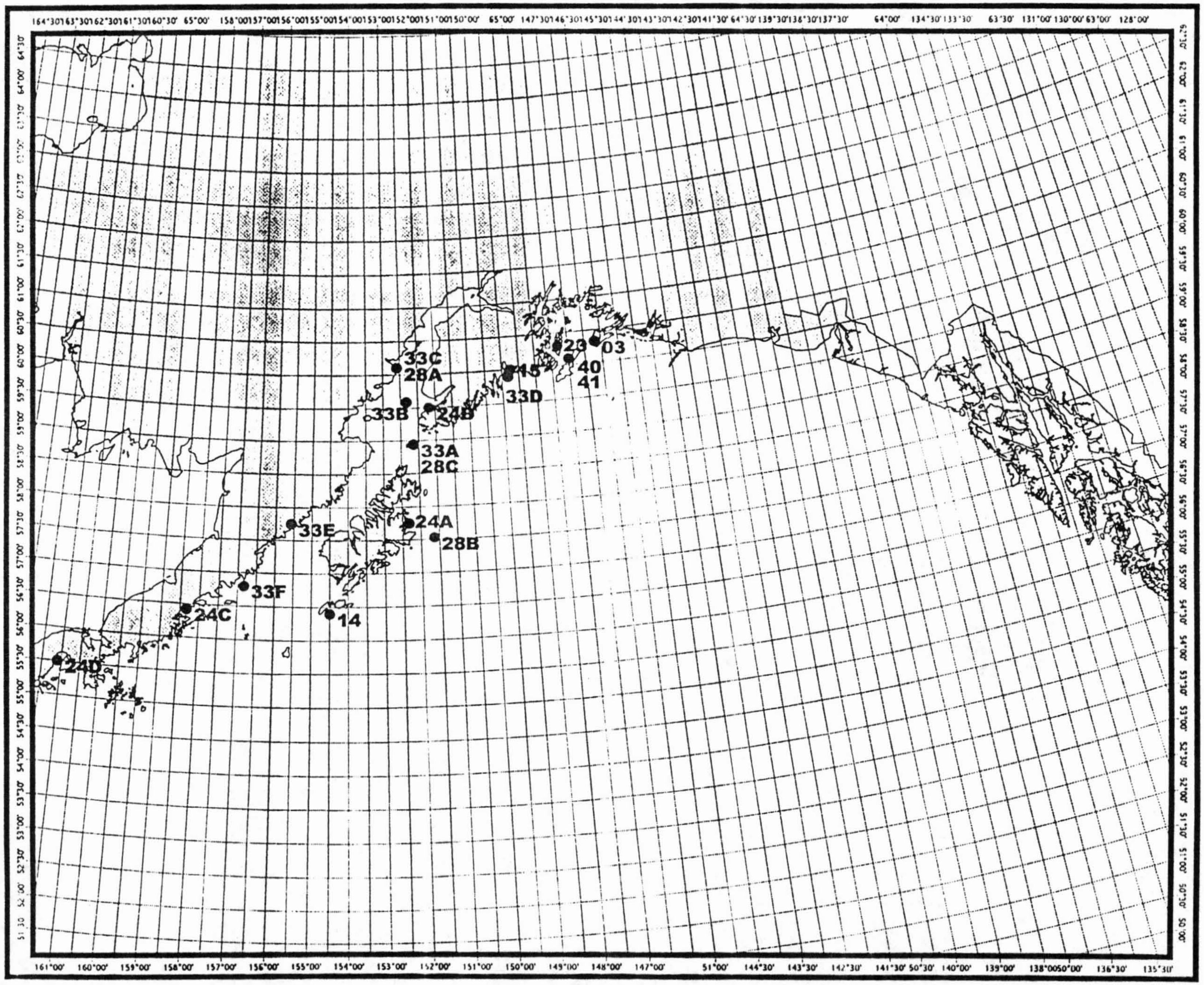
7 All cost estimates shown are very rough and are not intended to be the focus of the group discussion However, do the cost estimates shown seem to be at least "in the ballpark" for the type of work described?

<u>Questions for forage fish theme</u>

8 Are combinations of epi-benthic, mid-water and nearshore seining an appropriate strategy for all locations? Is the "Northern Cross" an appropriate pattern for selecting sampling locations?

9 Are the sampling sites, seasons and methods identified likely to cover all important forage fish species?

Forage Fish Theme



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Nearshore Plants & Animals Theme Summary Page

The nearshore marine environment, as a source of fascination and sustenance for humans, is perhaps the most vulnerable among the marine areas due to change caused by human activities Information gaps on the plants and animals of the nearshore marine environment are widening because uses of the nearshore environment are expanding rapidly in southcentral Alaska, as people gain wider access

A highly visible icon of the nearshore marine environment, the sea otter, is an important part of the food web of the nearshore environment, so the components taking measurements of sea otters are necessarily coordinated with and integrated into terrestrial, intertidal, and subtidal sampling programs Surveys measuring trends in sea otter populations are placed in the context of natural and human caused variation by studies of shoreline areas, intertidal and subtidal biota, and local geophysical conditions Variation among nearshore benthic communities depends on biological and geophysical processes and human activities Biological factors such as recruitment of young plants and animals to nearshore habitats and phytoplankton productivity and nutrient concentration vary significantly in accord with geophysical processes including currents and upwelling Use of shoreline campgrounds and moorings nearby can significantly alter both nearshore habitats and their biota

For closely coordinating nearshore sampling sites with geophysical processes, periodic intensive samples of larvae, recruits, and post-settlement individuals in both subtidal and intertidal communities would be combined with monitoring of nearshore waters using a mooring array, benthically mounted Acoustic Doppler Current Profilers (ADCPs), coastal radar units, and other remote sensing

Preliminary Hypotheses

Nearshore/intertidal algal and invertebrate communities fluctuate in response to climate (through effects of temperature and precipitation on availability of food and habitat), fluctuations in primary productivity, and top-down structuring by predation and human impacts Major sources of carbon for nearshore plants and animals include macroalgae, such as kelp and popweed, and terrestrial carbon, in addition to the phytoplankton that provide carbon to forage fish and seabird food webs

Preliminary Strategies for FY 2003-2007

Comp No		Annual Cost	GEM Share
• Monitor subtidal and intertidal communities in concert with terrestrial linkages and marine investigations			
01	Conduct intensive sampling of subtidal and intertidal communities, combined with monitoring of nearshore waters using remote sensing		
	A - Cook Inlet	$60 0	$39 0
	B - Prince William Sound	$60 0	$39 0
	C - Kodiak & Alaska Peninsula	$60 0	$39 0
	D - Kenai Fjords	$60 0	$39 0
36	Develop community-based monitoring program	$200 0	$100 0
• Monitor sea otters, a primary predator in the nearshore			
05	Monitor trends in sea otter populations	$120 0	$60 0
• Conduct research to answer questions derived from monitoring and to inform management decisions			
	To be developed		
	Funding total [NOTE All costs are rough estimates]	*$560 0*	*$316 0*

Questions for Workshop Group to Consider

Questions for all themes

1 Are the preliminary hypotheses, strategies, and components correctly related to the draft GEM Program document in terms of goals (i e , detect, understand, predict, inform, solve) and products?

2 Are the preliminary hypotheses the right ones for this theme? Are the preliminary strategies likely to result in collection of the information needed to address the hypotheses?

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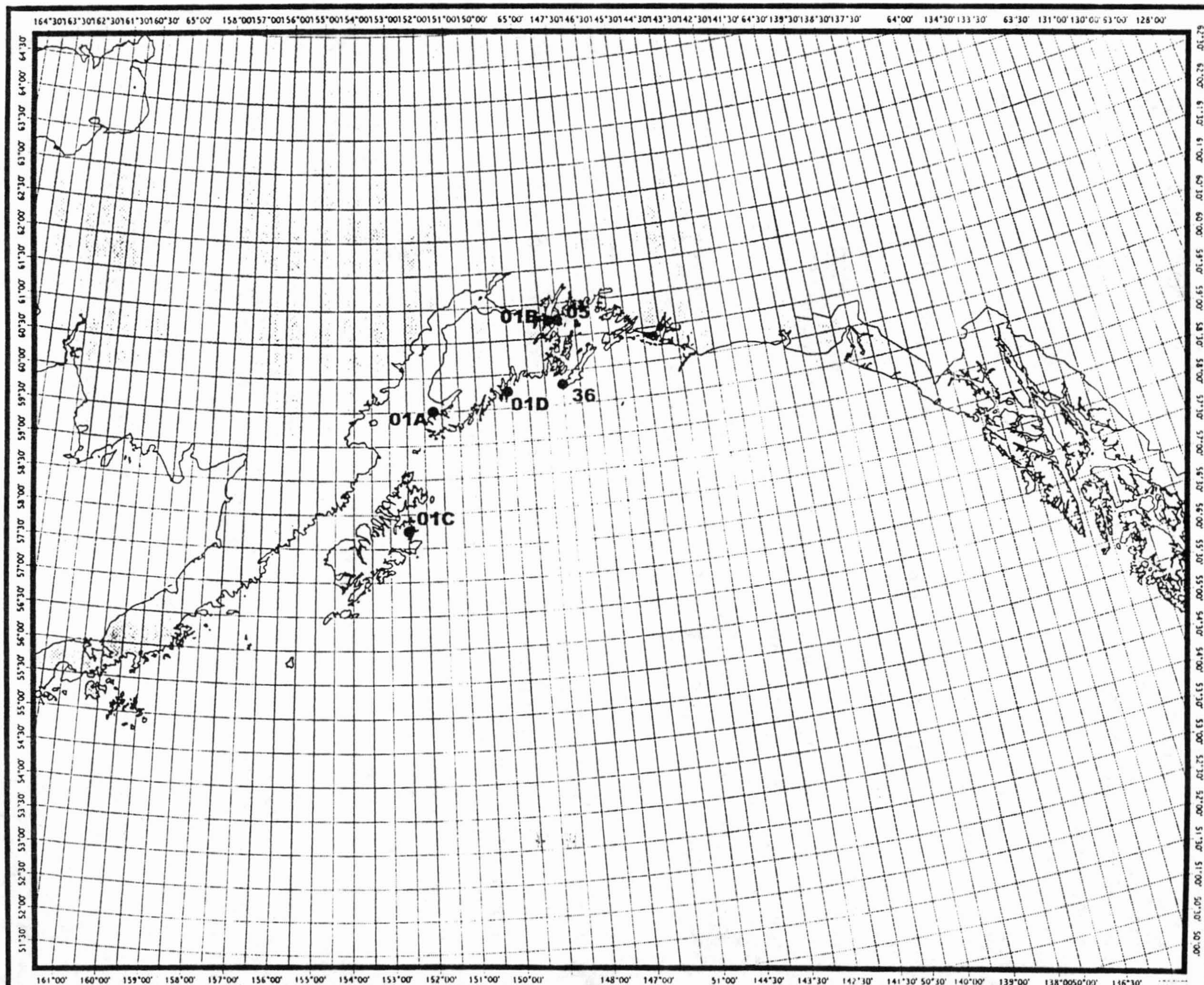
Questions for nearshore plants & animals theme

8 Are there components of the nearshore ecosystem, such as the benthos, that are inherently better suited to long-term monitoring than others?

9 Are there components of the nearshore ecosystem, such as the sea otter, that are absolutely essential to understanding origins of change in nearshore environments?

10 Is the PISCO approach (see Component #01) the most appropriate here? What does or doesn't it cover?

Nearshore Plants & Animals Theme



Terrestrial Linkages Theme Summary Page

The Terrestrial Linkages Theme brings together studies on land and in the nearshore marine environment to help understand the effects of natural forces and human activities on productivities of plants and animals in these environments Human impacts on the marine environment begin with activities on land and continue into the intertidal and subtidal areas Marine contributions to the productivity of the terrestrial environment begin in shoreline areas and are propagated throughout the watersheds Consequently, changes on the land in watersheds cannot be fully understood without appreciating the effects of the marine environment, and conversely

There is a gap in understanding overall land-sea interactions because management agencies and scientific disciplines are divided to a large degree into terrestrial and aquatic parts and also into freshwater and marine areas The role of marine nutrients in watersheds is key to understanding the relative importance of climate and human-induced changes in population levels of birds, fish and mammals By the same token, activities on land can determine the quality and quantity of nearby marine habitats and the species that occupy them

For example, human activities associated with shoreline campsites are expected to change both terrestrial and marine flora and fauna Eelgrass beds, being particularly vulnerable to the effects of human traffic, may be found to serve as sentinels of human impacts Other associated disturbances such as noise pollution, impacts on water quality, and introduction of contaminants are expected The design of monitoring programs and the interpretation of data for nearshore animals such as sea otters, harbor seals, rockfish and lingcod need to be advised by information on human uses as well as the influences of geophysical factors and biological changes Species that establish terrestrial-marine linkages, such as the harlequin duck, are both pathways to the watersheds for marine nutrients and dependent upon marine nutrients Species that transport marine nutrients play important roles in supporting a wide diversity of other fauna and flora, as determined from levels of marine nitrogen in juvenile fish, invertebrates, and aquatic and riparian plants

Coordination and integration of the harbor seal (see Forage Fish Theme) and sea otter (see Nearshore Plants and Animals Theme) components with those of the Terrestrial Linkages Theme are essential

Preliminary Hypotheses

Terrestrial and freshwater habitats change partly as a result of human impacts These habitats also change partly as a result of fluctuation of runs of anadromous fishes due to inputs of nitrogen Fluctuation of terrestrial precipitation and runoff is a major factor determining the composition of intertidal/nearshore communities and the strength of the Alaska Coastal Current

Preliminary Strategies for FY 2003-2007

Comp No		Annual Cost	GEM Share
• Evaluate the impact of land activities on the quality and quantity of nearby marine habitats and the species that occupy them			
30	Measure human impacts on vegetation and soil changes at recreation sites stratified by distance from Whittier	$120 0	$24 0
38	Monitor trends in harlequin duck abundance	$120 0	$24 0
• Evaluate the impact of anadromous fish runs on marine habitats and the species that occupy them			
18	Measure the input of marine nitrogen in freshwater and riparian-zone plants and animals	$50 0	$37 5
• Conduct research to answer questions derived from monitoring and to inform management decisions			
31	Develop a monitoring program for assessing human impacts to eelgrass beds	$80 0	$16 0
	Other To be developed		
	Funding total [NOTE All costs are rough estimates]	$370 0	$101 5

Questions for Workshop Group to Consider

Questions for all themes

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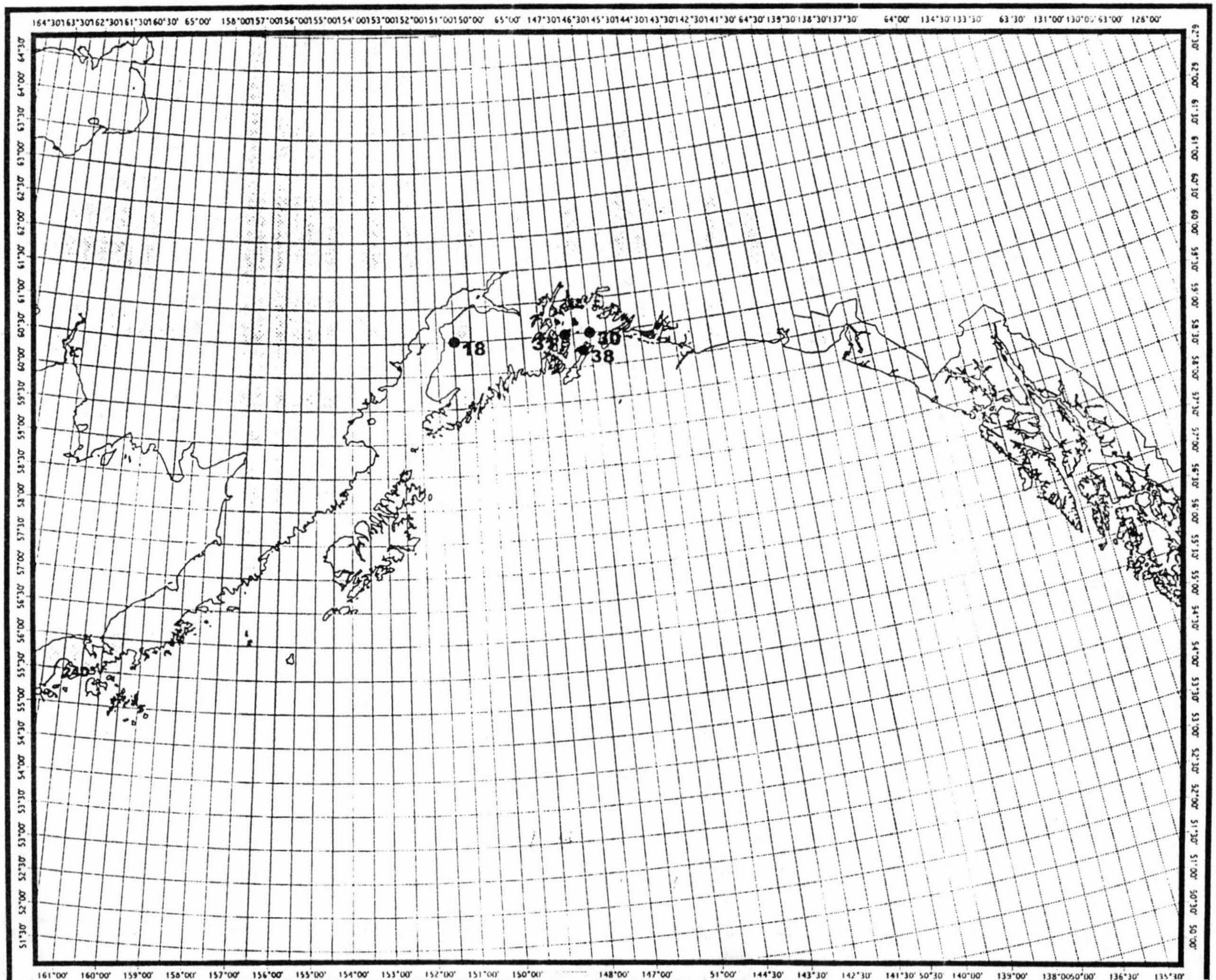
Questions for terrestrial linkages theme

8 How would you integrate GEM components with existing water quality and pollution contaminants monitoring programs?

9 Are the land-based activities that are the key stressors on the marine environment adequately addressed in the themes, hypotheses, and components?

Terrestrial Linkages Theme



Coastal Processes Theme Summary Page

Components in the Coastal Processes Theme would provide essential information for understanding the other themes and the basic oceanography of the region Coastal processes for the most part determine the productivities of marine plants and animals, and they play a very large role in setting the productivities on land Precipitation, wind, temperature, and circulation of air and water masses all combine to control and direct the flow of millions of tons of carbon and major nutrients, along with minute quantities of materials such as reduced iron and contaminants that are key to understanding biological change in the northern Gulf of Alaska

Given the challenges of studying physical processes that evolve on a global scale, information gaps exist in understanding the origin and path of the Alaska Coastal Current, pathways for carbon and other materials between the nearshore areas and the edge of the continental shelf, and the seasonal distribution and abundances of important plant and animal species Most of the coastal processes components would provide physical data that are essential to monitor variations in how the Alaska Gyre, which circulates in a counter-clockwise direction in the northeastern Gulf of Alaska, combines with freshwater runoff of the Alaska Coastal Current and marine geology of the Kodiak Archipelago to determine primary production in the northern Gulf of Alaska

Strategies for obtaining physical data incorporate sensors attached to moorings, sampling along transects from chartered vessels, sampling from ships of opportunity, and sampling by community-based programs Coupled to the physics is the productivity of diatoms and other phytoplankton, copepods, euphausiids and other zooplankton (primary and secondary production) as determined by sampling from most of the same platforms as the physical data Components in the Forage Fish Theme would also sample most of the same physical and biological variables as the coastal processes components, extending the range of localities and times covered

Preliminary Hypotheses

Long-term fluctuations in physical oceanography as represented by sea surface pressure, acting through changes in wind and freshwater input, result in uncoupling of inshore and shelf-break primary production Low atmospheric pressure during the winter results in increased offshore/shelf-break production and decreased inshore production The Alaska Coastal Current controls productivities of plants and animals in the nearshore environment through effects on food and habitats Effects of removals of plants and animals by all factors are modified by coastal processes

Preliminary Strategies for FY 2003-2007

Comp No		Annual Cost	GEM Share
• Collect physical data			
29	Attach surface sensors to mooring at Hinchinbrook Entrance	$35 0	$35 0
08	Attach subsurface sensors to mooring near Yakataga	$35 0	$35 0
11	Collect samples along transects from chartered vessels		
	A - Montague Canyon Stations	$150 0	$150 0
	B - Afognak Stations	$150 0	$150 0
	C - Seward Stations	$333 0	$166 5
	D - Hinchinbrook Stations	$333 0	$166 5
	E - Prince William Sound Stations	$333 0	$166 5
35	Collect samples along transects from vessels of opportunity		
	A - Develop a program to support existing vessel-of-opportunity programs	$250 0	$250 0
	B - Alaska Marine Highway	$100 0	$50 0
25	Use satellite data to monitor sea surface temperatures and other Gulf of Alaska parameters	$35 0	$35 0
10	Establish weather stations for physical oceanographic data		
	A - Seal River	$75 0	$18 8
	B - Prince William Sound	$75 0	$18 8
• Monitor for contaminants			
42	Monitor to address questions related to the origin and fate of environmental contaminants	$2 150 0	$107 5
• Conduct research to answer questions derived from monitoring and to inform management decisions			
32	Develop circulation and hydrological models for the northern Gulf of Alaska	$165 0	$82 5

Preliminary Strategies for FY 2003-2007			
Comp No		Annual Cost	GEM Share
	Other To be developed		
	Funding total [NOTE All costs are rough estimates]	$4,219 0	$1,432 0

Questions for Workshop Group to Consider

Questions for all themes

1 Are the preliminary hypotheses, strategies, and components correctly related to the draft GEM Program document in terms of goals (i e , detect, understand, predict, inform, solve) and products?

2 Are the preliminary hypotheses the right ones for this theme? Are the preliminary strategies likely to result in collection of the information needed to address the hypotheses?

3 Is the mix of components the right set of activities to be undertaken to implement the strategies?

4 Looking at the individual component descriptions (see "by component" tab later in this binder), are the proposed components appropriate as part of an answer to the ecological questions indicated (i e , food, habitat, removals, interactions)? Consider the types of measurements and locations and timing of samples in the answer, if applicable

5 Have the connections to other agencies and partners been adequately identified (i e , potential cost partners and other partners) ?

6 Have the connections to related but non-GEM funded activities at other agencies and partners been adequately identified?

7 All cost estimates shown are very rough and are not intended to be the focus of the group discussion However, do the cost estimates shown seem to be at least "in the ballpark" for the type of work described?

