14.02.34

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401, Anchorage, AK 99501-3451 907/278-8012 fax:907/276-7178

AGENDA

Exxon Valdez Oil Spill Trustee Council
Public Advisory Group
Fourth floor conference room
645 G Street, Anchorage, Alaska

Tuesday, October 26, 1999 - 9:00 a.m.

DRAFT **DRAFT**

PURPOSE:

1. Presentation on Cook Inlet Information Management and Monitoring System (CIIMMS) prototype.
2. Briefing/discussion on Gulf Ecosystem Monitoring (GEM) program.
3. Briefing/discussion on small parcel process.

Tuesday, October 26

9:00 a.m.	Welcome/roll call Approval of July 15-16, 1999 Meeting Summary	Charles Meacham, Vice-Chair
9:10	Update on recent Council and Restoration Office activities	Molly McCammon Executive Director
10:00	Cook Inlet Information Management and Monitoring System (CIIMMS)	Kelly Zeiner, Dept of Natural Resources Russell Knibe, Dept of Environmental Conservation Greg Kellogg, Environmental Protection Agency
	Break	
11:00	Gulf Ecosystem Monitoring (GEM) program briefing/discussion	Bob Spies, Chief Scientist Phil Mundy, Science Coordinator Molly McCammon

— *OVER* —

noon	lunch on your own	
1:30 p.m.	Public Comment	
2:00	GEM discussion continues	
	Small Parcel Process	Molly McCammon Sandra Schubert, Director of Restoration
	Set next meeting	
4:00	Adjourn	

Overall Timetable for GEM Program

The following are major milestones leading through development and implementation of a long-term research and monitoring plan in FY 2003:

1. Draft plan outline and begin fleshing out document, April – May 1999.

2. Convene small working group chaired by Chief Scientist and Executive Director, April – August 1999.

3. Complete first draft, July 1999.

4. Public review draft to Trustee Council, October 22, 1999.

5. Present to public draft for review and comment, October – December 1999. Public Advisory Group – October 26, 1999.

6. Complete revised version of public review draft, January 2000.

7. National Research Council (NRC) peer review of draft, January – December 2000.

8. Receive NRC report, January 2001.

9. Prepare FY 03 Science Invitation and invite projects needed for implementation of the long-term research and monitoring plan, February 2001.

10. Revise draft plan, March 2001.

11. Implement long-term research and monitoring plan, October 2002.

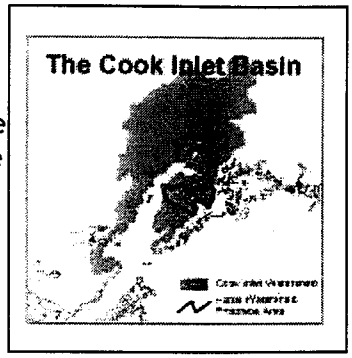
CIIMMS

COOK INLET INFORMATION MANAGEMENT/MONITORING SYSTEM

HOME | BROWSE | SEARCH | CONTRIBUTE | FEEDBACK

Contact us:
Phone:
(907) 269-8856
Fax:
(907) 269-8920
Email:
kellyz@dnr.state.ak.us

This **CIIMMS** prototype web site is the first step toward the development of a comprehensive information retrieval system, based on the latest Internet technologies, that will enable a wide range of users to *search*, *browse*, and *contribute* valuable information about the Cook Inlet watershed and Cook Inlet related projects and activities. Currently, the CIIMMS search provides access to six distributed sources of data and information.



Search

If you know exactly what you're looking for, enter specific words or phrases related to the information you want. Search tips are available to show you how it works.

Browse

If you are curious and just have a general topic in mind, and you want to see what's available, try browsing. The browse presents you with a list of topic choices leading to a pre-configured search. *[The browse uses a custom set of keywords which are in the process of being