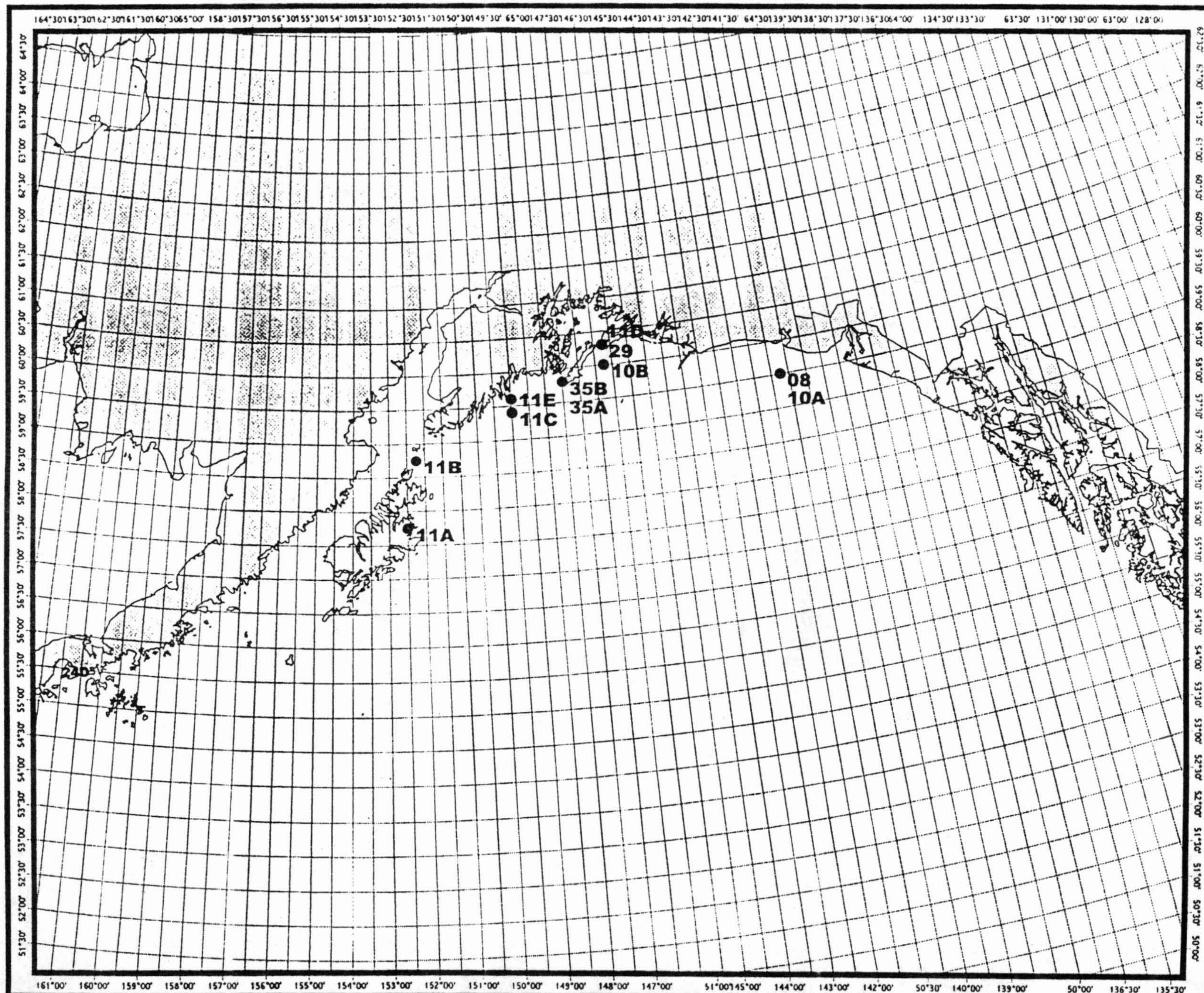
Questions for coastal processes theme

8 Do the moorings, including weather stations, for surface and subsurface instruments meet critical information gaps?

9 Are there opportunities for applications of expendable conductivity, depth and salinity devices (XCDT)?

10 Do the components proposed in this theme provide the necessary information for the other themes, especially the Seabird, Forage Fish, and Nearshore Plants and Animals themes?

Coastal Processes Theme



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Synthesis Theme Summary Page

The Synthesis Theme is designed to explore whether the needs for the information necessary to move ecosystem-based management forward are being met, and to fill gaps in regional analysis of information Policy makers, regulators, scientists and members of the public have frequently expressed the need to periodically bring together biological and geophysical data of the region in a way that allows them to draw conclusions about the status of the ecosystems Making connections between the work of climatologists, physical oceanographers and the many biological specialties is expected to help regulators and scientists understand the full range of opportunities and risks in natural resource management

The Synthesis Theme would fill these needs through public meetings and synthesis papers by individual scientists and teams of scientists The meetings, papers and supporting communications media, such as a web site (see Support Services Theme), would help those interested to draw conclusions about resource management actions and to chart future directions for GEM The Synthesis Theme promotes meetings and research projects that combine the information collected by all the themes and other sources to address and communicate current understandings of key ecological questions relating to production of food, extent of habitats, and the impacts of removals A biennial meeting would focus on communicating progress toward answering the questions to the public through visually oriented communication Synthesis in individual areas would identify limitations of monitoring data for answering the questions, and would recommend how the monitoring needs to be changed or augmented to gain the ability to answer questions

All synthesis components would promote interdisciplinary cooperation, coordination of research and monitoring, and integration of ideas and efforts toward answering questions relevant to understanding and managing natural resources

Preliminary Objectives

Synthesize knowledge about changes in the northern Pacific and northern Gulf of Alaska ecosystems with regard to the possible causes of those changes, whether human or natural Make suggestions on how monitoring and research programs can change in response to new knowledge about ecosystem function Inform the public, managers, and policy makers about the status of valued natural resources and their future prospects Provide tools to managers of valued natural resources

Preliminary Strategies for FY 2003-2007

Comp No		Annual Operating Cost	GEM Share
• Synthesize knowledge and present results			
06	Hold a biennial "State of the Gulf Symposium" to engage the public and policy makers in a dialogue with scientists	$50 0	$50 0
13	Publish annually a "State of the Gulf Index", including indicators of the aggregate state of the gulf ecosystem	$85 0	$42 5
17	Prepare biennially papers for presentation to the public and publication in peer reviewed journals		
	A - Forage fish	$50 0	$50 0
	B - Seabirds	$50 0	$50 0
	C - Nearshore plants and animals	$50 0	$50 0
	D - Terrestrial linkages	$50 0	$50 0
	E - Coastal processes	$50 0	$50 0
• Other To be developed			
	Funding total [NOTE All costs are rough estimates]	*$385 0*	*$342 5*

Questions for Workshop Group to Consider

Questions for all themes

1 Are the preliminary hypotheses, strategies, and components correctly related to the draft GEM Program document in terms of goals (i e , detect, understand, predict, inform, solve) and products?

2 Are the preliminary hypotheses the right ones for this theme? Are the preliminary strategies likely to result in collection of the information needed to address the hypotheses?

3 Is the mix of components the right set of activities to be undertaken to implement the strategies?

4 Looking at the individual component descriptions (see "by component" tab later in this binder), are the proposed components appropriate as part of an answer to the ecological questions indicated (i e , food, habitat, removals, interactions)? Consider the types of measurements and locations and timing of samples in the answer, if applicable

5 Have the connections to other agencies and partners been adequately identified (i e , potential cost partners and other partners) ?

6 Have the connections to related but non-GEM funded activities at other agencies and partners been adequately identified?

7 All cost estimates shown are very rough and are not intended to be the focus of the group discussion However, do the cost estimates shown seem to be at least "in the ballpark" for the type of work described?

<u>Questions for synthesis theme</u>

8 Are there specific areas of emphasis within themes that are particularly important to emphasize periodically (for example geochemistry, including origin and fate of contaminants within coastal processes)?

9 What are the essential elements of the State of the Gulf Index?

10 Should the elements of the State of the Gulf Index remain static or should they be periodically edited?

11 Should there be individual indices for themes, e g "State of Nearshore Plants and Animals?"

12 Is the use of synthesis papers a good method to achieve high-quality synthesized products? Any other suggestions?

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(there is no map for the Synthesis Theme because no components in this theme have field activities)

Support Services Theme Summary Page

Components in this theme would provide support services to GEM Details of these components have not yet been worked out, and the cost estimates are very preliminary

Preliminary Strategies for FY 2003-2007

Comp No		Annual Cost	GEM Share
07	Data management	$300 0	$300 0
19	Web-based and other communications	$75 0	$75 0
26	Scientific advice, peer review, and collaboration	$100 0	$100 0
34	Public advice and outreach	$30 0	$30 0
37	Administrative operations	$1,000 0	$1,000 0
	Funding total [NOTE All costs are rough estimates]	*$1,505 0*	*$1,505 0*

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Component Number	Title	Research or Monitoring	Start up Cost	Annual Op Cost	GEM Share Start up Cost	GEM Share Annual Cost
			ROUGH COST ESTIMATES			
Theme	Seabırds		$1 069 9	$1 019 9	$528 3	$499 1
02A	Monıtor Murres & Kıttıwakes (Fıeld Statıons) Chısık Island	Monıtorıng	$110 0	$110 0	$73 7	$73 7
02B	Monıtor Murres & Kıttıwakes (Fıeld Statıons) Gull Island	Monıtorıng	$110 0	$110 0	$73 7	$73 7
02C	Monıtor Murres & Kıttıwakes (Fıeld Statıons) East Amatulı Island	Monıtorıng	$75 0	$75 0	$50 3	$50 3
02D	Monıtor Murres & Kıttıwakes (Fıeld Statıons) Shoup Bay	Monıtorıng	$60 0	$60 0	$30 0	$30 0
02E	Monıtor Murres & Kıttıwakes (Fıeld Statıons) Kodıak Island	Monıtorıng	$100 0	$75 0	$67 0	$50 3
02F	Monıtor Murres & Kıttıwakes (Fıeld Statıons) Porpoıse Rocks	Monıtorıng	$70 0	$60 0	$35 0	$30 0
04A	Monıtor Murres & Kıttıwakes (Boat Survey) Puale Bay	Monıtorıng	$18 3	$18 3	$15 6	$15 6
04B	Monıtor Murres & Kıttıwakes (Boat Survey) Ugaıushak Island	Monıtorıng	$18 3	$18 3	$15 6	$15 6
04C	Monıtor Murres & Kıttıwakes (Boat Survey) Chıswell Islands	Monıtorıng	$18 3	$18 3	$15 6	$15 6
09	Monıtor Kıttıwakes Prınce Wıllıam Sound	Monıtorıng	$10 0	$10 0	$5 0	$5 0
12	Monıtor Murres & Kıttıwakes Chınıak Bay	Monıtorıng	$10 0	$10 0	$5 0	$5 0
16	Database Management for Gulf of Alaska Seabırds	Monıtorıng	$120 0	$120 0	$12 0	$12 0
20	Seabırd Monıtorıng (Multıple Specıes) Mıddleton Island	Monıtorıng	$180 0	$180 0	$45 0	$45 0
21	Seabırd Monıtorıng (Multıple Specıes) Forrester Island	Monıtorıng	$60 0	$60 0	$30 0	$30 0
22	Seabırd Monıtorıng (Multıple Specıes) Semıdı Islands	Monıtorıng	$80 0	$80 0	$40 0	$40 0
27	Analysıs of Seabırd Interactıons wıth Fısherıes ın the Gulf of Alaska	Research	$30 0	$15 0	$15 0	$7 5
Theme	Forage Fısh		$2 535 0	$2 155 0	$1 530 3	$1 270 9
03	Forage Fısh Dynamıcs as Indıcated by Puffin Dıet Samplıng	Monıtorıng	$120 0	$120 0	$60 0	$60 0
14	Marıne Reserve Network Identıficatıon	Research	$100 0	$100 0	$33 0	$33 0

GEM Monitoring & Research Plan   Proposed Components by Theme

Component Number	Title	Research or Monitoring	ROUGH COST ESTIMATES Start up Cost	Annual Op Cost	GEM Share Start up Cost	GEM Share Annual Cost
15	Nearshore Rockfish & Lingcod as Sentinel Species for Marine Reserves	Research	$100 0	$100 0	$50 0	$50 0
23	Harbor Seal Abundance	Monitoring	$200 0	$200 0	$20 0	$20 0
24A	Monitor Forage Fish & Epi-Benthic Ecosystem Chiniak	Monitoring	$120 0	$80 0	$80 4	$53 6
24B	Monitor Forage Fish & Epi-benthic Ecosystem Kachemak Bay	Monitoring	$120 0	$80 0	$80 4	$53 6
24C	Monitor Forage Fish & Epi-benthic Ecosystem Chignik Bay	Monitoring	$120 0	$80 0	$80 4	$53 6
24D	Monitor Forage Fish & Epi-benthic Ecosystem Pavlof Bay	Monitoring	$120 0	$80 0	$80 4	$53 6
28A	Mid-water Trawl Forage Fish Surveys Chisik Island	Monitoring	$100 0	$80 0	$67 0	$53 6
28B	Mid-water Trawl Forage Fish Surveys Chiniak Gully	Monitoring	$100 0	$80 0	$67 0	$53 6
28C	Mid-water trawl Forage Fish Surveys Barren Islands	Monitoring	$100 0	$80 0	$67 0	$53 6
33A	Nearshore Forage Fish Surveys Barren Islands	Monitoring	$100 0	$80 0	$67 0	$53 6
33B	Nearshore Forage Fish Surveys Gull Island	Monitoring	$100 0	$80 0	$67 0	$53 6
33C	Nearshore Forage Fish Surveys Chisik Island	Monitoring	$50 0	$20 0	$37 5	$15 0
33D	Nearshore Forage Fish Surveys Resurrection Bay	Monitoring	$120 0	$80 0	$80 4	$53 6
33E	Nearshore Forage Fish Surveys Puale Bay	Monitoring	$50 0	$20 0	$37 5	$15 0
33F	Nearshore Forage Fish Surveys Ugaiushak Island	Monitoring	$100 0	$80 0	$67 0	$53 6
39	Community-Based Monitoring Forage Fish Surveys Using Stomach Contents	Research	$115 0	$115 0	$86 3	$86 3
40	Models to Understand Early Marine Survival Pink Salmon	Research	$300 0	$300 0	$201 0	$201 0
41	Models to Understand Early Marine Survival Pacific Herring	Research	$300 0	$300 0	$201 0	$201 0
Theme	Nearshore Plants & Animals		$1 000 0	$560 0	$572 0	$316 0
01A	Nearshore Benthic Biodiversity Stations Cook Inlet	Monitoring	$120 0	$60 0	$78 0	$39 0

GEM Monitoring & Research Plan Proposed Components by Theme

Component Number	Title	Research or Monitoring	ROUGH COST ESTIMATES Start up Cost	Annual Op Cost	GEM Share, Start up Cost	GEM Share Annual Cost
01B	Nearshore Benthic Biodiversity Stations Prince William Sound	Monitoring	$120 0	$60 0	$78 0	$39 0
01C	Nearshore Benthic Biodiversity Stations Kodiak and Alaska Peninsula	Monitoring	$120 0	$60 0	$78 0	$39 0
01D	Nearshore Benthic Biodiversity Stations Kenai Fjords	Monitoring	$120 0	$60 0	$78 0	$39 0
05	Monitor Sea Otter Abundance, Productivity Survival & Behavior	Monitoring	$120 0	$120 0	$60 0	$60 0
36	Community-Based Coastal Monitoring	Monitoring	$400 0	$200 0	$200 0	$100 0
Theme	Terrestrial Linkages		$370 0	$370 0	$101 5	$101 5
18	Marine Contributions to Terrestrial Productivity	Monitoring	$50 0	$50 0	$37 5	$37 5
30	Monitoring Vegetation Responses to Recreational and Natural Disturbances	Monitoring	$120 0	$120 0	$24 0	$24 0
31	Anthropogenic Disturbance of Eelgrass (*zostera Spp*) Meadows	Research	$80 0	$80 0	$16 0	$16 0
38	Harlequin Duck Abundance Distribution & Age Structure	Monitoring	$120 0	$120 0	$24 0	$24 0
Theme	Coastal Processes		$4 709 0	$4 219 0	$1 759 5	$1 432 0
08	Alaska Coastal Current Deep Station Yakataga	Monitoring	$115 0	$35 0	$115 0	$35 0
10A	Marine Weather Station Seal River	Monitoring	$150 0	$75 0	$37 5	$18 8
10B	Marine Weather Station Prince William Sound	Monitoring	$150 0	$75 0	$37 5	$18 8
11A	Alaska Coastal Current Montague Canyon Stations	Monitoring	$150 0	$150 0	$150 0	$150 0
11B	Alaska Coastal Current Afognak Stations	Monitoring	$150 0	$150 0	$150 0	$150 0
11C	Alaska Coastal Current Seward Stations	Monitoring	$333 0	$333 0	$166 5	$166 5
11D	Alaska Coastal Current Hinchinbrook Stations	Monitoring	$333 0	$333 0	$166 5	$166 5
11E	Alaska Coastal Current Prince William Sound Stations	Monitoring	$333 0	$333 0	$166 5	$166 5
25	Satellite Monitoring Gulf of Alaska Surface Conditions	Monitoring	$115 0	$35 0	$115 0	$35 0

GEM Monitoring & Research Plan   Proposed Components by Theme

Component Number	Title	Research or Monitoring	Start up Cost	Annual Op Cost	GEM Share Start up Cost	GEM Share Annual Cost
			ROUGH COST ESTIMATES,			
29	Surface Mooring Hinchinbrook Entrance	Monitoring	$115 0	$35 0	$115 0	$35 0
32	Gulf of Alaska Coupled Circulation Hydrological Model	Research	$165 0	$165 0	$82 5	$82 5
35A	Ships of Opportunity Basic Program	Monitoring	$250 0	$250 0	$250 0	$250 0
35B	Ships Of Opportunity Oceanography of the Alaska Marine Highway	Monitoring	$200 0	$100 0	$100 0	$50 0
42	Monitoring Environmental Contaminants	Monitoring	$2 150 0	$2 150 0	$107 5	$107 5
Theme	Synthesis		$385 0	$385 0	$342 5	$342 5
06	Biennial State of the Gulf Symposium	Research	$50 0	$50 0	$50 0	$50 0
13	State of the Gulf Index	Research	$85 0	$85 0	$42 5	$42 5
17A	Forage Fish Synthesis	Research	$50 0	$50 0	$50 0	$50 0
17B	Seabird Synthesis	Research	$50 0	$50 0	$50 0	$50 0
17C	Nearshore Plants & Animals Synthesis	Research	$50 0	$50 0	$50 0	$50 0
17D	Terrestrial Linkages Synthesis	Research	$50 0	$50 0	$50 0	$50 0
17E	Coastal Processes Synthesis	Research	$50 0	$50 0	$50 0	$50 0
Theme	Support Services		$1 505 0	$1 505 0	$1 505 0	$1 505 0
07	Data Management		$300 0	$300 0	$300 0	$300 0
19	Web-based & Other Communications		$75 0	$75 0	$75 0	$75 0
26	Scientific Advice, Peer Review & Collaboration		$100 0	$100 0	$100 0	$100 0
34	Public Advice & Outreach		$30 0	$30 0	$30 0	$30 0
37	Administrative Operations		$1 000 0	$1 000 0	$1 000 0	$1 000 0
		Total	$11 573 9	$10 213 9	$6 339 1	$5 466 9

Scientific Discipline Work Sessions Summary Page

The primary organizational approach used in the Draft GEM Monitoring and Research Plan is by theme However, also reviewing the proposed components from the perspective of scientific discipline should help us determine if the draft plan is solid and cohesive The spreadsheet which follows lists the proposed components by the scientific disciplines listed below However, many of the components cross disciplines Each work group should evaluate the entire plan (i e , all of the components) from the perspective of its particular discipline The components listed under each discipline in the spreadsheet are meant as a starting point for discussion, and are not meant to limit discussion to those components only

- Marine Mammals
- Marine & Fish Ecology
- Seabird Ecology
- Nearshore, Benthic & Coastal Ecology
- Biological Oceanography
- Physical, Geochemical & Chemical Oceanography & Effects of Climate
- Interdisciplinary

The questions below are intended to help guide the analysis of components from the disciplinary perspective Work groups may address any questions that are acceptable to the group members, these questions are suggestions only

1 The proposed components assume that sections C and D of the Scientific Background document (see earlier tab in this binder) accurately capture the state of knowledge in your field Does the Scientific Background document adequately address the state of knowledge in your field?

2 Do the components in your discipline, taken as a whole, address the processes and mechanisms that are essential to understanding change in valued biological resources of the northern Gulf of Alaska?

3 Looking at the individual component descriptions (see "by component" tab later in this binder), are the technologies proposed for implementation in the components in your discipline state-of-the-art?

4 Are the experimental approaches and sampling methods recommended generally accepted in your discipline?

5 Are there other cooperating agencies that need to be identified as potential funding partners or that would be sources of information or technologies?

6 Are there other ways your discipline could contribute to the hypotheses and strategies in all the themes?

7 Behind the orange tab in this binder ("Active Projects") is a list of non-GEM-funded monitoring projects that are active in the northern Gulf of Alaska This list, organized by scientific discipline, was used in the informal "gap analysis" that informed the selection of the components in the Draft GEM Monitoring and Research Plan Are any relevant projects missing from this list?

GEM Monitoring & Research Plan   Proposed Components by Discipline

Component Number	Title	Research or Monitoring	Start up Cost	Annual Op Cost	GEM Share Start up Cost	GEM Share Annual Cost
			ROUGH COST ESTIMATES			
Discipline	Marine Mammals		$320 0	$320 0	$80 0	$80 0
05	Monitor Sea Otter Abundance, Productivity, Survival & Behavior	Monitoring	$120 0	$120 0	$60 0	$60 0
23	Harbor Seal Abundance	Monitoring	$200 0	$200 0	$20 0	$20 0
Discipline	Marine & Fish Ecology		$2 335 0	$1 955 0	$1 510 3	$1 250 9
03	Forage Fish Dynamics as Indicated by Puffin Diet Sampling	Monitoring	$120 0	$120 0	$60 0	$60 0
14	Marine Reserve Network Identification	Research	$100 0	$100 0	$33 0	$33 0
15	Nearshore Rockfish & Lingcod as Sentinel Species for Marine Reserves	Research	$100 0	$100 0	$50 0	$50 0
24A	Monitor Forage Fish & Epi-benthic Ecosystem Chiniak	Monitoring	$120 0	$80 0	$80 4	$53 6
24B	Monitor Forage Fish & Epi-benthic Ecosystem Kachemak Bay	Monitoring	$120 0	$80 0	$80 4	$53 6
24C	Monitor Forage Fish & Epi-benthic Ecosystem Chignik Bay	Monitoring	$120 0	$80 0	$80 4	$53 6
24D	Monitor Forage Fish & Epi-benthic Ecosystem Pavlof Bay	Monitoring	$120 0	$80 0	$80 4	$53 6
28A	Mid-water Trawl Forage Fish Surveys Chisik Island	Monitoring	$100 0	$80 0	$67 0	$53 6
28B	Mid-water Trawl Forage Fish Surveys Chiniak Gully	Monitoring	$100 0	$80 0	$67 0	$53 6
28C	Mid-water Trawl Forage Fish Surveys Barren Islands	Monitoring	$100 0	$80 0	$67 0	$53 6
33A	Nearshore Forage Fish Surveys Barren Islands	Monitoring	$100 0	$80 0	$67 0	$53 6
33B	Nearshore Forage Fish Surveys Gull Island	Monitoring	$100 0	$80 0	$67 0	$53 6
33C	Nearshore Forage Fish Surveys Chisik Island	Monitoring	$50 0	$20 0	$37 5	$15 0
33D	Nearshore Forage Fish Surveys Resurrection Bay	Monitoring	$120 0	$80 0	$80 4	$53 6
33E	Nearshore Forage Fish Surveys Puale Bay	Monitoring	$50 0	$20 0	$37 5	$15 0
33F	Nearshore Forage Fish Surveys Ugaiushak Island	Monitoring	$100 0	$80 0	$67 0	$53 6
39	Community-based Monitoring Forage Fish Surveys Using Stomach Contents	Research	$115 0	$115 0	$86 3	$86 3
40	Models to Understand Early Marine Survival Pink Salmon	Research	$300 0	$300 0	$201 0	$201 0
41	Models to Understand Early Marine Survival Pacific Herring	Research	$300 0	$300 0	$201 0	$201 0

GEM Monitoring & Research Plan   Proposed Components by Discipline

Component Number	Title	Research or Monitoring	ROUGH COST ESTIMATES Start up Cost	Annual Op Cost	GEM Share Start up Cost	GEM Share Annual Cost
Discipline	Seabird Ecology		$1 069 9	$1 019 9	$528 3	$499 1
02A	Monitor Murres & Kittiwakes (Field Stations) Chisik Island	Monitoring	$110 0	$110 0	$73 7	$73 7
02B	Monitor Murres & Kittiwakes (Field Stations) Gull Island	Monitoring	$110 0	$110 0	$73 7	$73 7
02C	Monitor Murres & Kittiwakes (Field Stations) East Amatuli Island	Monitoring	$75 0	$75 0	$50 3	$50 3
02D	Monitor Murres & Kittiwakes (Field Stations) Shoup Bay	Monitoring	$60 0	$60 0	$30 0	$30 0
02E	Monitor Murres & Kittiwakes (Field Stations) Kodiak Island	Monitoring	$100 0	$75 0	$67 0	$50 3
02F	Monitor Murres & Kittiwakes (Field Stations) Porpoise Rocks	Monitoring	$70 0	$60 0	$35 0	$30 0
04A	Monitor Murres & Kittiwakes (Boat Survey) Puale Bay	Monitoring	$18 3	$18 3	$15 6	$15 6
04B	Monitor Murres & Kittiwakes (Boat Survey) Ugaiushak Island	Monitoring	$18 3	$18 3	$15 6	$15 6
04C	Monitor Murres & Kittiwakes (Boat Survey) Chiswell Islands	Monitoring	$18 3	$18 3	$15 6	$15 6
09	Monitor Kittiwakes Prince William Sound	Monitoring	$10 0	$10 0	$5 0	$5 0
12	Monitor Murres & Kittiwakes Chiniak Bay	Monitoring	$10 0	$10 0	$5 0	$5 0
16	Database Management for Gulf of Alaska Seabirds	Monitoring	$120 0	$120 0	$12 0	$12 0
20	Seabird Monitoring (Multiple Species) Middleton Island	Monitoring	$180 0	$180 0	$45 0	$45 0
21	Seabird Monitoring (Multiple Species) Forrester Island	Monitoring	$60 0	$60 0	$30 0	$30 0
22	Seabird Monitoring (Multiple Species) Semidi Islands	Monitoring	$80 0	$80 0	$40 0	$40 0
27	Analysis of Seabird Interactions with Fisheries in the Gulf of Alaska	Research	$30 0	$15 0	$15 0	$7 5
Discipline	Nearshore, Benthic & Coastal Ecology		$800 0	$560 0	$376 0	$220 0
01A	Nearshore Benthic Biodiversity Stations Cook Inlet	Monitoring	$120 0	$60 0	$78 0	$39 0
01B	Nearshore Benthic Biodiversity Stations Prince William Sound	Monitoring	$120 0	$60 0	$78 0	$39 0
01C	Nearshore Benthic Biodiversity Stations Kodiak and Alaska Peninsula	Monitoring	$120 0	$60 0	$78 0	$39 0
01D	Nearshore Benthic Biodiversity Stations Kenai Fjords	Monitoring	$120 0	$60 0	$78 0	$39 0
30	Monitoring Vegetation Responses to Recreational and Natural Disturbances	Monitoring	$120 0	$120 0	$24 0	$24 0
31	Anthropogenic Disturbance of Eelgrass (*zostera Spp*) Meadows	Research	$80 0	$80 0	$16 0	$16 0

GEM Monitoring & Research Plan Proposed Components by Discipline

Component Number	Title	Research or Monitoring	ROUGH COST ESTIMATES Start up Cost	Annual Op Cost	GEM Share Start up Cost	GEM Share Annual Cost
38	Harlequin Duck Abundance Distribution & Age Structure	Monitoring	$120 0	$120 0	$24 0	$24 0
Discipline Biological Oceanography			$3 300 0	$3 000 0	$957 5	$807 5
11A	Alaska Coastal Current Montague Canyon Stations	Monitoring	$150 0	$150 0	$150 0	$150 0
11B	Alaska Coastal Current Afognak Stations	Monitoring	$150 0	$150 0	$150 0	$150 0
35A	Ships of Opportunity Basic Program	Monitoring	$250 0	$250 0	$250 0	$250 0
35B	Ships Of Opportunity Oceanography of the Alaska Marine Highway	Monitoring	$200 0	$100 0	$100 0	$50 0
36	Community-based Coastal Monitoring	Monitoring	$400 0	$200 0	$200 0	$100 0
42	Monitoring Environmental Contaminants	Monitoring	$2 150 0	$2 150 0	$107 5	$107 5
Discipline Physical, Geochemical & Chemical Oceanography & Effects of Climate			$1 859 0	$1 469 0	$1 039 5	$762 0
08	Alaska Coastal Current Deep Station Yakataga	Monitoring	$115 0	$35 0	$115 0	$35 0
10A	Marine Weather Station Seal River	Monitoring	$150 0	$75 0	$37 5	$18 8
10B	Marine Weather Station Prince William Sound	Monitoring	$150 0	$75 0	$37 5	$18 8
11C	Alaska Coastal Current Seward Stations	Monitoring	$333 0	$333 0	$166 5	$166 5
11D	Alaska Coastal Current Hinchinbrook Stations	Monitoring	$333 0	$333 0	$166 5	$166 5
11E	Alaska Coastal Current Prince William Sound Stations	Monitoring	$333 0	$333 0	$166 5	$166 5
18	Marine Contributions to Terrestrial Productivity	Monitoring	$50 0	$50 0	$37 5	$37 5
25	Satellite Monitoring Gulf of Alaska Surface Conditions	Monitoring	$115 0	$35 0	$115 0	$35 0
29	Surface Mooring Hinchinbrook Entrance	Monitoring	$115 0	$35 0	$115 0	$35 0
32	Gulf of Alaska Coupled Circulation Hydrological Model	Research	$165 0	$165 0	$82 5	$82 5
Discipline Interdisciplinary			$385 0	$385 0	$342 5	$342 5
06	Biennial State of the Gulf Symposium	Research	$50 0	$50 0	$50 0	$50 0
13	State of the Gulf Index	Research	$85 0	$85 0	$42 5	$42 5
17A	Forage Fish Synthesis	Research	$50 0	$50 0	$50 0	$50 0

GEM Monitoring & Research Plan Proposed Components by Discipline

Component Number	Title	Research or Monitoring	Start up Cost	Annual Op Cost	GEM Share Start up Cost	GEM Share Annual Cost
			ROUGH COST ESTIMATES			
17B	Seabird Synthesis	Research	*$50 0*	*$50 0*	*$50 0*	*$50 0*
17C	Nearshore Plants & Animals Synthesis	Research	*$50 0*	*$50 0*	*$50 0*	*$50 0*
17D	Terrestrial Linkages Synthesis	Research	*$50 0*	*$50 0*	*$50 0*	*$50 0*
17E	Coastal Processes Synthesis	Research	*$50 0*	*$50 0*	*$50 0*	*$50 0*
			$1 505 0	*$1 505 0*	*$1 505 0*	*$1 505 0*
Discipline	Support Services					
07	Data Management		*$300 0*	*$300 0*	*$300 0*	*$300 0*
19	Web-based & Other Communications		*$75 0*	*$75 0*	*$75 0*	*$75 0*
26	Scientific Advice, Peer Review & Collaboration		*$100 0*	*$100 0*	*$100 0*	*$100 0*
34	Public Advice & Outreach		*$30 0*	*$30 0*	*$30 0*	*$30 0*
37	Administrative Operations		*$1 000 0*	*$1 000 0*	*$1 000 0*	*$1 000 0*
		Total	*$11 573 9*	*$10 213 9*	*$6 339 1*	*$5 466 9*

Ecological Questions Work Sessions Summary Page

The primary organizational approach used in the Draft Monitoring and Research Plan is by theme However, also reviewing the proposed components from the perspective of ecological question should help us determine if the draft plan is solid and cohesive The spreadsheet which follows lists the proposed components by the ecological questions listed below However, many of the components address more than one question Each work group should evaluate the entire plan (i e , all of the components) from the perspective of its particular question The components listed under each question in the spreadsheet are meant as a starting point for discussion, and are not meant to limit discussion to those components only Changes to the current questions and additional questions are invited

- Food
  This question encompasses physical/chemical drivers of primary productivity as well as linkages among trophic levels (carbon transfer)
- Habitat
  This question encompasses marine animal home ranges/territories as well as use, selection, and importance
- Removals
  This question encompasses fishery impacts as well as other human uses and contaminants as sources of mortality predation
- Interactions Food, Habitat
  Impacts of habitat on food
- Interactions Food, Removals /predation + competition
  Impacts of removals on food
- Interactions Habitat, Removals
  Impacts of removals on habitat
- Interactions Food, Habitat, Removals
  The combined impact of removals and habitat on food

The questions below are intended to help guide the analysis of components from the ecological question perspective Work groups may address any questions that are acceptable to the group members, these questions are suggestions only

1 Do the components for each question, taken as a whole, address the ecological questions that are essential to answer in order to understand change in valued biological resources of the northern Gulf of Alaska? Have the right questions been asked?

2 Are the components actually directed at answering the ecological questions envisioned (see the upper right hand field in the "by component" descriptions)? For

example, would projects implemented along the lines of Component No 01/Nearshore Benthic Biodiversity Stations contribute information that would help answer questions of food, habitat and removals as controlling factors in nearshore environments?

3 The monitoring plan components assume that sections C and D of the Scientific Background document (see earlier tab in this binder) accurately capture the most important ecological questions in your field Does the Scientific Background document adequately identify the most important ecological questions in your field?

4 Are the questions identified for each component (i e , food, habitat, removals, interactions) adequate to allow formulation of testable hypotheses?

5 Are there additional compelling testable hypotheses that can be identified with respect to the components?

GEM Monitoring & Research Plan Proposed Components by Question

Component Number	Title	Research or Monitoring	Start up Cost	Annual Op. Cost	GEM Share Start up Cost	GEM Share Annual Cost
			ROUGH COST ESTIMATES			
Question Food			$3 934 9	$3 779 9	$1 309 6	$1 220 3
02A	Monitor Murres & Kittiwakes (Field Stations) Chisik Island	Monitoring	$110 0	$110 0	$73 7	$73 7
02B	Monitor Murres & Kittiwakes (Field Stations) Gull Island	Monitoring	$110 0	$110 0	$73 7	$73 7
02C	Monitor Murres & Kittiwakes (Field Stations) East Amatuli Island	Monitoring	$75 0	$75 0	$50 3	$50 3
02E	Monitor Murres & Kittiwakes (Field Stations) Kodiak Island	Monitoring	$100 0	$75 0	$67 0	$50 3
03	Forage Fish Dynamics as Indicated by Puffin Diet Sampling	Monitoring	$120 0	$120 0	$60 0	$60 0
04A	Monitor Murres & Kittiwakes (Boat Survey) Puale Bay	Monitoring	$18 3	$18 3	$15 6	$15 6
04B	Monitor Murres & Kittiwakes (Boat Survey) Ugaiushak Island	Monitoring	$18 3	$18 3	$15 6	$15 6
04C	Monitor Murres & Kittiwakes (Boat Survey) Chiswell Islands	Monitoring	$18 3	$18 3	$15 6	$15 6
11A	Alaska Coastal Current Montague Canyon Stations	Monitoring	$150 0	$150 0	$150 0	$150 0
11B	Alaska Coastal Current Afognak Stations	Monitoring	$150 0	$150 0	$150 0	$150 0
16	Database Management for Gulf of Alaska Seabirds	Monitoring	$120 0	$120 0	$12 0	$12 0
20	Seabird Monitoring (Multiple Species) Middleton Island	Monitoring	$180 0	$180 0	$45 0	$45 0
33E	Nearshore Forage Fish Surveys Puale Bay	Monitoring	$50 0	$20 0	$37 5	$15 0
35A	Ships of Opportunity Basic Program	Monitoring	$250 0	$250 0	$250 0	$250 0
35B	Ships Of Opportunity Oceanography of the Alaska Marine Highway	Monitoring	$200 0	$100 0	$100 0	$50 0
39	Community-based Monitoring Forage Fish Surveys Using Stomach Contents	Research	$115 0	$115 0	$86 3	$86 3
42	Monitoring Environmental Contaminants	Monitoring	$2 150 0	$2 150 0	$107 5	$107 5
Question Habitat			$100 0	$100 0	$33 0	$33 0
14	Marine Reserve Network Identification	Research	$100 0	$100 0	$33 0	$33 0
Question Removals			$30 0	$15 0	$15 0	$7 5
27	Analysis of Seabird Interactions with Fisheries in the Gulf of Alaska	Research	$30 0	$15 0	$15 0	$7 5

GEM Monitoring & Research Plan: Proposed Components by Question

Component Number	Title	Research or Monitoring	ROUGH COST ESTIMATES, Start up Cost	Annual Op. Cost	GEM Share, Start up Cost	GEM Share, Annual Cost
Question	Interactions Food, Habitat		$2 105 0	$1 545 0	$1 269 0	$927 1
02D	Monitor Murres & Kittiwakes (Field Stations) Shoup Bay	Monitoring	$60 0	$60 0	$30 0	$30 0
02F	Monitor Murres & Kittiwakes (Field Stations) Porpoise Rocks	Monitoring	$70 0	$60 0	$35 0	$30 0
09	Monitor Kittiwakes Prince William Sound	Monitoring	$10 0	$10 0	$5 0	$5 0
12	Monitor Murres & Kittiwakes Chiniak Bay	Monitoring	$10 0	$10 0	$5 0	$5 0
21	Seabird Monitoring (Multiple Species) Forrester Island	Monitoring	$60 0	$60 0	$30 0	$30 0
22	Seabird Monitoring (Multiple Species) Semidi Islands	Monitoring	$80 0	$80 0	$40 0	$40 0
24A	Monitor Forage Fish & Epi-benthic Ecosystem Chiniak	Monitoring	$120 0	$80 0	$80 4	$53 6
24B	Monitor Forage Fish & Epi-benthic Ecosystem Kachemak Bay	Monitoring	$120 0	$80 0	$80 4	$53 6
24C	Monitor Forage Fish & Epi-benthic Ecosystem Chignik Bay	Monitoring	$120 0	$80 0	$80 4	$53 6
24D	Monitor Forage Fish & Epi-benthic Ecosystem Pavlof Bay	Monitoring	$120 0	$80 0	$80 4	$53 6
28A	Mid-water Trawl Forage Fish Surveys Chisik Island	Monitoring	$100 0	$80 0	$67 0	$53 6
28B	Mid-water Trawl Forage Fish Surveys Chiniak Gully	Monitoring	$100 0	$80 0	$67 0	$53 6
28C	Mid-water Trawl Forage Fish Surveys Barren Islands	Monitoring	$100 0	$80 0	$67 0	$53 6
32	Gulf of Alaska Coupled Circulation Hydrological Model	Research	$165 0	$165 0	$82 5	$82 5
33A	Nearshore Forage Fish Surveys Barren Islands	Monitoring	$100 0	$80 0	$67 0	$53 6
33B	Nearshore Forage Fish Surveys Gull Island	Monitoring	$100 0	$80 0	$67 0	$53 6
33C	Nearshore Forage Fish Surveys Chisik Island	Monitoring	$50 0	$20 0	$37 5	$15 0
33D	Nearshore Forage Fish Surveys Resurrection Bay	Monitoring	$120 0	$80 0	$80 4	$53 6
33F	Nearshore Forage Fish Surveys Ugaiushak Island	Monitoring	$100 0	$80 0	$67 0	$53 6
36	Community-based Coastal Monitoring	Monitoring	$400 0	$200 0	$200 0	$100 0
Question	Interactions Food, Removals		$1 644 0	$1 254 0	$919 5	$642 0
08	Alaska Coastal Current Deep Station Yakataga	Monitoring	$115 0	$35 0	$115 0	$35 0
10A	Marine Weather Station Seal River	Monitoring	$150 0	$75 0	$37 5	$18 8

GEM Monitoring & Research Plan Proposed Components by Question

Component Number	Title	Research or Monitoring	Start-up Cost	Annual Op Cost	GEM Share Start up Cost	GEM Share Annual Cost
			ROUGH COST ESTIMATES			
10B	Marine Weather Station Prince William Sound	Monitoring	$150 0	$75 0	$37 5	$18 8
11C	Alaska Coastal Current Seward Stations	Monitoring	$333 0	$333 0	$166 5	$166 5
11D	Alaska Coastal Current Hinchinbrook Stations	Monitoring	$333 0	$333 0	$166 5	$166 5
11E	Alaska Coastal Current Prince William Sound Stations	Monitoring	$333 0	$333 0	$166 5	$166 5
25	Satellite Monitoring Gulf of Alaska Surface Conditions	Monitoring	$115 0	$35 0	$115 0	$35 0
29	Surface Mooring Hinchinbrook Entrance	Monitoring	$115 0	$35 0	$115 0	$35 0
Question	Interactions Habitat, Removals		$350 0	$350 0	$127 5	$127 5
15	Nearshore Rockfish & Lingcod as Sentinel Species for Marine Reserves	Research	$100 0	$100 0	$50 0	$50 0
18	Marine Contributions to Terrestrial Productivity	Monitoring	$50 0	$50 0	$37 5	$37 5
30	Monitoring Vegetation Responses to Recreational and Natural Disturbances	Monitoring	$120 0	$120 0	$24 0	$24 0
31	Anthropogenic Disturbance of Eelgrass (*zostera Spp*) Meadows	Research	$80 0	$80 0	$16 0	$16 0
Question	Interactions Food, Habitat, Removals		$1 905 0	$1 665 0	$1 160 5	$1 004 5
01A	Nearshore Benthic Biodiversity Stations Cook Inlet	Monitoring	$120 0	$60 0	$78 0	$39 0
01B	Nearshore Benthic Biodiversity Stations Prince William Sound	Monitoring	$120 0	$60 0	$78 0	$39 0
01C	Nearshore Benthic Biodiversity Stations Kodiak and Alaska Peninsula	Monitoring	$120 0	$60 0	$78 0	$39 0
01D	Nearshore Benthic Biodiversity Stations Kenai Fjords	Monitoring	$120 0	$60 0	$78 0	$39 0
05	Monitor Sea Otter Abundance, Productivity, Survival & Behavior	Monitoring	$120 0	$120 0	$60 0	$60 0
06	Biennial State of the Gulf Symposium	Research	$50 0	$50 0	$50 0	$50 0
13	State of the Gulf Index	Research	$85 0	$85 0	$42 5	$42 5
17A	Forage Fish Synthesis	Research	$50 0	$50 0	$50 0	$50 0
17B	Seabird Synthesis	Research	$50 0	$50 0	$50 0	$50 0
17C	Nearshore Plants & Animals Synthesis	Research	$50 0	$50 0	$50 0	$50 0
17D	Terrestrial Linkages Synthesis	Research	$50 0	$50 0	$50 0	$50 0
17E	Coastal Processes Synthesis	Research	$50 0	$50 0	$50 0	$50 0

GEM Monitoring & Research Plan   Proposed Components by Question

Component Number	Title	Research or Monitoring	Start up Cost	Annual Op Cost	GEM Share Start up Cost	GEM Share Annual Cost
			ROUGH COST ESTIMATES			
23	Harbor Seal Abundance	Monitoring	$200 0	$200 0	$20 0	$20 0
38	Harlequin Duck Abundance, Distribution & Age Structure	Monitoring	$120 0	$120 0	$24 0	$24 0
40	Models to Understand Early Marine Survival Pink Salmon	Research	$300 0	$300 0	$201 0	$201 0
41	Models to Understand Early Marine Survival Pacific Herring	Research	$300 0	$300 0	$201 0	$201 0
			$1 505 0	$1 505 0	$1 505 0	$1 505 0
Question Support Services						
07	Data Management		$300 0	$300 0	$300 0	$300 0
19	Web-based & Other Communications		$75 0	$75 0	$75 0	$75 0
26	Scientific Advice, Peer Review & Collaboration		$100 0	$100 0	$100 0	$100 0
34	Public Advice & Outreach		$30 0	$30 0	$30 0	$30 0
37	Administrative Operations		$1 000 0	$1 000 0	$1 000 0	$1 000 0
		Total	$11 573 9	$10 213 9	$6 339 1	$5 466 9

Issues Work Sessions Summary Page

A number of issues were identified in the GEM Program document that need to be examined in light of the Draft Monitoring and Research Plan Session IV on the workshop agenda is intended to provide an opportunity for small work groups to address these issues The issues identified thus far are citizen monitoring/community involvement/traditional knowledge, data and information management and transfer, modeling and forecasting, resource management applications, and human uses and impacts Other issues that warrant a small group session may be identified during the first day and a half of the workshop

The types of questions to be asked within each of the individual sessions depend on the particular issue The following are meant to be starting points for discussion

Citizen Monitoring, Community Involvement, and Traditional Knowledge

According to the GEM Program document, the inclusion of appropriate traditional and local knowledge and the involvement of communities in the northern gulf region are appropriate throughout the GEM program Local monitoring, documentation and stewardship projects must be linked wherever possible to other GEM research and monitoring projects

1 What kinds of citizen monitoring could be incorporated in the GEM monitoring and research program?

2 What are the best ways to ensure integration of local and traditional knowledge?

3 How do you address the issues of geographic extent and quality control of data with citizen monitoring?

Data and Information Management and Transfer

The final GEM program must include a comprehensive data management plan and policy

1 Given the scope of the proposed GEM Monitoring and Research Plan, to what extent should any GEM database be a centralized database as opposed to a distributed metadatabase?

2 What kinds of data should be kept in a centralized database?

3 What kinds of data use and archiving policies should be adopted by the Trustee Council?

4 Questions regarding relations between GEM and the people it pays to acquire observations Federal standards? State standards? Industry standards? What is the best compromise for a state-federal hybrid organization like GEM?

5 Questions regarding relations between GEM and the marine and atmospheric science data acquisition and research entities with which it must interact to be successful Do we keep a metadatabase pointing toward the active data acquisition programs of other entities? If so, what are the standard protocols (viz CIIMMS, FGDC)? If not, what are the alternatives for understanding where any one project proposal may fit into the whole? If the alternatives are passive in the sense that individuals must voluntarily post their metadata to a web site, are passive systems complete and current enough to serve the purposes of GEM?

6 Questions regarding relations between GEM and its clients What are the most economical and efficient approaches available to communicate data to resource managers, researchers, and the general public? Where and on what are these data stored?

Modeling and Forecasting

One of the goals of the GEM program is to predict – to develop the capacity to predict the status and trends of natural resources for use by resource managers and consumers

1 What are the priorities for modeling?

2 What are the prospects for using nowcast-forecast physical models to provide biological information?

3 Is the proposed strategy of using inexpensive correlative models of relations among geophysical and biological variables to help develop numerical models reasonable?

4 Given the commitment of GEM to tracking and understanding long-term changes in the Gulf of Alaska, how much emphasis should be put on annual forecasts?

Resource Management Applications

GEM is to provide synthesized information, tools and technologies to resource managers so they can improve management of marine resources and address problems that may arise from human activities Much of the information being gathered under GEM will likely have payoffs in the long-term, rather than the immediate term

1 Do the proposed components place enough emphasis on information, tools and technologies for resource managers?

2 Are there any tools and other technologies and information that may be valuable to resource managers in the short- or long-term that could be part of proposed components or that need to be added?

Human Uses and Impacts

The GEM mission is to detect change in marine resources and help determine if changes are natural or human-caused Although Alaska is relatively unpopulated and pristine, its marine resources are increasingly under pressure from fishing activities, growing urbanization and habitat degradation, an expanded tourist industry, and air-borne and water-borne pollutants

1 Are the sources of change due to human activities adequately identified and addressed in the themes, hypotheses, and components?

2 Do the themes, hypotheses, and components go far enough in addressing monitoring of human activities in the northern Gulf of Alaska?

3 What other programs and funding sources can be leveraged to provide better answers to questions on human uses and impacts that arise from the monitoring?

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How to Read Component Descriptions

The following pages describe the individual components in detail Each component description contains the following information

Theme	Themes are focal points around which studies of factors controlling changes in the ecosystem are organized
Discipline	Branch of scientific knowledge the component embodies
Question	Agent of change thought to control the species identified in the theme, questions in GEM Program document address food, habitat, removals, or interaction between two or more of these
Title	Component title
Description	What the component would do, the level of detail varies greatly because the concepts of some components are better developed than others
Measurement	What types of data the component would collect
Frequency	How often the component would be performed (every year, every 2 years every 3 years, etc)
Season	Time of year the component would be performed (all year, or specific months or season)
Where	Name of areas where data would be collected
Lat/Long	Geographic locality (by decimal latitude and longitude) at which the component would be performed, for components with multiple sites, a central, representative location is used
Region	Region in which geographic locality lies Prince William Sound (PWS), Cook Inlet (CI), Kodiak/Alaska Peninsula (KAP), northern Gulf of Alaska (NGOA), or all
Detect	Annual or long-term changes in the marine ecosystem that the component would detect, not every component addresses this goal
Understand	Causes of change in the marine ecosystem the component would identify, including natural variation, human influences, and their interaction, not every component addresses this goal
Predict	Status or trends of natural resources the component would predict, not every component addresses this goal
Inform	Information the component would integrate and synthesize for

	presentation to the public, resource managers, and others, not every component addresses this goal
Solve	Tools, technologies, or information the component would develop in order to help improve management of marine resources and address problems that may arise from human activities, not every component addresses this goal
Cost Sharing	Projected proportion of annual component cost that would be non-GEM funds, a number from zero to one
Start-Up Cost	Rough estimate of cost in Year 1 to get component underway, often includes cost of equipment purchase or other capitalization expense
Annual Operating Cost	Rough estimate of ongoing cost of component, for components that would be conducted every two years, cost has been spread across two years (etc) periodic cost of re-capitalization (e g , replacing equipment) is not included in these figures
GEM Share Start-Up	Rough estimate of GEM share of start-up cost, calculated by multiplying amount in "cost-sharing" field by amount in "start-up cost" field
GEM Share Annual	Rough estimate of GEM share of annual cost, calculated by multiplying amount in 'cost-sharing" field by amount in "annual operating cost" field
Cost Partners	Organizations that may be expected to share the cost of the component
Other Partners	Organizations that would not be expected to share costs, but would likely use data collected by the component, that have related projects underway, or that may offer coordination possibilities
Related GEM Components	Other proposed components, to be funded in whole or in part by GEM, that may collect information relevant to this component
Related Non-GEM Funded Activities	Programs underway by non-GEM organizations that relate to this component either in providing or using information or offering opportunities for coordination, including EVOS Restoration Projects
Projected Start	Year in which GEM funding would begin, for example, 10/01/02 is the beginning of Fiscal Year 2003
Projected Completion	Final year of GEM funding for research projects blank for monitoring projects
Monitoring or Research	Monitoring components collect observations on a short- or long-term basis research components interpret observations for user groups and/or develop or refine methods and objectives for monitoring

GEM Monitoring & Research Plan Component Description

Component No 01A

HEME Nearshore Plants & Animals | **DISCIPLINE** Nearshore Benthic & Coastal Ecology | **QUESTION** Interactions Food, Habitat, Removals

Title	Nearshore Benthic Biodiversity Stations Cook Inlet
Description	Measurements of nearshore plants and animals and their environments describe how variation among nearshore benthic communities depends on biological and geophysical processes Biological factors such as recruitment of young plants and animals to nearshore habitats, phytoplankton productivity and nutrient concentration vary significantly in accord with geophysical processes including currents and upwelling Periodic intensive sampling of larvae, recruits, and post-settlement individuals in both subtidal and intertidal communities is combined with monitoring of nearshore waters using a mooring array benthically mounted Acoustic Doppler Current Profilers (ADCPs) coastal radar units and other remote sensing Monitoring of predation intensity, growth rates, and condition for selected key species and ecological processes in individual intensive study areas will be combined with a series of experiments and measurements monitoring
Measurement	Abundance and distribution of larvae, recruits, and post-settlement individuals for selected species, current velocity and direction temperature, salinity
Frequency	Every year — Where: Kachemak, Kasitsna, Seldovia Port Graham
Season	Fall — Lat / Long: 59 50 / -151 75 — Region: CI

GOALS	PRODUCTS
Detect	Nearshore trophic dynamics change in nearshore ecosystem
Understand	Link to marine system
Predict	GOA trophic dynamics
Inform	Nearshore ecosystem status State of the Gulf Index
Solve	Health of nearshore

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 35	$120 0	$60 0	$78 0	$39 0

CONNECTIONS

Cost Partners	NOAA (NOA HAZMAT), EPA Packard Foundation
Other Partners	PISCO consortium KBNERR, Kasitsna Bay Laboratory NPS, Port Graham CIRCAC USGS
Related GEM Components	Nearshore Benthic Biodiversity Stations Kenai Fjords, PWS, Kodiak-Alaska Peninsula, Physical Oceanography
Related Non-GEM Funded Activities	Restoration Project 00510 Intertidal Monitoring Recommendations PISCO Sites Pt Conception and the Channel Islands Monterey Bay and the central Oregon Coast

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 01B

THEME Nearshore Plants & Animals **DISCIPLINE** Nearshore, Benthic & Coastal Ecology **QUESTION** Interactions Food, Hab Removals

Title	Nearshore Benthic Biodiversity Stations Prince William Sound
Description	Measurements of nearshore plants and animals and their environments describe how variation among nearshore benthic communities depends on biological and geophysical processes Biological factors such as recruitment of young plants and animals to nearshore habitats phytoplankton productivity and nutrient concentration vary significantly in accord with geophysical processes including currents and upwelling Periodic intensive sampling of larvae, recruits, and post-settlement individuals in both subtidal and intertidal communities is combined with monitoring of nearshore waters using a mooring array benthically mounted Acoustic Doppler Current Profilers (ADCPs), coastal radar units and other remote sensing Monitoring of predation intensity, growth rates, and condition for selected key species and ecological processes in individual intensive study areas will be combined with a series of experiments and measurements
Measurement	Abundance and distribution of larvae, recruits, and post-settlement individuals for selected species, current velocity and direction, temperature, salinity

Frequency	Every year	Where	Cordova Valdez Whittier		
Season	Fall	Lat / Long	60 75 / -148 25	Region	PWS

GOALS	PRODUCTS
Detect	Nearshore trophic dynamics change in nearshore ecosystem
Understand	Link to marine system
Predict	GOA trophic dynamics
Inform	Nearshore ecosystem status State of the Gulf Index
Solve	Health of nearshore

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 35	$120 0	$60 0	$78 0	$39 0

CONNECTIONS

Cost Partners	USFS ADEC, EPA, NOAA (NOS HAZMAT), Packard Foundation, NPS, OSRI
Other Partners	PISCO consortium, PWSSC, NMFS (AFSC Kodiak), PWSRCAC, USGS
Related GEM Components	Nearshore Benthic Biodiversity Stations Kenai Fjords Cook Inlet, Kodiak-Alaska Peninsula, Physical Oceanography
Related Non GEM Funded Activities	Restoration Project 00510 Intertidal Monitoring Recommendations USFS marine site monitoring EMAP Coastal 2000, PISCO Sites Pt Conception Channel Islands Monterey Bay central Oregon Coast, NPS coastal monitoring Glacier Bay

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 01C

HEME Nearshore Plants & Animals	**DISCIPLINE** Nearshore Benthic & Coastal Ecology	**QUESTION** Interactions Food, Habitat, Removals

Title	Nearshore Benthic Biodiversity Stations Kodiak and Alaska Peninsula
Description	Measurements of nearshore plants and animals and their environments describe how variation among nearshore benthic communities depends on biological and geophysical processes Biological factors such as recruitment of young plants and animals to nearshore habitats phytoplankton productivity and nutrient concentration vary significantly in accord with geophysical processes including currents and upwelling Periodic intensive sampling of larvae, recruits, and post-settlement individuals in both subtidal and intertidal communities is combined with monitoring of nearshore waters using a mooring array benthically mounted Acoustic Doppler Current Profilers (ADCPs), coastal radar units, and other remote sensing Monitoring of predation intensity, growth rates, and condition for selected key species and ecological processes in individual intensive study areas will be combined with a series of experiments and measurements monitoring
Measurement	Abundance and distribution of larvae, recruits, and post-settlement individuals for selected species, current velocity and direction, temperature, salinity

Frequency	Every year	Where	Chiniak Port Lions Perryville		
Season	Fall	Lat / Long	57 75 / -152 50	Region	KAP

GOALS	PRODUCTS
Detect	Nearshore trophic dynamics change in nearshore ecosystem
Understand	Link to marine system
Predict	GOA trophic dynamics
Inform	Nearshore ecosystem status State of the Gulf Index
Solve	Health of nearshore

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 35	$120 0	$60 0	$78 0	$39 0

CONNECTIONS

Cost Partners	NOAA (NOS HAZMAT) Packard Foundation, USFWS
Other Partners	PISCO consortium NMFS (AFSC Kodiak) USGS
Related GEM Components	Nearshore Benthic Biodiversity Stations Kenai Fjords PWS, Cook Inlet, Physical Oceanography
Related Non GEM Funded Activities	Restoration Project 00510 Intertidal Monitoring Recommendations, PISCO Sites Pt Conception and the Channel Islands Monterey Bay, and the central Oregon Coast

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 01D

THEME Nearshore Plants & Animals	**DISCIPLINE** Nearshore, Benthic & Coastal Ecology	**QUESTION** Interactions Food, Hab Removals

Title	Nearshore Benthic Biodiversity Stations Kenai Fjords
Description	Measurements of nearshore plants and animals and their environments describe how variation among nearshore benthic communities depends on biological and geophysical processes Biological factors such as recruitment of young plants and animals to nearshore habitats, phytoplankton productivity and nutrient concentration vary significantly in accord with geophysical processes including currents and upwelling Periodic intensive sampling of larvae, recruits, and post-settlement individuals in both subtidal and intertidal communities is combined with monitoring of nearshore waters using a mooring array, benthically mounted Acoustic Doppler Current Profilers (ADCPs) coastal radar units and other remote sensing Monitoring of predation intensity, growth rates and condition for selected key species and ecological processes in individual intensive study areas will be combined with a series of experiments and measurements monitoring
Measurement	Abundance and distribution of larvae, recruits, and post-settlement individuals for selected species, current velocity and direction, temperature, salinity

Frequency	Every year	Where	Aialik Bay		
Season	Fall	Lat / Long	59 75 / -149 60	Region	NGOA

GOALS	**PRODUCTS**
Detect	Nearshore trophic dynamics, change in nearshore ecosystem
Understand	Link to marine system
Predict	GOA trophic dynamics
Inform	Nearshore ecosystem status State of the Gulf Index
Solve	Health of nearshore

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 35	$120 0	$60 0	$78 0	$39 0

CONNECTIONS

Cost Partners	NPS, ADEC EPA NOAA (NOS, HAZMAT), Packard Foundation
Other Partners	PISCO consortium USGS
Related GEM Components	Nearshore Benthic Biodiversity Stations PWS, Kodiak-Alaska Peninsula, Cook Inlet, Physical Oceanography
Related Non-GEM Funded Activities	Restoration Project 00510 Intertidal Monitoring Recommendations, USFS marine site monitoring EMAP Coastal 2000 PISCO Sites Pt Conception and the Channel Islands Monterey Bay, and the central Oregon Coast

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 02A

HEME Seabirds	**DISCIPLINE** Seabird Ecology	**QUESTION** Food

Title	Monitor Murres & Kittiwakes (Field Stations) Chisik Island
Description	A field station will be supported on Chisik Island to collect data throughout breeding season on multiple seabird parameters, and ancillary data on oceanography and forage fish Note that survival and stress work require extended field season and laboratory investigations beyond 'typical' colony study duration and cost The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove, and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA runs both perpendicular and parallel to the Alaska Coastal Current (ACC) covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Murre and kittiwake parameters biology (population size, adult survival productivity phenology), behavior (foraging effort, attendance, feeding rate), physiology (growth, stress level) and diet composition (adult and chick) Ancillary data collected on other species, including puffins, gulls and cormorants with focus on population trends and diets

Frequency	Every year	Where	Chisik Island		
Season	Apr-Sept	Lat / Long	60 15 / -152 57	Region	CI

GOALS	**PRODUCTS**
Detect	ENSO PDO anthropogenic impacts, changes in marine food webs food stress
Understand	GOA trophic dynamics seabird population dynamics
Predict	Climate regime shift GOA trophic dynamics
Inform	State of the Gulf Index ecosystem status
Solve	Seabirds are indicators of marine ecosystem health

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 33	$110 0	$110 0	$73 7	$73 7

CONNECTIONS

Cost Partners	USGS (Alaska Biol Sci Center) / USFWS (Alaska Maritime NWR)
Other Partners	MMS
Related GEM Components	Seabird Monitoring (GOA, Cook Inlet Kodiak PWS) Forage Fish Monitoring (GOA Cook Inlet Kodiak PWS)
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design USFWS/USGS Seabird Status and Trends MMS Outer Continental Shelf Environmental Studies

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 02B

THEME Seabirds **DISCIPLINE** Seabird Ecology **QUESTION** Food

Title	Monitor Murres & Kittiwakes (Field Stations) Gull Island
Description	A field station will be supported on Gull Island to collect data throughout breeding season on multiple seabird parameters, and ancillary data on oceanography and forage fish Note that survival and stress work require extended field season and laboratory investigations beyond 'average' colony study duration and cost The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove, and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coastal Current (ACC), covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Murre and kittiwake parameters biology (population size, adult survival, productivity, phenology) behavior (foraging effort, attendance, feeding rate), physiology (growth, stress level) and diet composition (adult and chick) Ancillary data collected on other species, including puffins, gulls and cormorants with focus on population trends and diets

Frequency	Every year	Where	Gull Island		
Season	Apr-Sept	Lat / Long	59 59 / -151 33	Region	CI

GOALS	PRODUCTS
Detect	ENSO PDO anthropogenic impacts, changes in marine food webs food stress
Understand	GOA trophic dynamics seabird population dynamics
Predict	Climate regime shift GOA trophic dynamics
Inform	State of the Gulf Index ecosystem status
Solve	Seabirds are indicators of marine ecosystem health

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 33	$110 0	$110 0	$73 7	$73 7

CONNECTIONS

Cost Partners	USGS (Alaska Biol Sci Center) / USFWS (Alaska Maritime NWR)
Other Partners	MMS
Related GEM Components	Seabird Monitoring (GOA Cook Inlet, Kodiak, PWS), Forage Fish Monitoring (GOA Cook Inlet Kodiak PWS)
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design USFWS/USGS Seabird Status and Trends, MMS Outer Continental Shelf Environmental Studies

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 02C

HEME Seabirds	**DISCIPLINE** Seabird Ecology	**QUESTION** Food

Title	Monitor Murres & Kittiwakes (Field Stations) East Amatuli Island
Description	A field station will be supported on East Amatuli Island to collect data throughout breeding season on multiple seabird parameters, and ancillary data on oceanography and forage fish (see Links) Note that survival and stress work require extended field season and laboratory investigations beyond 'average' colony study duration and cost The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove, and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coastal Current (ACC), covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Murre and kittiwake parameters biology (population size, adult survival, productivity, phenology), behavior (foraging effort, attendance, feeding rate), physiology (growth, stress level) and diet composition (adult and chick) Ancillary data collected on other species, including puffins gulls and cormorants with focus on population trends and diets

Frequency	Every year	Where	East Amatuli Island, Barren Islands		
Season	Apr Sept	Lat / Long	58 92 / -152 17	Region	CI KAP

GOALS	PRODUCTS
Detect	ENSO PDO anthropogenic impacts changes in marine food webs food stress
Understand	GOA trophic dynamics seabird population dynamics
Predict	Climate regime shift GOA trophic dynamics
Inform	State of the Gulf Index ecosystem status
Solve	Seabirds are indicators of marine ecosystem health

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 33	$75 0	$75 0	$50 3	$50 3

CONNECTIONS

Cost Partners	USGS (Alaska Biol Sci Center) / USFWS (Alaska Maritime NWR)
Other Partners	MMS
Related GEM Components	Seabird Monitoring (GOA Cook Inlet Kodiak, PWS) Forage Fish Monitoring (GOA Cook Inlet Kodiak PWS)
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design USFWS/USGS Seabird Status and Trends MMS Outer Continental Shelf Environmental Studies

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 02D

THEME Seabirds **DISCIPLINE** Seabird Ecology **QUESTION** Interactions Food, Habit.

Title	Monitor Murres & Kittiwakes (Field Stations) Shoup Bay
Description	A field station will be supported at Shoup Bay to collect data throughout breeding season on multiple seabird parameters, and data on forage fish abundance Note that survival and stress work require extended field season and laboratory investigations beyond 'average' colony study duration and cost Kittiwake parameters will be measured Ancillary data will be collected on other species including gulls and terns with focus on population trends and diets
Measurement	Biology (population size, adult survival, productivity, phenology) behavior (foraging effort attendance feeding rate) physiology (growth stress level) and diet (adult and chick diet composition)
Frequency	Every year Where Shoup Bay
Season	Summer Lat / Long 61 10 / -146 37 Region PWS

GOALS	**PRODUCTS**
Detect	PDO Food web changes, SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles, availability of forage fishes for seabirds and marine mammals
Inform	Fishery management, State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$60 0	$60 0	$30 0	$30 0

CONNECTIONS

Cost Partners	USFWS
Other Partners	USGS, ADF&G (Herring Surveys)
Related GEM Components	Seabird Monitoring (GOA, Cook Inlet Kodiak PWS) Forage Fish Monitoring (GOA, Cook Inlet, Kodiak PWS)
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design, USFWS/USGS Seabird Status and Trends, MMS Outer Continental Shelf Environmental Studies ADF&G Herring Surveys

Projected Start 06/01/03   Projected Completion

Monitoring or Research   Monitoring

GEM Monitoring & Research Plan Component Description

Component No 02E

HEME Seabirds	**DISCIPLINE** Seabird Ecology	**QUESTION** Food

Title	Monitor Murres & Kittiwakes (Field Stations) Kodiak Island
Description	This component will support a field station based in the town of Kodiak to collect core data throughout breeding season on multiple seabird parameters at multiple sites, and ancillary data on oceanography and forage fish Sites to be visited via road/Zodiac by mobile crew Marmot I (58 17, -151 83), Long I (57 42, -152 58), Chiniak I (57 62 -152 17), Viesoki I (57 70, -152 45), The Triplets (57 97, -152 47), Anton Larsen Bay (57 88, -152 67) The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove, and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coastal Current (ACC), covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Murre and kittiwake parameters biology (population size, adult survival, productivity phenology), behavior (foraging effort attendance, feeding rate), physiology (growth, stress level) and diet composition (adult and chick) Ancillary data collected on other species, including puffins, gulls and cormorants with focus on population trends and diets

Frequency	Every year	Where	Kodiak		
Season	Apr-Sept	Lat / Long	57 62 / -152 17	Region	KAP

GOALS	**PRODUCTS**
Detect	ENSO PDO anthropogenic impacts, changes in marine food webs, food stress
Understand	GOA trophic dynamics seabird population dynamics
Predict	Climate regime shift, GOA trophic dynamics
Inform	State of the Gulf Index ecosystem status
Solve	Seabirds are indicators of marine ecosystem health

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 33	$100 0	$75 0	$67 0	$50 3

CONNECTIONS

Cost Partners	USGS (Alaska Biol Sci Center) / USFWS (Alaska Maritime NWR)
Other Partners	MMS
Related GEM Components	Seabird Monitoring (GOA Cook Inlet, Kodiak, PWS) Forage Fish Monitoring (GOA Cook Inlet Kodiak, PWS)
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design USFWS/USGS Seabird Status and Trends MMS Outer Continental Shelf Environmental Studies

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 02F

THEME Seabirds	**DISCIPLINE** Seabird Ecology	**QUESTION** Interactions Food, Hat

Title	Monitor Murres & Kittiwakes (Field Stations) Porpoise Rocks
Description	A field station will be supported at Porpoise Rocks to collect data throughout breeding season on multiple seabird parameters, and data on forage fish abundance Note that survival and stress work require extended field season and laboratory investigations beyond 'average' colony study duration and cost Murre and kittiwake parameters will be measured, ancillary data will be collected on other species, including puffins and gulls with focus on population trends and diets Annual data input into the Alaska Seabird Colony Catalog database and the Pacific Seabird Monitoring Database
Measurement	Biology (population size, adult survival, productivity, phenology), behavior (foraging effort attendance, feeding rate), physiology (growth, stress level) and diet (adult and chick diet composition)

Frequency	Every year	Where	Porpoise Rocks		
Season	Summer	Lat / Long	60 19 / -146 40	Region	PWS

GOALS	**PRODUCTS**
Detect	PDO Food web changes, SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
Inform	Fishery management , State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annu
0 50	$70 0	$60 0	$35 0	$30 0

CONNECTIONS

Cost Partners	USFWS
Other Partners	USGS ADF&G (Herring Surveys)
Related GEM Components	Seabird Monitoring (GOA, Cook Inlet, Kodiak PWS) Forage Fish Monitoring (GOA, Cook Inlet Kodiak PWS)
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design, USFWS/USGS Seabird Status and Trends, MMS Outer Continental Shelf Environmental Studies, ADF&G Herring Surveys

Projected Start 06/01/2003 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 03

THEME Forage Fish **DISCIPLINE** Marine & Fish Ecology **QUESTION** Food

Title	Forage Fish Dynamics as Indicated by Puffin Diet Sampling
Description	Roving crew will annually visit each of 8-10 colonies for one to two days during two-week cruise of support vessel such as *M/V Tiglax* Samples will be collected using burrow-screening technique Productivity (chicks/burrow) will be recorded using burrow cameras and/or visual inspection, weights and wing measurements from a subsample of chicks will be used to calculate condition indices by colony and year Fish samples will be analyzed genetically for stock identification of key forage species Data collection sites Porpoise Rocks (60 32, -146 69) Chiswell Is (59 60, -149 60), Flat I (56 83 -153 74) E Brother I (55 92 -158 83), Karpa I (55 51 -160 05), Egg I (55 28 -160 52), Midun I (54 84, 162 17), Aiktak I (54 19, -164 83) Will collect prey samples from tufted puffins during chick-rearing and obtain annual indices of puffin productivity and chick growth Puffin diet sampling during chick-rearing is a proven technique, which is cost effective and highly informative as to the distribution and relative abundances of forage fish species near seabird colonies This component will generate important time series on forage fish dynamics to complement other sampling approaches that may be used in fishery research Will add geographic breadth to puffin diet sampling that would occur at a smaller number of GEM-affiliated stations for seabird monitoring in the Gulf of Alaska In many localities, this monitoring likely will provide the best or only quantitative information available on non-commercial or difficult-to-sample prey such as sand lance capelin, and juvenile pollock
Measurement	Forage fish species composition relative abundance, productivity (chicks/burrow), chick weights and wing measurements

Frequency	Every year	Where	Porpoise Rocks		
Season	Apr Sept	Lat / Long	60 32 / -146 69	Region	PWS

GOALS	PRODUCTS
Detect	Component ENSO PDO anthropogenic impacts changes in marine food webs, food stress
Understand	GOA trophic dynamics, seabird population dynamics
Predict	Climate regime shift, GOA trophic dynamics
Inform	State of the Gulf Index ecosystem status
Solve	Seabirds are indicators of marine ecosystem health

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$120 0	$120 0	$60 0	$60 0

CONNECTIONS

Cost Partners	USGS (Alaska Biol Sci Center) USFWS Alaska Maritime NWR
Other Partners	MMS
Related GEM Components	Seabird Monitoring (GOA, Cook Inlet, Kodiak PWS) Forage Fish Monitoring (GOA, Cook Inlet Kodiak PWS)
Related Non GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design USFWS/USGS Seabird Status and Trends MMS Outer Continental Shelf Environmental Studies

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 04A

THEME Seabirds	**DISCIPLINE** Seabird Ecology	**QUESTION** Food

Title	Monitor Murres & Kittiwakes (Boat Survey) Puale Bay
Description	This component will support boat-based surveys to collect data during the breeding season on seabird populations The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the NGOA The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove, and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coastal Current (ACC) covers a large enough geographic area to allow comparison of areas of high and low primary productivity and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Murre and kittiwake biology (population size, productivity for kittiwakes only phenology) and diet (adult and chick diet composition)

Frequency	Every 3 years	Where	Alaska Peninsula		
Season	Summer	Lat / Long	57 68 / -155 48	Region	KAP

GOALS	PRODUCTS
Detect	ENSO PDO, anthropogenic impacts, changes in marine food webs
Understand	GOA trophic dynamics, seabird population dynamics
Predict	Climate regime shift GOA trophic dynamics
Inform	State of the Gulf Index, ecosystem status
Solve	Seabird population trends

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 15	$18 3	$18 3	$15 6	$15 6

CONNECTIONS

Cost Partners	USGS (Alaska Biol Sci Center) / USFWS (Alaska Maritime NWR)
Other Partners	MMS (OCSES)
Related GEM Components	Seabird Monitoring (GOA, Cook Inlet, Kodiak, PWS), Forage Fish Monitoring (GOA Cook Inlet Kodiak, PWS)
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design, USFWS/USGS Seabird Status and Trends, MMS Outer Continental Shelf Environmental Studies

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 04B

HEME Seabirds	**DISCIPLINE** Seabird Ecology	**QUESTION** Food

Title	Monitor Murres & Kittiwakes (Boat Survey) Ugaiushak Island
Description	This component will support boat-based surveys to collect data during the breeding season on seabird populations The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside PWS down the Shelikof Strait to the vicinity of King Cove and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coastal Current (ACC), covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Murre and kittiwake biology (population size, productivity for kittiwakes only phenology) and diet (adult and chick diet composition)

Frequency	Every 3 years	Where	Alaska Peninsula		
Season	Summer	Lat / Long	56 78 / -156 85	Region	KAP

GOALS	**PRODUCTS**
Detect	ENSO, PDO, anthropogenic impacts changes in marine food webs
Understand	GOA trophic dynamics seabird population dynamics
Predict	Climate regime shift GOA trophic dynamics
Inform	State of the Gulf Index, ecosystem status
Solve	Seabird population trends

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 15	$18 3	$18 3	$15 6	$15 6

CONNECTIONS

Cost Partners	USGS (Alaska Biol Sci Center) / USFWS (Alaska Maritime NWR)
Other Partners	MMS (OCSES)
Related GEM Components	Seabird Monitoring (GOA, Cook Inlet, Kodiak, PWS), Forage Fish Monitoring (GOA, Cook Inlet, Kodiak, PWS)
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design, USFWS/USGS Seabird Status and Trends MMS Outer Continental Shelf Environmental Studies

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 04C

THEME Seabirds	**DISCIPLINE** Seabird Ecology	**QUESTION** Food

Title Monitor Murres & Kittiwakes (Boat Survey) Chiswell Islands

Description This component will support boat-based surveys to collect data during the breeding season on seabird populations The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove, and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coastal Current (ACC) covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA

Measurement Murre and kittiwake biology (population size, productivity for kittiwakes only, phenology) and diet (adult and chick diet composition)

Frequency	Every 3 years	Where	Chiswell Islands, Resurrection Bay SE Seward		
Season	Summer	Lat / Long	59 67 / -149 67	Region	NGOA

GOALS	PRODUCTS
Detect	ENSO PDO Anthropogenic impacts Changes in marine food webs
Understand	GOA trophic dynamics, Seabird population dynamics
Predict	Climate regime shift GOA trophic dynamics
Inform	State of the Gulf Index Ecosystem status
Solve	Seabird population trends

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 15	$18 3	$18 3	$15 6	$15 6

CONNECTIONS

Cost Partners	USGS (Alaska Biol Sci Center) / USFWS (Alaska Maritime NWR)
Other Partners	MMS (OCSES)
Related GEM Components	Seabird Monitoring (GOA, Cook Inlet, Kodiak, PWS), Forage Fish Monitoring (GOA Cook Inlet, Kodiak, PWS)
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design, USFWS/USGS Seabird Status and Trends, MMS Outer Continental Shelf Environmental Studies

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 05

HEME Nearshore Plants & Animals **DISCIPLINE** Marine Mammals **QUESTION** Interactions Food, Habitat, Removals

Title	Monitor Sea Otter Abundance, Productivity, Survival & Behavior
Description	Sea otters change the species composition and relative abundances of animals and plants in the habitats which they occupy in nearshore marine habitats In conjunction with studies at the Nearshore Benthic Biodiversity Stations (see Component No 1), basic sea otter surveys conducted by management agencies would be supplemented for interpretation of change in these environments
Measurement	Sea otter abundance, distribution and age composition
Frequency	Every year — Where: Cook Inlet PWS, Kenai Fjords, Kodiak/AK Peninsula
Season	TBA — Lat / Long: 60 75 / -148 00 — Region: All

GOALS	PRODUCTS
Detect	Food web changes
Understand	Changes in nearshore ecosystem
Predict	Sea otter population dynamics
Inform	Nearshore ecosystem status, State of Gulf Index
Solve	Health of nearshore

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$120 0	$120 0	$60 0	$60 0

CONNECTIONS

Cost Partners	DOI NOAA, Packard Foundation
Other Partners	
Related GEM Components	
Related Non-GEM Funded Activities	

Projected Start   Projected Completion

Monitoring or Research   Monitoring

GEM Monitoring & Research Plan Component Description

Component No 06

THEME Synthesis **DISCIPLINE** Interdisciplinary **QUESTION** Interactions Food, Hat Removals

Title	Biennial State of the Gulf Symposium
Description	Scientists from Alaska and the world speak to the public on the state of the Gulf of Alaska its climate and ecosystems A scientific keynote speaker selected one to two years in advance through a grant award process describes the State of the Gulf Index (SGI) and how it relates to a biological or geophysical question of understanding ecological change in the speaker's area of specialization GEM supports preparation of the paper in the State of the Gulf Index component A policy keynote speaker talks about challenges in resource management and the degree to which the SGI and its components are helping to meet those challenges Other talks describe GEM monitoring and research Talks are aimed at general audiences with emphasis on graphic visualization of scientific information in a geographic context Scientists meet and exchange technical information in poster sessions and special purpose seminars before and/or after the State of the Gulf presentations for the public
Measurement	Manuscripts, reprints, oral presentations

Frequency Every 2 years Where NA

Season NA Lat / Long NA / NA Region All

GOALS	PRODUCTS
Detect	State of Gulf Index
Understand	Health of the GOA ecosystem
Predict	Impact of changes in GOA
Inform	Symposium proceedings, abstracts and links on web presentations on web
Solve	A policy scorecard

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 00	$50 0	$50 0	$50 0	$50 0

CONNECTIONS

Cost Partners	
Other Partners	Alaska Sea Grant
Related GEM Components	State of the Gulf Index
Related Non-GEM Funded Activities	PICES meeting

Projected Start 10/01/03 Projected Completion

Monitoring or Research Research

GEM Monitoring & Research Plan Component Description

Component No 07

HEME Support Services	**DISCIPLINE** Support Services	**QUESTION** Support Services

Title	Data Management
Description	Data management capabilities are essential in order to serve the purposes of providing integrated and synthesized information to the public, resource managers, industry, and policy makers GEM needs to have data management and linking capabilities that allow all interested people to readily find information relevant to GEM activities and allied programs By the most efficient and economical means available GEM will build a data archive containing long time series of key parameters that describe the health and diversity of the ecosystem in the northern Gulf of Alaska The data archive would be a particularly important source for unpublished data from Restoration and GEM projects that would be accessible for synthesis by concerned scientists and others Information on data management approaches and options will be available from the final report of Restoration Project 00455
Measurement	Web site, text, data metadata

Frequency		Where			
Season		Lat / Long	/	Region	All

GOALS	PRODUCTS
Detect	Support function
Understand	Support function
Predict	Support function
nform	Absolutely essential to success of other informing components
Solve	Support function

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 00	$300 0	$300 0	$300 0	$300 0

CONNECTIONS

Cost Partners	
Other Partners	NOAA DOI USFS ADEC ADF&G
Related GEM Components	All
Related Non-GEM Funded Activities	Restoration Project 00455, PICES

Projected Start 10/01/02 Projected Completion

Monitoring or Research

GEM Monitoring & Research Plan Component Description

Component No 08

THEME Coastal Processes **DISCIPLINE** Physical Geochemical & Chemical Oceanography & Effects of Climate **QUESTION** Interactions Food, Removals

Title	Alaska Coastal Current Deep Station Yakataga
Description	This component will support a bottom mooring to detect changes in physical parameters to be used in understanding the state of the Gulf of Alaska in relation to biological productivity and human use
Measurement	Temperature, salinity, current velocity and direction, sea level (bottom pressure)
Frequency	Every year Where Yakataga
Season	All year Lat / Long 59 50 / -141 75 Region NGOA

GOALS	PRODUCTS
Detect	PDO NPI, SGI
Understand	PDO, NPI, SGI, physical models
Predict	GOA circulation model
Inform	State of the Gulf Index
Solve	TBA

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 00	$115 0	$35 0	$115 0	$35 0

CONNECTIONS

Cost Partners	
Other Partners	NOAA (NOS, NMFS)
Related GEM Components	State of the Gulf Index Gulf of Alaska Coupled Circulation Hydrological Model
Related Non-GEM Funded Activities	GLOBEC FOCI ARGO Drogues GOOS C-GOOS GODAE

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 09

HEME Seabirds	**DISCIPLINE** Seabird Ecology	**QUESTION** Interactions Food, Habitat	

Title	Monitor Kittiwakes Prince William Sound
Description	This component will support monitoring of total population and productivity of all 27 kittiwake colonies in Prince William Sound Annual data input into the Alaska Seabird Colony Catalog database and the Pacific Seabird Monitoring Database
Measurement	A total population count and total productivity of kittiwake colonies in Prince William Sound, clutch size at 10 colonies

Frequency	Every year	Where	Prince William Sound		
Season	Summer	Lat / Long	60 40 / -147 00	Region	PWS

GOALS	**PRODUCTS**
Detect	PDO Food web changes, SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
Inform	Fishery management , State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$10 0	$10 0	$5 0	$5 0

CONNECTIONS

Cost Partners	USGS (Alaska Science Center) USFWS (Alaska Maritime NWR)
Other Partners	MMS OCSES
Related GEM Components	State of the Gulf Index, Northern Cross Projects Monitoring of forage fish and epi-benthic ecosystem, Nearshore forage fish surveys, Seabird colony surveys, Seabird boat surveys
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design USFWS/USGS Seabird Status and Trends, MMS Outer Continental Shelf Environmental Studies

Projected Start 05/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 10A

THEME Coastal Processes **DISCIPLINE** Physical, Geochemical & Chemical Oceanography & Effects of Climate **QUESTION** Interactions Food, Removals

Title	Marine Weather Station Seal River
Description	A surface deployed "deep ocean buoy" with multiple sensors will collect the standard National Weather Service (NWS) observations for navigational stations, will also serve as a platform and mooring for other sensors, surface and deep
Measurement	Air and sea surface temperature wind direction and velocity, wave height others
Frequency	Every year Where Yakataga
Season	All year Lat / Long 59 50 / -141 75 Region NGOA

GOALS	PRODUCTS
Detect	PDO, NPI, SGI
Understand	PDO NPI SGI, physical models
Predict	Weather forecasts, GOA circulation model
Inform	State of the Gulf Index
Solve	Weather conditions public safety

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 75	$150 0	$75 0	$37 5	$18 8

CONNECTIONS

Cost Partners	NWS DOD
Other Partners	U S Coast Guard, NOAA (NOS NMFS) NSF
Related GEM Components	Alaska Coastal Current Deep Station One, weather forecasting, State of the Gulf Index, Gulf of Alaska Coupled Circulation Hydrological Model
Related Non-GEM Funded Activities	NWS forecasts, GLOBEC, FOCI, ARGO Drogues, GOOS, C-GOOS, GODAE

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 10B

HEME Coastal Processes **DISCIPLINE** Physical, Geochemical & Chemical Oceanography & Effects of Climate **QUESTION** Interactions Food, Removals

Title	Marine Weather Station Prince William Sound
Description	A surface deployed "deep ocean buoy" with multiple sensors will collect the standard National Weather Service (NWS) observations for navigational stations, will also serve as a platform and mooring for other sensors surface and deep
Measurement	Air and sea surface temperature wind direction and velocity, wave height, others
Frequency.	Every year Where Prince William Sound
Season	All year Lat / Long 60 00 / -146 75 Region PWS

GOALS	PRODUCTS
Detect	PDO, NPI, SGI
Understand	PDO NPI SGI physical models
Predict	Weather forecasts, PWS circulation model
Inform	State of the Gulf Index
Solve	Weather conditions public safety

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 75	$150 0	$75 0	$37 5	$18 8

CONNECTIONS

Cost Partners	NWS DOD
Other Partners	U S Coast Guard NOAA (NOS NMFS) OSRI
Related GEM Components	Alaska Coastal Current Deep Station One, weather forecasting, State of the Gulf Index, Gulf of Alaska Coupled Circulation Hydrological Model
Related Non-GEM Funded Activities	NWS forecasts GLOBEC FOCI ARGO Drogues, GOOS, C-GOOS, GODAE

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 11A

THEME Coastal Processes **DISCIPLINE** Biological Oceanography **QUESTION** Food

Title	Alaska Coastal Current Montague Canyon Stations
Description	This component will support monitoring to address key questions regarding 1) seasonal and interannual variability in oceanographic structure, nutrients, phytoplankton production, zooplankton assemblages, condition, and production, and 2) how this variability may relate to variations in biological production in Prince William Sound, Cook Inlet, and Kodiak 3) how variations in shelf properties and cross-shelf exchange affect inshore biological productivity, and 4) how 2 and 3 above are linked to physical forcing on a wider geographic scale Productivities inside Prince William Sound Cook Inlet and Kodiak waters are linked to processes on the continental shelf to the east and northeast Renewal of nutrients and planktonic species in the inshore regions largely depends on exchange processes occurring over the shelf and slope Monitoring is essential to understand processes on the shelf and over the slope such as transport of nutrients and carbon, water masses plants and animals and others Such processes regulate the magnitude and pattern of biological productivity across wide areas, ultimately determining the fisheries yield for this region Measurements from nearshore to offshore of productivity and species composition of phytoplankton and zooplankton, macronutrients and micronutrients near the surface and at depths inaccessible to satellite measurements are essential to understanding biological productivity "upstream" of the critically important forage and commercial fish species The marine transect is a time series of observations around which observations from satellites and ships of opportunity may be organized
Measurement	Temperature salinity nutrient content, species composition, exchange of nutrients phytoplankton and zooplankton between offshore and inshore, and distinct biological production processes occurring on the shelf and slope

Frequency	Every 3 years	Where	Montague Island to Middleton Island Area		
Season	Fall	Lat / Long	57 75 / -152 50	Region	PWS NGOA

GOALS	**PRODUCTS**
Detect	Components multiple -- PDO NPI SGI
Understand	PDO NPI SGI physical models
Predict	GOA circulation model
Inform	SGI
Solve	TBA

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 00	$150 0	$150 0	$150 0	$150 0

CONNECTIONS

Cost Partners	
Other Partners	ADF&G NOAA (PMEL NMFS/AFSC)
Related GEM Components	Other ACC stations
Related Non-GEM Funded Activities	GLOBEC GOOS C-GOOS

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 11B

HEME Coastal Processes **DISCIPLINE** Biological Oceanography **QUESTION** Food

Title	Alaska Coastal Current Afognak Stations
Description	This component will support monitoring to address key questions regarding 1) seasonal and interannual variability in oceanographic structure, nutrients, phytoplankton production, zooplankton assemblages, condition, and production, and 2) how this variability may relate to variations in biological production in Prince William Sound, Cook Inlet, and Kodiak, 3) how variations in shelf properties and cross-shelf exchange affect inshore biological productivity, and 4) how 2 and 3 above are linked to physical forcing on a wider geographic scale Productivities inside Prince William Sound, Cook Inlet, and Kodiak waters are linked to processes on the continental shelf to the east and northeast Renewal of nutrients and planktonic species in the inshore regions largely depends on exchange processes occurring over the shelf and slope Monitoring is essential to understand processes on the shelf and over the slope such as transport of nutrients and carbon, water masses, plants and animals and others Such processes regulate the magnitude and pattern of biological productivity across wide areas, ultimately determining the fisheries yield for this region Measurements from nearshore to offshore of productivity and species composition of phytoplankton and zooplankton, macronutrients and micronutrients near the surface and at depths inaccessible to satellite measurements are essential to understanding biological productivity "upstream" of the critically important forage and commercial fish species The marine transect is a time series of observations around which observations from satellites and ships of opportunity may be organized
Measurement	Temperature, salinity, nutrient content, species composition, exchange of nutrients phytoplankton, and zooplankton between offshore and inshore, and distinct biological production processes occurring on the shelf and slope

Frequency	Every 3 years	Where	Afognak to Continental Shelf break		
,eason	Fall	Lat / Long	58 75 / -152 25	Region	KAP, NGOA

GOALS	PRODUCTS
Detect	Components multiple PDO, NPI SGI
Understand	PDO NPI SGI, physical models
Predict	GOA circulation model
Inform	SGI
Solve	TBA

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 00	$150 0	$150 0	$150 0	$150 0

CONNECTIONS

Cost Partners	
Other Partners	ADF&G NOAA (PMEL NMFS/AFSC)
Related GEM Components	Other ACC stations
Related Non-GEM unded Activities	GLOBEC GOOS, C-GOOS

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 11C

THEME Coastal Processes **DISCIPLINE** Physical Geochemical & Chemical Oceanography & Effects of Climate **QUESTION** Interactions Food, Removals

Title	Alaska Coastal Current Seward Stations
Description	This component will support monitoring to address key questions regarding 1) seasonal and interannual variability in oceanographic structure, nutrients, phytoplankton production, zooplankton assemblages condition, and production, and 2) how this variability may relate to variations in biological production in Prince William Sound, Cook Inlet, and Kodiak, 3) how variations in shelf properties and cross-shelf exchange affect inshore biological productivity, and 4) how 2 and 3 above are linked to physical forcing on a wider geographic scale Productivities inside Prince William Sound, Cook Inlet and Kodiak waters are linked to processes on the continental shelf to the east and northeast Renewal of nutrients and planktonic species in the inshore regions largely depends on exchange processes occurring over the shelf and slope Monitoring is essential to understand processes on the shelf and over the slope such as transport of nutrients and carbon, water masses, plants and animals and others Such processes regulate the magnitude and pattern of biological productivity across wide areas, ultimately determining the fisheries yield for this region Measurements from nearshore to offshore of productivity and species composition of phytoplankton and zooplankton, macronutrients and micronutrients near the surface and at depths inaccessible to satellite measurements are essential to understanding biological productivity "upstream" of the critically important forage and commercial fish species The marine transect is a time series of observations around which observations from satellites and ships of opportunity may be organized
Measurement	Temperature, salinity, nutrient content, species composition, inshore/offshore plankton exchange, and distinct biological production processes occurring on the shelf and slope

Frequency	Every 3 years	Where	Resurrection Bay, across shelf		
Season	All year	Lat / Long	59 4 / -149 5	Region	NGOA

GOALS	PRODUCTS
Detect	PDO NPI SGI
Understand	PDO NPI SGI physical models
Predict	GOA circulation model
Inform	State of the Gulf Index
Solve	TBA

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$333 0	$333 0	$166 5	$166 5

CONNECTIONS

Cost Partners	NOAA (NOS NMFS) NSF
Other Partners	UAF
Related GEM Components	State of the Gulf Index Gulf of Alaska Coupled Circulation Hydrological Model
Related Non-GEM Funded Activities	GLOBEC FOCI GOOS GODAE ARGO Drogues GOOS C-GOOS

Projected Start 10/01/04 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 11D

ΗEME Coastal Processes		**DISCIPLINE** Physical, Geochemical & Chemical Oceanography & Effects of Climate		**QUESTION** Interactions Food, Removals	

Title — Alaska Coastal Current Hinchinbrook Stations

Description — This component will support monitoring to address key questions regarding 1) seasonal and interannual variability in oceanographic structure, nutrients, phytoplankton production, zooplankton assemblages, condition, and production and 2) how this variability may relate to variations in biological production in Prince William Sound Cook Inlet, and Kodiak, 3) how variations in shelf properties and cross-shelf exchange affect inshore biological productivity and 4) how 2 and 3 above are linked to physical forcing on a wider geographic scale Productivities inside Prince William Sound Cook Inlet, and Kodiak waters are linked to processes on the continental shelf to the east and northeast Renewal of nutrients and planktonic species in the inshore regions largely depends on exchange processes occurring over the shelf and slope Monitoring is essential to understand processes on the shelf and over the slope such as transport of nutrients and carbon, water masses, plants and animals and others Such processes regulate the magnitude and pattern of biological productivity across wide areas, ultimately determining the fisheries yield for this region Measurements from nearshore to offshore of productivity and species composition of phytoplankton and zooplankton, macronutrients and micronutrients near the surface and at depths inaccessible to satellite measurements are essential to understanding biological productivity "upstream' of the critically important forage and commercial fish species The marine transect is a time series of observations around which observations from satellites and ships of opportunity may be organized

Measurement — Temperature salinity current velocity and direction sea level (bottom pressure)

Frequency	Every year	Where	Hinchinbrook Entrance, across shelf		
Season	All year	Lat / Long	60 3 / -146 75	Region	NGOA

GOALS	**PRODUCTS**
Detect	PDO NPI, SGI
Understand	PDO NPI SGI, physical models
Predict	GOA circulation model
Inform	State of the Gulf Index
Solve	TBA

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$333 0	$333 0	$166 5	$166 5

CONNECTIONS

Cost Partners	OSRI NOAA (NOS NMFS) NSF
Other Partners	UAF
Related GEM Components	State of the Gulf Index Gulf of Alaska Coupled Circulation Hydrological Model
Related Non-GEM Funded Activities	GLOBEC, FOCI ARGO Drogues GOOS C-GOOS

Projected Start 10/01/2004 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 11E

THEME Coastal Processes **DISCIPLINE** Physical, Geochemical & Chemical Oceanography & Effects of Climate **QUESTION** Interactions Food Removals

Title	Alaska Coastal Current Prince William Sound Stations
Description	This component will support monitoring to address key questions regarding 1) seasonal and interannual variability in oceanographic structure, nutrients, phytoplankton production, zooplankton assemblages, condition, and production and 2) how this variability may relate to variations in biological production in Prince William Sound, Cook Inlet, and Kodiak, 3) how variations in shelf properties and cross-shelf exchange affect inshore biological productivity, and 4) how 2 and 3 above are linked to physical forcing on a wider geographic scale Productivities inside Prince William Sound Cook Inlet and Kodiak waters are linked to processes on the continental shelf to the east and northeast Renewal of nutrients and planktonic species in the inshore regions largely depends on exchange processes occurring over the shelf and slope Monitoring is essential to understand processes on the shelf and over the slope such as transport of nutrients and carbon, water masses, plants and animals and others Such processes regulate the magnitude and pattern of biological productivity across wide areas ultimately determining the fisheries yield for this region Measurements from nearshore to offshore of productivity and species composition of phytoplankton and zooplankton macronutrients and micronutrients near the surface and at depths inaccessible to satellite measurements are essential to understanding biological productivity "upstream" of the critically important forage and commercial fish species The marine transect is a time series of observations around which observations from satellites and ships of opportunity may be organized
Measurement	Temperature, salinity current velocity and direction, sea level (bottom pressure)

Frequency	Every 3 years	Where	"Black Hole" to Montague		
Season	All year	Lat / Long	59 6 / -149 5	Region	PWS

GOALS	PRODUCTS
Detect	PDO NPI, SGI
Understand	PDO NPI SGI physical models
Predict	GOA circulation model
Inform	State of the Gulf Index
Solve	TBA

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$333 0	$333 0	$166 5	$166 5

CONNECTIONS

Cost Partners	NOAA (NOS, NMFS) NSF
Other Partners	UAF
Related GEM Components	State of the Gulf Index Gulf of Alaska Coupled Circulation Hydrological Model
Related Non-GEM Funded Activities	GLOBEC FOCI ARGO Drogues GOOS C-GOOS

Projected Start 10/01/04 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 12

HEME Seabirds	**DISCIPLINE** Seabird Ecology	**QUESTION** Interactions Food, Habitat

Title	Monitor Murres & Kittiwakes Chiniak Bay
Description	Count total population and total productivity of kittiwake colonies and total population of murre colonies in Chiniak Bay, Kodiak Island Annual data input into the Alaska Seabird Colony Catalog database and the Pacific Seabird Monitoring Database
Measurement	Kittiwake population and productivity, murre populations
Frequency	Every year — Where: Chiniak Bay, E Kodiak Island
Season	Summer — Lat / Long: 57 50 / -152 00 — Region: KAP

GOALS	**PRODUCTS**
Detect	PDO Food web changes SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles, availability of forage fishes for seabirds and marine mammals
Inform	Fishery management State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$10 0	$10 0	$5 0	$5 0

CONNECTIONS

Cost Partners	USFWS
Other Partners	USGS ADF&G (Herring Surveys)
Related GEM Components	Seabird Monitoring (GOA, Cook Inlet Kodiak PWS) Forage Fish Monitoring (GOA Cook Inlet, Kodiak PWS)
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design USFWS/USGS Seabird Status and Trends, MMS Outer Continental Shelf Environmental Studies ADF&G Herring Surveys

Projected Start 06/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 13

THEME Synthesis **DISCIPLINE** Interdisciplinary **QUESTION** Interactions Food, Hal Removals

Title	State of the Gulf Index
Description	Calculate and publish indicators of the aggregate state of the Gulf of Alaska ecosystem, and status of individual areas of interest such as birds, shellfish, mammals, fish, climate, human use, contaminants Assemble and maintain for the public credible time series of geophysical and biological data indicative of the State of the Gulf (primary) and the states of individual resources and human uses (secondary)
Measurement	Multiple time series geophysical and biological characteristics
Frequency	Every year Where NA
Season	N/A Lat / Long NA / NA Region All

GOALS	PRODUCTS
Detect	State of the Gulf Index
Understand	Key time series State of the Gulf Index
Predict	Key time series
Inform	State of the Gulf Index
Solve	State of the Gulf Index

COST ESTIMATES

Cost Sharing	Start Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$85 0	$85 0	$42 5	$42 5

CONNECTIONS

Cost Partners	ADEC ADF&G DOI, NOAA USFS DNR
Other Partners	
Related GEM Components	Biennial State of the Gulf Symposium (including keynote speaker)
Related Non-GEM Funded Activities	

Projected Start 10/01/02 Projected Completion

Monitoring or Research Research

GEM Monitoring & Research Plan Component Description

Component No 14

HEME Forage Fish	**DISCIPLINE** Marine & Fish Ecology	**QUESTION** Habitat

Title Marine Reserve Network Identification

Description Fishery managers are keenly interested in establishing marine no-take reserves (MRs) as an additional management tool MRs protect biodiversity allow overfished populations to recover, reduce bycatch, protect habitat, reserve a portion of spawning stock biomass protect a portion of the stock from fishery selectivity buffer errors in management actions or stock assessments, and allow separation of the effects of environment and fisheries on fish populations GEM requires a framework for monitoring changes in fish populations Specific activities for this component include

1) Inventory and map nearshore marine habitats from Prince William Sound to Kodiak Island using hydroacoustic surveys (side-scan or multi-beam sonar) and ground-truthing with a remotely operated vehicle (ROV) Initial efforts would be focused on mapping habitats of pelagic and demersal shelf rockfish and lingcod The area mapped would be a function largely of the level of available funding Mapping of benthic habitat could conceivably be conducted concurrent with monitoring of physical oceanographic conditions (salinity temperature)

2) Combine the information from habitat surveys and commercial and recreational landings data to identify potential monitoring sites encompassing a diverse range of habitat types and harvest history Include existing Stellar sea lion rookeries as de-facto harvest refugia

One of the best possible monitoring frameworks is arguably a system of marine reserves Establishment of MRs and monitoring of long-lived species such as rockfishes and lingcod is consistent with the ecosystem approach embraced by GEM It will clearly take many years to acquire and disseminate information needed to design an appropriate reserve system including habitat assessment and inventory physical oceanography distribution and stock structure of fish populations and patterns of larval transport and settling Using GEM funds in conjunction with agency funding to gather this data serves a dual purpose it establishes a framework for GEM monitoring and provides the vehicle for establishing a long-term management strategy for marine species at risk of overharvest

In the long-term monitoring would consist of periodic collection of information on species composition (e g community richness) relative abundance and size and age composition Assessing relative changes in these indicators in many small areas may be more viable than estimating changes over broad areas Methods used could include but not be limited to

1) Standardized scuba surveys (line transect) to assess changes in the shallow water communities (< 30 m) These could provide information on changes in species composition, density, and length composition of pelagic rockfishes lingcod greenlings and other shallow water species Changes in abundance of juvenile rockfish lingcod and other species would be examined in relation to environmental variables such as temperature salinity and upwelling that are collected by other GEM components

2) Standardized longline surveys could be used to survey deeper waters for changes in species composition as well as length and age composition Relative variability in year class strength would be examined in relation to time series of environmental variables

3) Once habitat associations were understood and clusters of suitable habitat mapped, lingcod abundance could be monitored through open model mark-recapture experiments in defined areas Lingcod can effectively be captured and tagged using jig and dingle bar gear with limited bycatch It may also be possible to examine food habits of these large predators and relate changes in diet to relative changes in abundance of prey species

Measurement Define biological and geophysical characteristics of marine reserves

Frequency — Where PWS Kenai Peninsula Cook Inlet Kodiak/AK Peninsula

Season — Lat / Long 56 40 / 154 5 Region All

GOALS	PRODUCTS
Detect	Component separation of changes due to environmental effects and changes due to fishery effects
Understand	Effects of fisheries on marine ecosystem

GEM Monitoring & Research Plan Component Description

Predict	Effects of fisheries on marine ecosystem
Inform	Fishery management SGI
Solve	Harvest management tools, managing fisheries for long-term sustained yield

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 67	$100 0	$100 0	$33 0	$33 0

CONNECTIONS

Cost Partners	ADF&G, OSRI, NMFS, Packard, Pew Charitable Trust
Other Partners	PWSSC NOAA/NURP
Related GEM Components	Nearshore Benthic Biodiversity Stations Kenai Fjords, PWS and Cook Inlet, Rockfish and Lingcod as Sentinel Species in Marine Reserves
Related Non-GEM Funded Activities	Magnuson-Stevens habitat definitions, Alaska Board of Fisheries regulatory actions, C-GOOS (CONNS)

Projected Start 10/01/02 Projected Completion 9/30/2007

Monitoring or Research Research

GEM Monitoring & Research Plan Component Description

Component No 15

HEME Forage Fish	**DISCIPLINE** Marine & Fish Ecology	**QUESTION** Interactions Habitat, Removals

Title	Nearshore Rockfish & Lingcod as Sentinel Species for Marine Reserves
Description	Rockfish and lingcod are long-lived marine species with individuals and populations that integrate environmental conditions within fixed areas over long periods of time The marine reserve approach to conservation of marine resources is especially appropriate for nearshore rockfish stocks in the northern Gulf of Alaska This component will develop a monitoring program for rockfish that includes stock assessment techniques including fishery-independent surveys to index relative abundance Activities will include 1) Increased sampling of commercial and recreational harvests for genetic differentiation if warranted Current genetic studies are comparing broad areas, but if differences are found, more intensive sampling along boundaries would be useful 2) In situ tagging of yelloweye and other demersal species with sonic tags to examine short and long-term movements of adults among identified clusters of habitat 3) Investigation of decompression injury and survival of demersal rockfishes as a function of depth of capture and handling and release methods Limited work done so far indicates ranges of depth that are suitable for capture with minimal mortality In addition, there are at least three handling and release methods that show promise in reducing the mortality of released fish, but they have not been rigorously investigated Knowledge gained from such an experiment would reduce bycatch mortality in fisheries and could increase the success of tagging and other assessment programs Analysis of project data and interpretation of existing data will be applied to the task of establishing marine reserves in Prince William Sound and the outer Kenai Peninsula for application to all areas in the northern Gulf of Alaska

Measurement	Metrics of rockfish abundance and age structure				
requency	Every year	Where	PWS outer Kenai Peninsula		
Season	All year	Lat / Long	60 00 / -149 25	Region	PWS, NGOA

GOALS	**PRODUCTS**
Detect	Component
Understand	Nearshore ecosystem
Predict	GOA trophic dynamics
Inform	Ecosystem status
Solve	Fishery management, SGI

COST ESTIMATES

Cost Sharing	Start Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$100 0	$100 0	$50 0	$50 0

CONNECTIONS

Cost Partners	OSRI ADF&G Packard
Other Partners	NMFS PWSSC
Related GEM Components	Nearshore Benthic Biodiversity Stations Kenai Fjords PWS and Cook Inlet Marine Reserve Network Identification
Related Non-GEM Funded Activities	Magnuson Stevens habitat definitions Alaska Board of Fisheries regulatory actions C GOOS (CONNS)

Projected Start 10/01/02 Projected Completion

Monitoring or Research Research

GEM Monitoring & Research Plan Component Description

Component No 16

THEME Seabirds	**DISCIPLINE** Seabird Ecology	**QUESTION** Food

Title	Database Management for Gulf of Alaska Seabirds
Description	Annual data input into the Alaska Seabird Colony Catalog database and the Pacific Seabird Monitoring Database, to be made available on the Internet for the public to use Manage the Seabird Colony Catalog and the Pacific Seabird Monitoring Database for all data collected by the Gulf of Alaska seabird monitoring components for Gulf of Alaska, Cook Inlet, Kodiak, and Prince William Sound
Measurement	Seabird Colony Catalog, Pacific Seabird Monitoring Database
Frequency	Every year Where
Season	Lat / Long / Region All

GOALS	**PRODUCTS**
Detect	ENSO, PDO, anthropogenic impacts, changes in marine food webs, food stress, seabird population trends
Understand	GOA trophic dynamics, seabird population dynamics
Predict	Climate regime shift, GOA trophic dynamics
Inform	State of the Gulf Index, ecosystem status
Solve	Seabirds are indicators of marine ecosystem health

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Ann
0 90	$120 0	$120 0	$12 0	$12 0

CONNECTIONS

Cost Partners	USGS (Alaska Biol Sci Center) / USFWS (Alaska Maritime NWR)
Other Partners	MMS (OCSES)
Related GEM Components	Seabird Monitoring (GOA, Cook Inlet Kodiak PWS), Forage Fish Monitoring (GOA, Cook Inlet Kodiak PWS)
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design USFWS/USGS Seabird Status and Trends MMS Outer Continental Shelf Environmental Studies

Projected Start 10/01/02   Projected Completion

Monitoring or Research   Monitoring

GEM Monitoring & Research Plan Component Description

Component No 17A

HEME Synthesis	**DISCIPLINE** Interdisciplinary	**QUESTION** Interactions Food, Habitat, Removals

Title	Forage Fish Synthesis
Description	Periodic award to relate geophysical measures to biological data relevant to forage fish theme by statistical correlative analyses, or through deterministic numerical modeling,or both Critique of present forage fish monitoring programs and recommendations for improvements Present paper at the State of the Gulf Symposium and publish in peer-reviewed journal One of five awards in the following themes (see related components) Forage fish Seabirds Nearshore plants and animals Terrestrial linkages Coastal processes
Measurement	Manuscripts, reprints, oral presentations
Frequency	Every 2 years Where NA
Season	NA Lat / Long NA / NA Region All

GOALS	**PRODUCTS**
Detect	Changes in forage fish, primary productivity in GOA ecosystem
Understand	Links to PDO and upwelling, status of GOA ecosystem
Predict	Impact of physical change in fish and GOA marine ecosystem
nform	Symposium proceedings, abstracts and links on web presentations on web
Solve	A policy scorecard SGI, fishery management

COST ESTIMATES

Cost Sharing	Start Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 00	$50 0	$50 0	$50 0	$50 0

CONNECTIONS

Cost Partners	
Other Partners	
Related GEM Components	State of the Gulf Index, State of the Gulf Symposium, other Synthesis Components (harbor seal, seabirds sea otter, terrestrial linkages)
Related Non-GEM Funded Activities	PICES meeting

Projected Start 10/01/03   Projected Completion

Monitoring or Research   Research

GEM Monitoring & Research Plan Component Description

Component No 17B

THEME Synthesis **DISCIPLINE** Interdisciplinary **QUESTION** Interactions Food, Hab Removals

Title	Seabird Synthesis
Description	Periodic award to relate geophysical measures to biological data relevant to seabird theme by statistical correlative analyses, or through deterministic numerical modeling or both Critique of present seabird monitoring programs and recommendations for improvements Present paper at the State of the Gulf Symposium and publish in peer reviewed journal One of five awards in the following themes Forage fish Seabird Nearshore plants and animals Terrestrial linkages Coastal processes
Measurement	Manuscripts, reprints, oral presentations
Frequency	Every 2 years Where NA
Season	NA Lat / Long NA / NA Region All

GOALS	PRODUCTS
Detect	Change in GOA ecosystem
Understand	Links to PDO and climate change status of GOA ecosystem
Predict	Impact of change in GOA marine ecosystem
Inform	Symposium proceedings abstracts and links on web, presentations on web
Solve	A policy scorecard SGI causes of change in GOA ecosystem

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 00	$50 0	$50 0	$50 0	$50 0

CONNECTIONS

Cost Partners	
Other Partners	
Related GEM Components	State of the Gulf Index, State of the Gulf Symposium
Related Non-GEM Funded Activities	PICES meeting

Projected Start 10/01/03 Projected Completion

Monitoring or Research Research

GEM Monitoring & Research Plan Component Description

Component No 17C

HEME Synthesis	**DISCIPLINE** Interdisciplinary	**QUESTION** Interactions Food, Habitat, Removals

Title	Nearshore Plants & Animals Synthesis
Description	Periodic award to relate geophysical measures to biological data relevant to nearshore plants and animals theme by statistical correlative analyses, or through deterministic numerical modeling, or both Critique of present nearshore monitoring programs and recommendations for improvements Present paper at the State of the Gulf Symposium and publish in peer-reviewed journal One of five awards in the following themes Forage fish Seabird Nearshore plants and animals Terrestrial linkages Coastal processes
Measurement	Manuscripts reprints oral presentations

Frequency	Every 2 years	Where	NA		
Season	NA	Lat / Long	NA / NA	Region	All

GOALS	**PRODUCTS**
Detect	Change in nearshore environment
Understand	Link to marine processes, status of GOA ecosystem
Predict	Effects of change on nearshore resources
Inform	Symposium proceedings, abstracts and links on web, presentations on web
Solve	A policy scorecard SGI management applications

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 00	$50 0	$50 0	$50 0	$50 0

CONNECTIONS

Cost Partners	
Other Partners	
Related GEM Components	State of the Gulf Index, State of the Gulf Symposium
Related Non-GEM Funded Activities	PICES meeting

Projected Start 10/01/03 Projected Completion

Monitoring or Research Research

GEM Monitoring & Research Plan Component Description

Component No 17D

THEME Synthesis **DISCIPLINE** Interdisciplinary **QUESTION** Interactions Food, Habi Removals

Title	Terrestrial Linkages Synthesis
Description	Periodic award to relate geophysical measures to biological data relevant to terrestrial linkages theme by statistical correlative analyses, or through deterministic numerical modeling, or both Critique of present terrestrial linkages monitoring programs and recommendations for improvements Present paper at the State of the Gulf Symposium and publish in peer reviewed journal One of five awards in the following themes Forage fish Seabird Nearshore plants and animals Terrestrial linkages Coastal processes
Measurement	Manuscripts reprints, oral presentations
Frequency	Every 2 years Where NA
Season	NA Lat / Long NA / NA Region All

GOALS	PRODUCTS
Detect	Change in coastal environment of NGOA
Understand	Interaction of marine and terrestrial systems with coastal environment
Predict	Impact of change in GOA
Inform	Symposium proceedings abstracts and links on web presentations on web
Solve	A policy scorecard SGI

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 00	$50 0	$50 0	$50 0	$50 0

CONNECTIONS

Cost Partners	
Other Partners	
Related GEM Components	State of the Gulf Index State of the Gulf Symposium
Related Non-GEM Funded Activities	PICES meeting

Projected Start 10/01/03 Projected Completion

Monitoring or Research Research

GEM Monitoring & Research Plan Component Description

Component No **17E**

HEME Synthesis **DISCIPLINE** Interdisciplinary **QUESTION** Interactions Food Habitat, Removals

Title	Coastal Processes Synthesis
Description	Periodic award to relate geophysical measures to biological data relevant to coastal processes theme by statistical correlative analyses, or through deterministic numerical modeling, or both Critique of present coastal processes monitoring programs and recommendations for improvements Present paper at the State of the Gulf Symposium and publish in peer-reviewed journal One of five awards in the following themes (see related components) Forage fish Seabirds Nearshore plants and animals Terrestrial linkages Coastal processes
Measurement	Manuscripts, reprints, oral presentations
Frequency	Every 2 years Where NA
Season	NA Lat / Long NA / NA Region All

GOALS	PRODUCTS
Detect	Changes in coastal processes
Understand	Effects of geophysical changes on biological resources
Predict	Climate regime shift
nform	Symposium proceedings, abstracts and links on web presentations on web
Solve	A policy scorecard

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 00	$50 0	$50 0	$50 0	$50 0

CONNECTIONS

Cost Partners	
Other Partners	
Related GEM Components	State of the Gulf Index State of the Gulf Symposium, other Synthesis Components (harbor seal, seabirds, sea otter, terrestrial linkages)
Related Non-GEM Funded Activities	PICES meeting

Projected Start 10/01/03   Projected Completion

Monitoring or Research   Research

GEM Monitoring & Research Plan Component Description

Component No 18

THEME	Terrestrial Linkages	**DISCIPLINE**	Physical, Geochemical & Chemical Oceanography & Effects of Climate	**QUESTION**	Interactions Habitat, Removals

Title	Marine Contributions to Terrestrial Productivity
Description	Measure the input of marine nitrogen in freshwater plants and animals and riparian zone plants and animals from samples to be taken in conjunction with water quality and biological samples collected for other programs Inputs of marine nutrients to some drainages are important determinants of productivity for many plant and animal species, including ecologically, culturally and commercially important species such as salmon, bald eagle, and brown bear Strong environmental signals such as the Pacific Decadal Oscillation (PDO) and El Nino Southern Oscillation (ENSO) may be reflected in the annual fluctuations of the amount of marine nitrogen relative to its freshwater counterpart Changes in the productivities of individual resources, such as salmon, may be reflected in the ratios of marine to terrestrial nitrogen in the bodies of individuals Aggregated ratios across species may provide an index to the productivity of the watershed that could be used by resource managers
Measurement	Stable isotopes of nitrogen in freshwater plants and animals, contaminants, water quality

Frequency	Every year	Where	PWS, CI, Kodiak/AK Peninsula, outer Kenai Peninsula		
Season	Summer/Fall	Lat / Long	60 5 / -151 00	Region	All

GOALS	**PRODUCTS**
Detect	Changes in productivity
Understand	Relation of marine inputs to terrestrial productivities
Predict	Changes in productivity
Inform	Fihery riparian zone, land management actions
Solve	Measure of effectiveness of anadromous fish management

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 25	$50 0	$50 0	$37 5	$37 5

CONNECTIONS

Cost Partners	Cook Inlet Keeper, ADEC, EPA, USGS, USFS
Other Partners	ADNR
Related GEM Components	Monitoring Vegetation Responses to Recreational and Natural Disturbances, State of the Gulf Index
Related Non GEM Funded Activities	EMAP, ADEC surveys, USGS surveys

Projected Start 10/01/02 Projected Completion 10/1/2007

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 19

HEME Support Services **DISCIPLINE** Support Services **QUESTION** Support Services

Title	Web-based & Other Communications
Description	The draft GEM Science Program (April 2000) cites a GEM website as a major tool for disseminating data and interpreted and synthesized results from GEM to the public, stakeholders, and the greater scientific community This website could be along the lines of the Bering Sea and North Pacific Ocean Theme Page which is maintained by NOAA The site could provide access to GEM databases and other products (e g metadata and bibliographies of reports and publications), as well as present and discuss research results, program information and evolving insights about the northern Gulf of Alaska marine ecosystem Another example of an effective tool for facilitating exchange of data and research is the North Pacific Marine Science Organization (PICES) web site This component would also fund other, non-web based communication activities essential to serving the needs of GEM activities and constituents, such as a newsletter or special publications
Measurement	Web site and content including hardware and software, publications
Frequency	Where
Season	Lat / Long / Region All

GOALS	**PRODUCTS**
Detect	PDO food web changes, State of the Gulf Index
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
'nform	Fishery management State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 00	$75 0	$75 0	$75 0	$75 0

CONNECTIONS

Cost Partners	
Other Partners	ADEC NMFS, USFWS, USGS USFS, ADF&G
Related GEM Components	All components
Related Non-GEM Funded Activities	Too numerous to list

Projected Start 10/01/02 Projected Completion

Monitoring or Research

GEM Monitoring & Research Plan Component Description

Component No 20

THEME Seabirds	**DISCIPLINE** Seabird Ecology	**QUESTION** Food

Title	Seabird Monitoring (Multiple Species) Middleton Island
Description	Monitor populations productivity survival and food habits of 6 species (black-legged kittiwake, common murre pelagic cormorant, tufted puffin, rhinoceros auklet, and glaucous-winged gull) Middleton Island is strategically located to sample the Alaska Stream near the outer edge of the continental shelf in the northern Gulf of Alaska Observations from as early as 1956 and regular monitoring since the mid 1970's provide some of the longest and most complete time series available for any seabird colony in Alaska Unique infrastructure on the island enables manipulations and data collection possible nowhere else This component will measure 1) populations and productivity of kittiwakes murres puffins, gulls, cormorants, and auklets, 2) annual survival of kittiwakes and cormorants and 3) diet information for kittiwakes gulls, cormorants, puffins and auklets Kittiwakes and cormorants will be observed at specially constructed nesting ledges on the sides of an abandoned radar tower Supplemental feeding will provide sensitive indices of natural food availability both between and within years Artificial and accessible habitats for murres, puffins and auklets are also under development Corticosterone and other blood chemistry will be used to monitor health and nutritional status Food deliveries to nestling tufted puffins and rhinoceros auklets will be used to monitor changes in the forage fish community on the outer shelf
Measurement	Populations and productivity of kittiwakes murres, puffins gulls cormorants and auklets, annual survival of kittiwakes and cormorants diet information for kittiwakes gulls cormorants puffins and auklets

Frequency	Every year	Where	Middleton Island		
Season	Apr Sept	Lat / Long	59 44 / -146 33	Region	NGOA

GOALS	PRODUCTS
Detect	Component ENSO PDO anthropogenic impacts changes in marine food webs food stress
Understand	GOA trophic dynamics seabird population dynamics
Predict	Climate regime shift GOA trophic dynamics
Inform	State of the Gulf Index ecosystem status
Solve	Seabirds are indicators of marine ecosystem health

COST ESTIMATES

Cost Sharing	Start Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 75	$180 0	$180 0	$45 0	$45 0

CONNECTIONS

Cost Partners	USGS (Alaska Biol Sci Center)
Other Partners	MMS USFWS (Alaska Maritime NWR)
Related GEM Components	Seabird Monitoring (GOA Cook Inlet Kodiak PWS) Forage Fish Monitoring (GOA Cook Inlet Kodiak PWS)
Related Non GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design USFWS/USGS Seabird Status and Trends MMS Outer Continental Shelf Environmental Studies

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 21

HEME Seabirds	**DISCIPLINE** Seabird Ecology	**QUESTION** Interactions Food, Habitat

Title Seabird Monitoring (Multiple Species) Forrester Island

Description Forrester Island (with two small adjacent islands, Petrel and Lowrie) is the main center of diversity and abundance for colonial seabirds in southeastern Alaska supporting more than 1 million individuals of 12 species This location affords the opportunity to monitor several burrow-nesting species that are otherwise under-represented in seabird monitoring efforts in the Gulf of Alaska Prior work at Forrester is minimal Monitoring will include field measurements made over a period of 1-2 months from mid-June to mid-August, emphasizing production indices from permanent plots of six species Food deliveries to nestling tufted puffins and rhinoceros auklets will be used to monitor changes in the forage fish community near the upstream end of the Alaska Coastal Current system Forrester I (54 95, -133 54), Petrel I (54 90, -133 55)

Measurement Numbers, productivity and/or food habits of tufted puffin, fork-tailed & Leach's storm-petrels, Cassin's auklet ancient murrelet, and rhinoceros auklet, including some food deliveries

Frequency	Every year	Where	Forrester Island		
Season	Summer	Lat / Long	54 95 / -133 54	Region	NGOA

GOALS	PRODUCTS
Detect	PDO Food web changes, SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
Inform	Fishery management , State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$60 0	$60 0	$30 0	$30 0

CONNECTIONS

Cost Partners	USGS (Alaska Science Center) USFWS (Alaska Maritime NWR)
Other Partners	MMS OCSES
Related GEM Components	State of the Gulf Index Northern Cross Projects Monitoring of forage fish and epi-benthic ecosystem Nearshore forage fish surveys, Seabird colony surveys, Seabird boat surveys
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design, CCAMLR NMML UAF CIK KBNERR

Projected Start 05/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 22

THEME Seabirds	**DISCIPLINE** Seabird Ecology	**QUESTION** Interactions Food, Hal

Title	Seabird Monitoring (Multiple Species) Semidi Islands
Description	The Semidi Islands support the greatest diversity and abundance of breeding seabirds (2-3 million birds of 20 species) found anywhere in the Gulf of Alaska Studies conducted in 18 years between 1976 and 1998 provide some of the longest and most detailed time series available for any location in Alaska Because of the importance of the Semidis to North Pacific seabird populations the relative accessibility of many species for observation, and the quality of historical data, this site is targeted for annual visits in the monitoring plan for the Alaska Maritime National Wildlife Refuge That level of effort has not been achieved, however, due to insufficient funding This component will monitor populations, productivity, and food habits of cliff-nesting seabirds (common and thick-billed murres, black-legged kittiwakes, northern fulmars) and selected burrow/crevice nesters (horned and tufted puffins fork-tailed and Leach s storm-petrels, Cassin's auklet, ancient murrelet) Base camp (Chowiet Island) will be occupied for approximately four months, May-August Satellite operations on neighboring islands (Suklik, Kaliktigik, Kateekuk) will be conducted seasonally Standard protocols and permanent plots established in prior years will be used Food deliveries to nestling tufted puffins and rhinoceros auklets will be used to monitor changes in the forage fish community in the vicinity of the Semidi Islands

Measurement	Populations, productivity and food habits of cliff-nesting seabirds				
Frequency	Every year	Where	Semidi Islands		
Season	Summer	Lat / Long	56 03 / -156 73	Region	KAP

GOALS	PRODUCTS
Detect	PDO food web changes SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles, availability of forage fishes for seabirds and marine mammals
Inform	Fishery management State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$80 0	$80 0	$40 0	$40 0

CONNECTIONS

Cost Partners	USGS (Alaska Science Center) USFWS (Alaska Maritime NWR)
Other Partners	
Related GEM Components	Seabird Monitoring (GOA Cook Inlet Kodiak, PWS) Forage Fish Monitoring (GOA Cook Inlet Kodiak, PWS)
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design USFWS/USGS Seabird Status and Trends MMS Outer Continental Shelf Environmental Studies, ADF&G Herring Surveys

Projected Start 06/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 23

HEME Forage Fish **DISCIPLINE** Marine Mammals **QUESTION** Interactions Food, Habitat, Removals

Title	Harbor Seal Abundance				
Description	Harbor seals undergo long term fluctations in abundance in response to factors currently poorly understood, such as predation, harvest (removals), and availability of food, including through competition from fisheries and other species Determination of the role of potentially fluctuating food items such as forage fish species, and removals by subsistence harvest would supplement regular agency monitoring of harbor seals				
Measurement	Harbor seal abundance distribution and age composition				
Frequency	Every year	Where	PWS Cook Inlet, Kodiak, Tudgidak Island		
Season	TBA	Lat / Long	60 3 / -147 80	Region	All

GOALS	PRODUCTS
Detect	Changes in harbor seal populations
Understand	Cause of these changes impact of changes in forage fish and subsistence harvest
Predict	Impact of natural and human induced changes on harbor seal population
Inform	Survival model, SGI
Solve	Improve management actions, regulations

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 90	$200 0	$200 0	$20 0	$20 0

CONNECTIONS

Cost Partners	DOI NOAA (NMML) Packard
Other Partners	ADF&G
Related GEM Components	Nearshore Rockfish and Lingcod as Sentinel Species for Marine Reserves, Marine Reserve Network Identification
Related Non-GEM Funded Activities	Restoration Project 00509 Harbor Seal Experimental Design

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 24A

THEME Forage Fish **DISCIPLINE** Marine & Fish Ecology **QUESTION** Interactions Food, Habi

Title	Monitor Forage Fish & Epi-benthic Ecosystem Chiniak
Description	This component will support an annual small-meshed (shrimp) bottom trawl survey to monitor the benthic and epi-benthic components of the ecosystem occupying stations that have been sampled since the early 1970s CTD casts will be taken at all trawl sites to link oceanic parameters with natural dynamics of the Gulf of Alaska fish community The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA runs both perpendicular and parallel to the Alaska Coastal Current (ACC) covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Species composition abundance and distribution of nekton, temperature, salinity

Frequency	Every year	Where	Chiniak Bay E-SE Kodiak Island		
Season	Summer	Lat / Long	57 75 / -152 33	Region	KAP

GOALS	PRODUCTS
Detect	PDO food web changes SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
Inform	Fishery management State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 33	$120 0	$80 0	$80 4	$53 6

CONNECTIONS

Cost Partners	NMFS (Kodiak) USGS (Alaska Biol Sci Ctr), ADF&G
Other Partners	KBNERR, NPFMC
Related GEM Components	State of the Gulf Index, Northern Cross Projects Mid-water trawl forage fish surveys Nearshore forage fish surveys Seabird colony surveys, Seabird boat surveys
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design GLOBEC FOCI, CCAMLR NMML, UAF

Projected Start 05/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 24B

THEME Forage Fish	DISCIPLINE Marine & Fish Ecology	QUESTION Interactions Food, Habitat

Title	Monitor Forage Fish & Epi-benthic Ecosystem Kachemak Bay
Description	This component will support an annual small-meshed (shrimp) bottom trawl survey to monitor the benthic and epi-benthic components of the ecosystem, occupying stations that have been sampled since the early 1970s CTD casts will be taken at all trawl sites to link oceanic parameters with natural dynamics of the Gulf of Alaska fish community The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove, and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coastal Current (ACC), covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Species composition abundance and distribution of nekton, temperature, salinity

Frequency	Every year	Where	Kachemak Bay S Homer		
Season	Summer	Lat / Long	59 50 / -151 67	Region	CI

GOALS	PRODUCTS
Detect	PDO, food web changes, SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
Inform	Fishery management, State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 33	$120 0	$80 0	$80 4	$53 6

CONNECTIONS

Cost Partners	NMFS (Kodiak), USGS (Alaska Biol Sci Ctr), ADF&G
Other Partners	KBNERR, NPFMC
Related GEM Components	State of the Gulf Index, Northern Cross Components Mid-water trawl forage fish surveys Nearshore forage fish surveys, Seabird colony surveys, Seabird boat surveys
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design GLOBEC, FOCI, CCAMLR NMML, UAF

Projected Start 05/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 24C

THEME Forage Fish **DISCIPLINE** Marine & Fish Ecology **QUESTION** Interactions Food, Hat

Title	Monitor Forage Fish & Epi-benthic Ecosystem Chignik Bay
Description	This component will support an annual small-meshed (shrimp) bottom trawl survey to monitor the benthic and epi-benthic components of the ecosystem, occupying stations that have been sampled since the early 1970s CTD casts will be taken at all trawl sites to link oceanic parameters with natural dynamics of the Gulf of Alaska fish community The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove, and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA runs both perpendicular and parallel to the Alaska Coastal Current (ACC) covers a large enough geographic area to allow comparison of areas of high and low primary productivity and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Species composition abundance and distribution of nekton, temperature, salinity

Frequency	Every year	Where	Chignik Bay SW Kodiak		
Season	Summer	Lat / Long	56 42 / -158 33	Region	KAP

GOALS	PRODUCTS
Detect	PDO food web changes SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
Inform	Fishery management State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 33	$120 0	$80 0	$80 4	$53 6

CONNECTIONS

Cost Partners	NMFS (Kodiak) USGS (Alaska Sci Ctr) ADF&G
Other Partners	KBNERR, NPFMC
Related GEM Components	State of the Gulf Index, Northern Cross Components Mid-water trawl forage fish surveys, Nearshore forage fish surveys Seabird colony surveys, Seabird boat surveys
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design GLOBEC FOCI CCAMLR, NMML UAF

Projected Start 05/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 24D

HEME Forage Fish **DISCIPLINE** Marine & Fish Ecology **QUESTION** Interactions Food, Habitat

Title	Monitor Forage Fish & Epi-benthic Ecosystem Pavlof Bay
Description	This component will support an annual small-meshed (shrimp) bottom trawl survey to monitor the benthic and epi-benthic components of the ecosystem, occupying stations that have been sampled since the early 1970s CTD casts will be taken at all trawl sites to link oceanic parameters with natural dynamics of the Gulf of Alaska fish community The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove, and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coastal Current (ACC) covers a large enough geographic area to allow comparison of areas of high and low primary productivity and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Species composition, abundance and distribution of nekton, temperature, salinity

Frequency	Every year	Where	Pavlof Bay NW King Cove		
Season	Summer	Lat / Long	55 50 / -161 6	Region	KAP

GOALS	PRODUCTS
Detect	PDO food web changes, SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
Inform	Fishery management State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 33	$120 0	$80 0	$80 4	$53 6

CONNECTIONS

Cost Partners	NMFS (Kodiak), USGS (Alaska Biol Sci Ctr) ADF&G
Other Partners	KBNERR, NPFMC
Related GEM Components	State of the Gulf Index, Northern Cross Components Mid-water trawl forage fish surveys, Nearshore forage fish surveys, Seabird colony surveys, Seabird boat surveys
Related Non GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design GLOBEC FOCI, CCAMLR NMML UAF

Projected Start 05/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 25

THEME Coastal Processes **DISCIPLINE** Physical Geochemical & Chemical Oceanography & Effects of Climate **QUESTION** Interactions Food, Removals

Title	Satellite Monitoring Gulf of Alaska Surface Conditions
Description	Synthesize and make available satellite monitoring of Gulf of Alaska sea surface temperature chlorophyll and other parameters Information will be used in understanding the state of the Gulf of Alaska in relation to biological productivity and human use
Measurement	Temperature, chlorophyll a, sea color, eddy detection, sea level
Frequency	Every year Where Northern GOA
Season	All year Lat / Long / Region NGOA

GOALS	PRODUCTS
Detect	PDO, NPI, SGI
Understand	PDO, NPI, SGI, physical models, biological production
Predict	GOA Circulation model
Inform	State of the Gulf Index
Solve	TBA

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 00	$115 0	$35 0	$115 0	$35 0

CONNECTIONS

Cost Partners	
Other Partners	NOAA (NOS, NMFS), NASA, NSF
Related GEM Components	State of the Gulf Index, Gulf of Alaska Coupled Circulation Hydrological Model
Related Non-GEM Funded Activities	NEMO, MERIS, SeaWiFS GLI, MODIS, GLOBEC, FOCI, ARGO Drogues, GOOS C-GOOS

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 26

-IEME Support Services **DISCIPLINE** Support Services **QUESTION** Support Services

Title	Scientific Advice, Peer Review & Collaboration
Description	The draft GEM Science Program (April 2000) describes independent peer review as an essential feature of the GEM program Although details have not yet been worked out, there will be an external *ad hoc* technical review process, the primary purpose of which will be to provide rigorous peer review of the scientific merits of all monitoring and research proposals and selected reports In addition, from time to time, special review panels will be convened to evaluate and make recommendations on various aspects of the program Periodic review by an outside entity, such as the National Research Council also may be appropriate Some reviews will be sought on a voluntary basis, however, some costs are expected The numbers shown here are preliminary estimates An additional important feature of GEM is coordination and collaboration with other organizations Costs in this component will include some of the costs of this collaboration, such as co-sponsorship of workshops

Measurement

Frequency Where

Season Lat / Long / Region All

GOALS **PRODUCTS**

Detect

Jnderstand

Predict

Inform

Solve

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 00	$100 0	$100 0	$100 0	$100 0

CONNECTIONS

Cost Partners

Other Partners

Related GEM Components

Related Non-GEM Funded Activities

Projected Start 10/1/02 Projected Completion

Monitoring or Research

GEM Monitoring & Research Plan Component Description

Component No 27

THEME Seabirds **DISCIPLINE** Seabird Ecology **QUESTION** Removals

Title	Analysis of Seabird Interactions with Fisheries in the Gulf of Alaska
Description	Synthesize data on seabird distribution, foraging range, and diet in the Gulf of Alaska with fisheries allocations and bycatch records Products will assist allocation decisions, and predict and test effects of fisheries allocations on seabird populations Spatial and temporal overlap between fisheries prey resources, and seabirds will require GIS and modeling components As a part of the overall GEM approach, this component will focus on producing maps, references and models directly available to managers It will also identify data gaps that might be addressed by GEM monitoring components Estimates of resource needs and predictions under different natural and anthropogenic schemes will be refined periodically Products will provide information on optimum and minimal biomass species composition and distribution properties of seabird prey for both summer and winter Fisheries managers increasingly are expected to consider impacts on non-target species in determination of fish allocation and minimizing bycatch, but often lack the data to make informed decisions A prototype model of trophic mass-balance was developed for Prince William Sound following the oil spill, but there is no model or database that specifically incorporates information on seabirds in relation to exploitation activities in the Gulf of Alaska Monitoring components can provide data on seabird foraging range, habitat, diet productivity, and population trends This component would use the seabird data in conjunction with fisheries data to identify areas and times of potential conflict quantify prey resource requirements for seabirds of specific areas and predict impacts on seabirds due to fisheries
Measurement	None (use existing data)
Frequency	Every 2 years Where
Season	Lat / Long / Region All

GOALS	PRODUCTS
Detect	Anthropogenic impacts, changes in marine food webs food stress
Understand	GOA trophic dynamics seabird population dynamics
Predict	Impact of fisheries, fishery management decisions, GOA trophic dynamics
Inform	State of the Gulf index, ecosystem status
Solve	Factors influencing seabird population trends

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$30 0	$15 0	$15 0	$7 5

CONNECTIONS

Cost Partners	USFWS (MBM) NPFMC
Other Partners	ADF&G USGS NMFS (AR AFSC)
Related GEM Components	Seabird monitoring forage fish monitoring
Related Non GEM Funded Activities	USFWS/USGS Seabird Status and Trends MMS Outer Continental Shelf Environmental Studies NOAA Plan Teams

Projected Start 1/01/02 Projected Completion

Monitoring or Research Research

GEM Monitoring & Research Plan Component Description

Component No 28A

HEME Forage Fish **DISCIPLINE** Marine & Fish Ecology **QUESTION** Interactions Food, Habitat

Title	Mid-water Trawl Forage Fish Surveys Chisik Island
Description	This component will support an annual mid-water trawl survey within 40 km (foraging range) of main seabird colonies in lower Cook Inlet and the Gulf of Alaska in conjunction with CTD casts and zooplankton tows This is the best method for sampling sand lance, herring, capelin and juvenile pollock Abundance and species composition of pelagic forage fish will be measured Historical surveys were conducted from 1995-1999, and continued monitoring of the forage fish community will detect food web changes in collaboration with seabird monitoring in the area The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coatal Current (ACC), covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Abundance, species composition, length, weight, and energetics Water temperature salinity, turbidity chlorophyll concentration and zooplankton settled volume

Frequency	Every year	Where	Chisik Island western central Cook Inlet		
Season	Summer	Lat / Long	60 10 / -152 58	Region	CI

GOALS	**PRODUCTS**
Detect	PDO food web changes SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
Inform	Fishery management, State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 33	$100 0	$80 0	$67 0	$53 6

CONNECTIONS

Cost Partners	NMFS (Kodiak) USGS (Alaska Biol Sci Ctr)
Other Partners	FWS ADF&G KBNERR NPFMC
Related GEM Components	State of the Gulf Index Northern Cross Components Monitoring of forage fish and epi-benthic ecosystem Nearshore forage fish surveys Seabird colony surveys Seabird boat surveys
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design CCAMLR NMML, UAF CIK KBNERR

Projected Start 05/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 28B

THEME Forage Fish **DISCIPLINE** Marine & Fish Ecology **QUESTION** Interactions Food Hab

Title	Mid-water Trawl Forage Fish Surveys Chiniak Gully
Description	This component will support an annual mid-water trawl survey within 40 km (foraging range) of main seabird colonies in lower Cook Inlet and the Gulf of Alaska in conjunction with CTD casts and zooplankton tows This is the best method for sampling sand lance, herring capelin and juvenile pollock Abundance and species composition of pelagic forage fish will be measured Historical surveys were conducted from 1995-1999, and continued monitoring of the forage fish community will detect food web changes in collaboration with seabird monitoring in the area The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove, and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coatal Current (ACC), covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Abundance species composition, length, weight, energetics, water temperature salinity turbidity chlorophyll concentration and zooplankton settled volume

Frequency	Every year	Where	E-SE Kodiak		
Season	Summer	Lat / Long	57 53 / -151 65	Region	KAP

GOALS	**PRODUCTS**
Detect	PDO, food web changes SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
Inform	Fishery management State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start Up	GEM Share Annual
0 33	$100 0	$80 0	$67 0	$53 6

CONNECTIONS

Cost Partners	NMFS (Kodiak), USGS (Alaska Biol Sci Ctr)
Other Partners	USFWS ADF&G KBNERR, NPFMC
Related GEM Components	State of the Gulf Index, Northern Cross Components Monitoring of forage fish and epi-benthic ecosystem, Nearshore forage fish surveys, Seabird colony surveys Seabird boat surveys
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design, CCAMLR NMML UAF CIK, KBNERR

Projected Start 05/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 28C

HEME forage Fish **DISCIPLINE** Marine & Fish Ecology **QUESTION** Interactions Food, Habitat

Title	Mid-water Trawl Forage Fish Surveys Barren Islands
Description	This component will support an annual mid-water trawl survey within 40 km (foraging range) of main seabird colonies in lower Cook Inlet and the Gulf of Alaska in conjunction with CTD casts and zooplankton tows This is the best method for sampling sand lance, herring, capelin and juvenile pollock Abundance and species composition of pelagic forage fish will be measured Historical surveys were conducted from 1995-1999 and continued monitoring of the forage fish community will detect food web changes in collaboration with seabird monitoring in the area The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coatal Current (ACC), covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Abundance, species composition length weight, energetics, water temperature, salinity, turbidity, chlorophyll concentration, and zooplankton settled volume

Frequency	Every year	Where	near Barren Islands NE Afognak		
Season	Summer	Lat / Long	58 94 / -152 15	Region	KAP, CI

GOALS	PRODUCTS
Detect	PDO ood web changes, SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
Inform	Fishery management State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 33	$100 0	$80 0	$67 0	$53 6

CONNECTIONS

Cost Partners	NMFS (Kodiak), USGS (Alaska Biol Sci Ctr)
Other Partners	FWS ADF&G KBNERR NPFMC
Related GEM Components	State of the Gulf Index Northern Cross Components Monitoring of forage fish and epi benthic ecosystem Nearshore forage fish surveys Seabird colony surveys, Seabird boat surveys
Related Non GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design CCAMLR NMML UAF, CIK KBNERR

Projected Start 05/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 29

THEME Coastal Processes **DISCIPLINE** Physical, Geochemical & Chemical Oceanography & Effects of Climate **QUESTION** Interactions Food, Removals

Title	Surface Mooring Hinchinbrook Entrance
Description	This component will fund a surface mooring to detect changes in physical parameters to be used in understanding the state of the Gulf of Alaska in relation to biological productivity and human use
Measurement	Temperature, salinity current velocity and direction, sea level (bottom pressure)
Frequency	Every year Where Hinchinbrook Entrance
Season	All year Lat / Long 60 3 / -146 75 Region PWS

GOALS	PRODUCTS
Detect	PDO NPI, SGI
Understand	PDO, NPI, SGI, physical models
Predict	PWS Circulation model
Inform	State of the Gulf Index
Solve	TBA

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 00	$115 0	$35 0	$115 0	$35 0

CONNECTIONS

Cost Partners	
Other Partners	NOAA (NOS, NMFS), NSF, OSRI
Related GEM Components	State of the Gulf Index, Gulf of Alaska Coupled Circulation Hydrological Model
Related Non-GEM Funded Activities	GLOBEC, FOCI ARGO Drogues GOOS, C-GOOS GODAE

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 30

HEME Terrestrial Linkages **DISCIPLINE** Nearshore, Benthic, & Coastal Ecology **QUESTION** Interactions Habitat, Removals

Title	Monitoring Vegetation Responses to Recreational and Natural Disturbances
Description	Recreational use in Prince William Sound is expected to increase with the opening of the road to Whittier One of the effects may be an increase in human-caused disturbance to vegetation and soils at nearshore campsites Information on campsites at 63 beaches in Prince William Sound indicates moderate to high disturbance including loss of vegetation cover, damage to trees, increase in exposed roots presence of tree stumps multiple trail development, and the presence of camping trash Impacts of shoreside degradation on the intertidal and near subtidal seem likely Building on prior information a network of approximately 20 permanent plots will be established at recreation sites stratified by distance from Whittier Depending on statistical findings, each of the plots will be measured each year to examine trends in vegetation and soil changes determined by statistical concerns Coordination with intertidal, subtidal, EMAP water quality, and contaminant work will permit complete site characterization
Measurement	Erosion sedimentation, species composition of terrestrial vegetation, stable isotope ratios of nitrogen in terrestrial vegetation, contaminants water quality

Frequency	Every year	Where	Prince William Sound		
Season	Spring/Fall	Lat / Long	60 50 / -147 00	Region	PWS

GOALS	PRODUCTS
Detect	SGI human uses
Jnderstand	SGI camp site management
Predict	Quantify changes in response to recreational use and natural processes
Inform	Regulatory decisions State of the Gulf Index
Solve	Shoreline management tool

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 80	$120 0	$120 0	$24 0	$24 0

CONNECTIONS

Cost Partners	USFS ADEC EPA
Other Partners	DNR, KBNERR, PWSSC, NOAA NOLS, OSRI, USCG
Related GEM Components	Marine Contributions to Terrestrial Productivity State of the Gulf Index, Gulf of Alaska Coupled Circulation Hydrological Model
Related Non-GEM Funded Activities	Restoration Project 00510 Intertidal Monitoring Recommendations NOAA NS&T, Mussel Watch Restoration Projects 00210 & 00610 Youth Area Watch PISCO C-GOOS (CONNS Level 1)

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 31

THEME Terrestrial Linkages **DISCIPLINE** Nearshore Benthic, & Coastal Ecology **QUESTION** Interactions Habitat, Removals

Title	Anthropogenic Disturbance of Eelgrass (*zostera Spp*) Meadows
Description	Over a period of two years, this research project will establish a baseline GIS map of the density and distribution of eelgrass beds and assess the current level of anthropogenic disturbance of eelgrass beds in Prince William Sound to provide data for establishing a monitoring program Eelgrass (*Zostera marina*) and other seagrasses have long been recognized as important components of nearshore marine ecosystems Human activities on these sensitive habitats can have a detrimental and cumulative effect on commercially important fish species, invertebrates, shorebirds, and the plant communities themselves Eelgrass beds in Southcentral Alaska have apparently experienced anthropogenic impacts associated with increased use by the public However, present information does not permit the extent of past damage nor the rate of decline to be described Coordination with intertidal, subtidal, EMAP water quality, and contaminant work would permit complete site characterization
Measurement	Erosion, sedimentation, species composition of terrestrial,vegetation, stable isotope ratios of nitrogen in terrestrial vegetation
Frequency	Every year Where Prince William Sound
Season	Spring/Fall Lat / Long 60 50 / -147 75 Region PWS

GOALS	**PRODUCTS**
Detect	SGI human uses
Understand	SGI camp site management
Predict	Quantify changes in response to recreational use and natural processes
Inform	Regulatory decisions State of the Gulf Index
Solve	Shoreline management tool

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 80	$80 0	$80 0	$16 0	$16 0

CONNECTIONS

Cost Partners	USFS ADEC, EPA
Other Partners	DNR KBNERR, PWSSC, NOAA NOLS, OSRI USCG
Related GEM Components	Monitoring Vegetation Responses to Recreational and Natural Disturbances, State of the Gulf Index Gulf of Alaska Coupled Circulation Hydrological Model
Related Non-GEM Funded Activities	Restoration Project 00510 Intertidal Monitoring Recommendations, NOAA NS&T Mussel Watch, Restoration Projects 00210 & 00610 Youth Area Watch PISCO

Projected Start 10/01/02 Projected Completion 9/30/2004

Monitoring or Research Research

GEM Monitoring & Research Plan Component Description

Component No 32

HEME Coastal Processes **DISCIPLINE** Physical Geochemical & Chemical Oceanography & Effects of Climate **QUESTION** Interactions Food, Habitat

Title	Gulf of Alaska Coupled Circulation Hydrological Model
Description	This component will develop unified circulation and hydrological models for the northern Gulf of Alaska (NGOA) through three sequential steps 1) establish a high resolution Gulf of Alaska ocean circulation model and a hydrological model for freshwater coastal discharge into the gulf, 2) couple the hydrological model to ocean circulation model and 3) build a foundation for physical forcing for other GEM components and a solid foundation toward a nowcast/forecast system for the gulf There are a a number of important questions to be answered about the geophysical processes that are presumed to control animal and plant populations in the northern Gulf of Alaska (GOA) For example, wind-driven circulation is controlled by the Aleutian Low What is the seasonal pattern of the GOA ocean circulation? Freshwater runoff in the GOA is characterized by both point source (53% of the total runoff by seven largest rivers) and line source (47%) How does runoff contribute to the Alaska Coastal Current (ACC) and the general oceanic circulation on seasonal and interannual time scales? What is the tidal current pattern and residual current pattern along coasts of GOA? How does the GOA circulation influence the Prince William Sound circulation in terms of physical advection, biological transport and ecosystem dynamics?
Measurement	Temperature, salinity current velocity and direction, sea level (bottom pressure)

Frequency | Where

Season | Lat / Long / | Region NGOA

GOALS	PRODUCTS
Detect	PDO NPI SGI
Understand	PDO NPI SGI, physical models
Predict	ACC
Inform	State of the Gulf Index
Solve	Nowcast/forecast capabilities

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$165 0	$165 0	$82 5	$82 5

CONNECTIONS

Cost Partners	NOAA (NOS, NMFS), OSRI, NSF
Other Partners	
Related GEM Components	State of the Gulf Index Gulf of Alaska Coupled Circulation Hydrological Model
Related Non-GEM Funded Activities	GLOBEC FOCI ARGO Drogues GOOS C-GOOS, NOPP

Projected Start 10/01/02 Projected Completion 9/30/2007

Monitoring or Research Research

GEM Monitoring & Research Plan Component Description

Component No 33A

THEME Forage Fish **DISCIPLINE** Marine & Fish Ecology **QUESTION** Interactions Food, Hab

Title	Nearshore Forage Fish Surveys Barren Islands
Description	This component will support annual beach seine collections of nearshore forage fish at multiple sites in the vicinity of important seabird colonies Similar surveys were conducted in mid-1970's and from 1995-1999 This is the best method for survey of sand lance populations Continued monitoring of the forage fish community will detect food web changes and complement studies of seabirds (critical for understanding trophic interactions) The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coastal Current (ACC), covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Nearshore forage fish abundance and species composition, forage fish length, weight condition and energetics

Frequency	Every year	Where	near Barren Islands NE Afognak		
Season	Summer	Lat / Long	58 94 / -152 15	Region	CI KAP

GOALS	PRODUCTS
Detect	PDO food web changes SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
Inform	Fishery management State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 33	$100 0	$80 0	$67 0	$53 6

CONNECTIONS

Cost Partners	NMFS (Kodiak) USGS (Alaska Biol Sci Ctr)
Other Partners	USFWS, ADF&G KBNERR NPFMC
Related GEM Components	State of the Gulf Index Northern Cross Components Monitoring of forage fish and epi-benthic ecosystem, Nearshore forage fish surveys Seabird colony surveys Seabird boat surveys
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design CCAMLR NMML UAF CIK KBNERR

Projected Start 05/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 33B

HEME Forage Fish **DISCIPLINE** Marine & Fish Ecology **QUESTION** Interactions Food, Habitat

Title	Nearshore Forage Fish Surveys Gull Island
Description	This component will support annual beach seine collections of nearshore forage fish at multiple sites in the vicinity of important seabird colonies Similar surveys were conducted in mid-1970's and from 1995-1999 This is the best method for survey of sand lance populations Continued monitoring of the forage fish community will detect food web changes and complement studies of seabirds (critical for understanding trophic interactions) The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coastal Current (ACC), covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Nearshore forage fish abundance and species composition forage fish length, weight condition and energetics

Frequency	Every year	Where	vicinity Gull Island SE Homer		
Season	Summer	Lat / Long	59 59 / -152 33	Region	CI

GOALS	PRODUCTS
Detect	PDO food web changes, SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
Inform	Fishery management, State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 33	$100 0	$80 0	$67 0	$53 6

CONNECTIONS

Cost Partners	NMFS (Kodiak), USGS (Alaska Biol Sci Ctr)
Other Partners	USFWS, ADF&G, KBNERR, NPFMC
Related GEM Components	State of the Gulf Index Northern Cross Components Monitoring of forage fish and epi-benthic ecosystem Nearshore forage fish surveys Seabird colony surveys Seabird boat surveys
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design CCAMLR NMML UAF, CIK KBNERR

Projected Start 05/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 33C

THEME Forage Fish	**DISCIPLINE** Marine & Fish Ecology	**QUESTION** Interactions Food Ha

Title Nearshore Forage Fish Surveys Chisik Island

Description This component will support annual beach seine collections of nearshore forage fish at multiple sites in the vicinity of important seabird colonies Similar surveys were conducted in mid-1970's and from 1995-1999 This is the best method for survey of sand lance populations Continued monitoring of the forage fish community will detect food web changes and complement studies of seabirds (critical for understanding trophic interactions) The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coastal Current (ACC), covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA

Measurement Nearshore forage fish abundance and species composition, forage fish length, weight condition and energetics

Frequency Every year **Where** Chisik Island western central Cook Inlet

Season Summer **Lat / Long** 60 10 / -152 58 **Region** CI

GOALS	**PRODUCTS**
Detect	PDO food web changes, SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
Inform	Fishery management, State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 25	$50 0	$20 0	$37 5	$15 0

CONNECTIONS

Cost Partners	USGS, USFWS, NMFS
Other Partners	ADF&G KBNERR NPFMC
Related GEM Components	State of the Gulf Index, Northern Cross Components Monitoring of forage fish and epi benthic ecosystem Nearshore forage fish surveys Seabird colony surveys, Seabird boat surveys
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design, CCAMLR NMML, UAF CIK KBNERR

Projected Start 05/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 33D

HEME Forage Fish	**DISCIPLINE** Marine & Fish Ecology	**QUESTION** Interactions Food, Habitat

Title Nearshore Forage Fish Surveys Resurrection Bay

Description This component will support annual beach seine collections of nearshore forage fish at multiple sites in the vicinity of important seabird colonies Similar surveys were conducted in mid-1970's and from 1995-1999 This is the best method for survey of sand lance populations Continued monitoring of the forage fish community will detect food web changes and complement studies of seabirds (critical for understanding trophic interactions) The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove, and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coastal Current (ACC), covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA

Measurement Nearshore forage fish abundance and species composition, forage fish length, weight, condition and energetics

Frequency	Every year	Where	Resurrection Bay SE Seward		
Season	Summer	Lat / Long	59 90 / -149 33	Region	NGOA

GOALS	PRODUCTS
Detect	PDO food web changes, SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles, availability of forage fishes for seabirds and marine mammals
Inform	Fishery management State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 33	$120 0	$80 0	$80 4	$53 6

CONNECTIONS

Cost Partners	NMFS (Kodiak) USGS (Alaska Biol Sci Ctr) ADF&G
Other Partners	KBNERR, NPFMC
Related GEM Components	State of the Gulf Index Northern Cross Components Mid-water trawl forage fish surveys Nearshore forage fish surveys Seabird colony surveys Seabird boat surveys
Related Non GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design CCAMLR NMML UAF CIK KBNERR

Projected Start 05/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 33E

THEME Forage Fish **DISCIPLINE** Marine & Fish Ecology **QUESTION** Food

Title	Nearshore Forage Fish Surveys Puale Bay
Description	This component will support annual beach seine collections of nearshore forage fish at multiple sites in the vicinity of important seabird colonies Similar surveys were conducted in mid-1970 s and from 1995-1999 This is the best method for survey of sand lance populations Continued monitoring of the forage fish community will detect food web changes and complement studies of seabirds (critical for understanding trophic interactions) The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove, and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coastal Current (ACC), covers a large enough geographic area to allow comparison of areas of high and low primary productivity, and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Nearshore forage fish abundance and species composition, forage fish length, weight, condition and energetics

Frequency	Every year	Where	Alaska Peninsula W Kodiak		
Season	Summer	Lat / Long	57 75 / -155 58	Region	KAP

GOALS	PRODUCTS
Detect	ENSO PDO anthropogenic impacts changes in marine food webs
Understand	GOA trophic dynamics seabird population dynamics
Predict	Climate regime shift GOA trophic dynamics
Inform	State of the Gulf Index, ecosystem status
Solve	Seabird population trends

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 25	$50 0	$20 0	$37 5	$15 0

CONNECTIONS

Cost Partners	USGS (Alaska Biol Sci Center) / USFWS (Alaska Maritime NWR) USGS NMFS (AFSC)
Other Partners	MMS (OCSES)
Related GEM Components	Seabird Monitoring (GOA Cook Inlet, Kodiak PWS), Forage Fish Monitoring (GOA Cook Inlet Kodiak PWS)
Related Non GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design USFWS/USGS Seabird Status and Trends MMS Outer Continental Shelf Environmental Studies

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 33F

HEME Forage Fish	**DISCIPLINE** Marine & Fish Ecology	**QUESTION** Interactions Food, Habitat

Title	Nearshore Forage Fish Surveys Ugaiushak Island
Description	This component will support annual beach seine collections of nearshore forage fish at multiple sites in the vicinity of important seabird colonies Similar surveys were conducted in mid-1970's and from 1995-1999 This is the best method for survey of sand lance populations Continued monitoring of the forage fish community will detect food web changes and complement studies of seabirds (critical for understanding trophic interactions) The Northern Cross approach organizes monitoring of seabirds and their prey base of forage fishes around the spatial structure (a cross) defined by the key features of the oceanography of the northern Gulf of Alaska (NGOA) The long axis of the cross runs from waters just outside Prince William Sound down the Shelikof Strait to the vicinity of King Cove, and the short axis runs from central Cook Inlet through the Barren Islands to the southeast of Kodiak The Northern Cross straddles the most productive area of the NGOA, runs both perpendicular and parallel to the Alaska Coastal Current (ACC) covers a large enough geographic area to allow comparison of areas of high and low primary productivity and builds upon historical sampling programs for seabirds and forage fish in the NGOA
Measurement	Nearshore forage fish abundance and species composition Forage fish length, weight condition and energetics

Frequency	Every year	Where	Semidis E Chignik SW Kodiak		
Season	Summer	Lat / Long	56 80 / -156 83	Region	KAP

GOALS	**PRODUCTS**
Detect	PDO food web changes, SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
Inform	Fishery management State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 33	$100 0	$80 0	$67 0	$53 6

CONNECTIONS

Cost Partners	NMFS (Kodiak) USGS (Alaska Biol Sci Ctr)
Other Partners	USFWS, ADF&G, KBNERR, NPFMC
Related GEM Components	State of the Gulf Index, Northern Cross Components Monitoring of forage fish and epi benthic ecosystem Nearshore forage fish surveys Seabird colony surveys Seabird boat surveys
Related Non-GEM Funded Activities	Restoration projects 00501 and 00493 Seabird Sampling Protocols and Trawl Survey Design CCAMLR NMML UAF, CIK KBNERR

Projected Start 05/01/03 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 34

THEME Support Services **DISCIPLINE** Support Services **QUESTION** Support Services

Title	Public Advice & Outreach
Description	The draft GEM Science Program (April 2000) stresses the importance of public participation The Trustee Council is committed to public input and public outreach as vital components of GEM Just how this should be achieved has not yet been determined, but it is almost certain that a public advisory group (PAG) of some sort will continue The costs listed here are a rough estimate, based on operational costs of the Council's current PAG
Measurement	
Frequency	Where
Season	Lat / Long / Region All

GOALS **PRODUCTS**

Detect

Understand

Predict

Inform

Solve

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Anr
0 00	$30 0	$30 0	$30 0	$30 0

CONNECTIONS

Cost Partners

Other Partners

Related GEM Components

Related Non-GEM Funded Activities

Projected Start 10/1/02 Projected Completion

Monitoring or Research

GEM Monitoring & Research Plan Component Description

Component No 35A

HEME Coastal Processes	**DISCIPLINE** Biological Oceanography		**QUESTION** Food		

Title	Ships of Opportunity Basic Program
Description	In this component, gaps in physical and biological oceanographic information would be closed by developing a program to support existing ships of opportunity programs, and to identify opportunities for new programs The objective is to promote collection of plankton species composition via continuous recorder, along with temperature and salinity on the routes of commercial and government operated vessels in Prince William Sound Cook Inlet, Kodiak and the Gulf of Alaska Gaps exist in biological and physical oceanographic information available in all these marine areas during the winter particularly, but in all seasons for many localities
Measurement	Species composition abundance and distribution of plankton, temperature, salinity

Frequency	Every year	Where	Waters Juneau - Seward - Kodiak - Homer		
Season	All year	Lat / Long	59 80 / -148 00	Region	NGOA

GOALS	PRODUCTS
Detect	SGI
Understand	ACC
Predict	
Inform	
Solve	

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 00	$250 0	$250 0	$250 0	$250 0

CONNECTIONS

Cost Partners	
Other Partners	AMHS NOAA NSF UAF, KBNERR CDFO
Related GEM Components	Community Based Marine Monitoring Programs Ships of Opportunity AMHS
Related Non GEM Funded Activities	NPRB CPR, GOOS C-GOOS

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 35B

THEME Coastal Processes **DISCIPLINE** Biological Oceanography **QUESTION** Food

Title	Ships Of Opportunity Oceanography of the Alaska Marine Highway
Description	This component will measure species composition via continuous plankton recorder of phytoplankton and zooplankton, temperature and salinity along the route of the Alaska Marine Highway in Prince William Sound, Cook Inlet, Kodiak and the Gulf of Alaska Gaps exist in information available in all of these marine areas during the winter Establishing a working relationship with the Alaska Marine Highway could provide opportunities for sampling over time, based on experience in developing logistic and technical capabilities with the *M/V Tustumena* and the *M/V Kennicott* Sampling opportunities based on current schedules are October - March Homer-Seldovia-Kodiak-Seward-Valdez *M/V Tustumena* January and March Cross-Gulf Juneau-Seward *M/V Kennicott* March Homer-Seldovia-Kodiak-Seward-Valdez *M/V Kennicott*
Measurement	Species composition abundance and distribution of plankton, temperature, salinity
Frequency	Every year Where Juneau - Seward - Kodiak - Homer
Season	Winter Lat / Long 59 80 / -148 00 Region NGOA

GOALS	PRODUCTS
Detect	SGI
Understand	ACC
Predict	
Inform	
Solve	

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$200 0	$100 0	$100 0	$50 0

CONNECTIONS

Cost Partners	ADOT
Other Partners	NOAA NSF, UAF KBNERR, CDFO
Related GEM Components	Community-Based Marine Monitoring Programs, Ships of Opportunity Program
Related Non-GEM Funded Activities	NPRB CPR, GOOS, C-GOOS

Projected Start 10/01/02   Projected Completion

Monitoring or Research   Monitoring

GEM Monitoring & Research Plan Component Description

Component No 36

HEME Nearshore Plants & Animals **DISCIPLINE** Biological Oceanography **QUESTION** Interactions Food, Habitat

Title	Community-based Coastal Monitoring
Description	This component will support a coastal monitoring program designed around basic monitoring and communication of physical data in the form of temperature and salinity to support the Forage Fish, Seabird, and Nearshore Plants & Animals themes Extension of these and additional data types to answer questions of local interest, as defined by the concerned communities and organizations and their funding partners such as PSP (paralytic shellfish poisoning) ASP (amnesiac shellfish poisoning), contaminants and improving water safety with better weather forecasting will be a long-term goal of this component The component provides funding for establishing the basic human and communications infrastructures necessary to gather and distribute the information by using the existing physical infrastructure of villages and towns, salmon hatcheries government-supported marine stations and private natural resource-based businesses throughout the region Potential locations Cordova Valdez Tatitlek Whittier Chenega, Seward, Anchorage, Homer, Kenai, Soldotna, Seldovia, Port Graham Nanwalek, Kodiak Port Lions, Ouzinkie, Karluk, Chignik, and Perryville
Measurement	Temperature, salinity
Frequency	Every year Where PWS CI, Kodiak
Season	All year Lat / Long 59 80 / -148 00 Region All

GOALS	PRODUCTS
Detect	SGI changes in forage fish sea otters, harbor seals seabirds
Understand	ACC
Predict	
Inform	Responses of nearshore waters to shifts in global climate
Solve	

COST ESTIMATES

Cost Sharing	Start Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 50	$400 0	$200 0	$200 0	$100 0

CONNECTIONS

Cost Partners	ADEC, EPA, CRRC
Other Partners	CIK CDFU USCG AMHS NOAA, USFS, NSF, UAF, KBNERR, CDFO, USFS PWSSC, OSRI, AWC
Related GEM Components	EPA Coastal 2000 Ships of Opportunity AMHS, Ships of Opportunity Basic Program
Related Non-GEM Funded Activities	C GOOS (CONNS Level 1) Restoration Project 00567 Monitoring Environmental Contaminants GLOBE CIK AWC

Projected Start 10/01/02   Projected Completion

Monitoring or Research   Monitoring

GEM Monitoring & Research Plan Component Description

Component No 37

THEME Support Services **DISCIPLINE** Support Services **QUESTION** Support Services

Title Administrative Operations

Description The draft GEM Science Program (April 2000) states that GEM will be administered by a core professional staff that is not directly affiliated with any particular agency institution or program, as is currently the case with management of the EVOS Restoration Office An executive director will oversee the financial program management, scientific, and public involvement aspects of the program A senior staff scientist, hired by the executive director, will provide in-house scientific counsel and leadership to GEM and the Trustee Council Additional staff will support these functions

Details of the administrative structure have not been worked out and the cost shown below is a preliminary estimate, based roughly on current Restoration Office expenses In addition to staff support, costs of this component will include financial management/investment advice audit services production and distribution costs of annual invitations and work plans, travel, office space and related expenses, etc

Measurement

Frequency Where

Season Lat / Long / Region All

GOALS **PRODUCTS**

Detect

Understand

Predict

Inform

Solve

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start Up	GEM Share Annual
0 00	$1000 0	$1000 0	$1000 0	$1000 0

CONNECTIONS

Cost Partners

Other Partners

Related GEM Components

Related Non GEM Funded Activities

Projected Start 10/01/02 Projected Completion

Monitoring or Research

GEM Monitoring & Research Plan Component Description

Component No 38

HEME Terrestrial Linkages **DISCIPLINE** Nearshore, Benthic & Coastal Ecology **QUESTION** Interactions Food, Habitat, Removals

Title	Harlequin Duck Abundance, Distribution & Age Structure
Description	The annual cycle of harlequin ducks encompasses both terrestrial and nearshore coastal habitats Hence, population dynamics of harlequin ducks are the result of demographic processes that occur in both upland breeding streams and marine nonbreeding habitats Unique attributes of harlequin duck natural history allow measurement of important demographic properties within nonbreeding aggregations which are core subpopulations from a population structure perspective These data can be used to evaluate variation in numbers of harlequin ducks in relation to upland and coastal conditions and further indicate the demographic mechanisms by which population change occurs
Measurement	Harlequin duck numbers age class distribution, and survival and dispersal of marked individuals
Frequency	Every year Where Cook Inlet, PWS, Kenai Fjords, Kodiak/AK Peninsula
Season	Fall, Winter Lat / Long 60 25 / -147 25 Region All

GOALS	PRODUCTS
Detect	Changes in productivity
Understand	Marine-terrestrial linkages
Predict	Changes in productivity
Inform	Riparian and land management
Solve	Land and duck management issues

COST ESTIMATES

Cost Sharing	Start Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 80	$120 0	$120 0	$24 0	$24 0

CONNECTIONS

Cost Partners	ADF&G DOI
Other Partners	
Related GEM Components	Nearshore Plants & Animals Terrestrial Linkages
Related Non-GEM Funded Activities	ADF&G and DOI surveys

Projected Start 10/01/02 Projected Completion 9/30/2007

Monitoring or Research Monitoring

GEM Monitoring & Research Plan Component Description

Component No 39

THEME Forage Fish **DISCIPLINE** Marine & Fish Ecology **QUESTION** Food

Title	Community-based Monitoring Forage Fish Surveys Using Stomach Contents
Description	Under this component, a three-year research program will develop measures of presence/absence and relative abundance data on capelin and sand lance using community-based samples of stomach contents of catches of large predatory fish species A monitoring program is expected to result from this effort where large predatory fish stomachs (e g , halibut, cod, rockfish, lingcod) will be collected annually from local residents and businesses to monitor forage fish populations, particularly capelin and sand lance The communities involved will be Homer, Seldovia, Port Graham Nanwalek Seward Valdz Cordova, Chenega Bay Tatitlek, Kodiak, Ouzinkie, Port Lions and possibly others Similar collections were made in Kachemak Bay /lower Cook Inlet during 1995-1999 This is a relatively inexpensive, cost-effective method for tracking changes in capelin and sand lance populations that is designed to involve local communities and students (e g Youth Area Watch programs) Tracking long-term changes in capelin and sand lance populations will complement studies of seabirds and marine mammals (critical for understanding trophic interactions)
Measurement	Measures of presence/absence and relative abundance data for capelin and sand lance

Frequency		Where	Kachemak Bay Resurrection Bay PWS, Kodiak		
Season	Summer Winter	Lat / Long	/	Region	All

GOALS	PRODUCTS
Detect	PDO food web changes
Understand	Link oceanic climate with natural perturbations in forage fish community structure
Predict	Changes in the forage fish community structure and how they affect higher trophic levels
Inform	Natural cycles in the quantity and quality of forage fishes available for higher trophic levels (seabirds and marine mammals)
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 25	$115 0	$115 0	$86 3	$86 3

CONNECTIONS

Cost Partners	CRRC USGS (Alaska Biol Sci Center) USFWS (Alaska Maritime NWR) NMFS (Kodiak)
Other Partners	
Related GEM Components	Northern Cross Components community-based coastal monitoring
Related Non-GEM Funded Activities	NMML KBNERR

Projected Start 10/01/02 Projected Completion 9/30/2005

Monitoring or Research Research

GEM Monitoring & Research Plan Component Description

Component No 40

HEME Forage Fish **DISCIPLINE** Marine & Fish Ecology **QUESTION** Interactions Food, Habitat, Removals

Title	Models to Understand Early Marine Survival Pink Salmon
Description	Develop a deterministic model of survival of juvenile pink salmon as a function of geophysical and biological factors of sufficient precision to inform fishery management decisions Understanding factors responsible for survival of pink salmon during the first three months of marine life requires 1) measuring the distributions of pink salmon and their prey items such as Neocalanus copepods, and their predators such as pollock 2) measuring consumption of Neocalanus by pink salmon, 3) understanding the influence of geophysical factors on distribution and consumption and 4) relating factors 1 through 3 above to recruitment of adult salmon Information derived from the SEA (Sound Ecosystem Assessment) program serves as the foundation to develop a more detailed understanding of mechanisms responsible for determining survival of juvenile pink salmon such as trophic dynamics and physical and biological forcing of marine spatial distribution
Measurement	Abundance and distribution of juvenile pink salmon zooplankton, and pollock, abundance and species composition, contaminants pristane levels in mussels

Frequency — Where PWS

Season — Lat / Long 60 10 / -147 50 — Region PWS

GOALS	PRODUCTS
Detect	PDO food web changes SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles availability of forage fishes for seabirds and marine mammals
Inform	Fishery management State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 33	$300 0	$300 0	$201 0	$201 0

CONNECTIONS

Cost Partners	OSRI ADF&G NOAA (ABL)
Other Partners	USGS USFWS CDFU
Related GEM Components	Models to understand early marine survival Pacific herring Gulf Circulation and Hydrological Model Northern Cross Components
Related Non GEM Funded Activities	OSRI (Predictive Ecology Program) PWSAC VDFA

Projected Start 10/01/02 Projected Completion 9/30/2007

Monitoring or Research Research

GEM Monitoring & Research Plan Component Description

Component No 41

THEME Forage Fish **DISCIPLINE** Marine & Fish Ecology **QUESTION** Interactions Food Hab Removals

Title	Models to Understand Early Marine Survival Pacific Herring
Description	Develop a deterministic model of survival of juvenile Pacific herring as a function of geophysical and biological factors of sufficient precision to inform fishery management decisions Build on the foundation developed in the SEA (Sound Ecosystem Assessment) program, with the advice of the recommendations of the herring synthesis project (EVOS Project 00374)
Measurement	Abundance and distribution of juvenile Pacific herring, zooplankton, and pollock, bundance and species composition Fish length, weight, condition and energetics

Frequency Where PWS

Season Lat / Long 60 10 / -147 50 Region PWS

GOALS	PRODUCTS
Detect	PDO food web changes, SGI
Understand	Ocean/climate in relation to forage fish and epi-benthic community structure
Predict	Natural cycles, availability of forage fishes for seabirds and marine mammals
Inform	Fishery management, State of the Gulf Index
Solve	Develop indices of forage fish abundance

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annı
0 33	$300 0	$300 0	$201 0	$201 0

CONNECTIONS

Cost Partners	OSRI ADF&G UAF
Other Partners	USGS USFWS CDFU
Related GEM Components	Models to understand early marine survival pink salmon Gulf Circulation and Hydrological Model Northern Cross Components
Related Non-GEM Funded Activities	Restoration Project 00374 Planning for Herring Research OSRI (Predictive Ecology Program)

Projected Start 10/01/02 Projected Completion 9/30/2007

Monitoring or Research Research

GEM Monitoring & Research Plan Component Description

Component No 42

THEME Coastal Processes	**DISCIPLINE** Biological Oceanography	**QUESTION** Food

Title	Monitoring Environmental Contaminants				
Description	Monitor to address key questions regarding origin and fate of environmental contaminants in the northern Gulf of Alaska in concert with programs in adjacent geographic regions and cooperating agencies within the geographic scope of GEM Support for sampling and long-term storage of samples will be provided in cooperation with concerned agencies				
Measurement	Environmental contaminants				
Frequency	Every year	Where	NGOA		
Season	All year	Lat / Long	/	Region	All

GOALS	**PRODUCTS**
Detect	Changes in environmental contaminants
Understand	Origins of change
Predict	Need for regulatory actions pathways of contaminants
Inform	Management of food resources, users of GOA species
Solve	Regulatory questions

COST ESTIMATES

Cost Sharing	Start-Up Cost	Annual Operating Cost	GEM Share Start-Up	GEM Share Annual
0 95	$2150 0	$2150 0	$107 5	$107 5

CONNECTIONS

Cost Partners	ADEC EPA NOAA (PMEL NMFS/AFSC) NSF NIH USPHS USFWS
Other Partners	Arctic Council ADF&G UA ANHSC CIK AK Native Fish & Wildlife Society, CRRC Indigenous Peoples Committee on Marine Mammals AK Native Health Bd
Related GEM Components	All contaminant sampling components
Related Non GEM Funded Activities	AMAP EMAP

Projected Start 10/01/02 Projected Completion

Monitoring or Research Monitoring

Exxon Valdez Oil Spill Trustee Council

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Following is the latest Bibliography of Published Research, Dissertations, and Theses Sponsored by the Trustee Council. The bibliography was compiled from information submitted to the Restoration Office as of September 2000. The author's name in **bold** indicates we do not have a copy of the article on file. Ideally the Restoration Office prefers three reprints (that can then be distributed): one for ARLIS, one for the Chief Scientist's office, and one for the EVOS office. If reprints are not available, a copy or copies are accepted.

Items that were submitted to the Restoration Office but did not have complete information are not yet on this list. They are not lost, just waiting for more information: name of publication, volume, issue, page, and in press or publication date when it becomes available. Only Publications that are published or *in press* will be added to the bibliography.

Please contact Cherri Womac at the EVOS office if you have any corrections or additions to the bibliography.

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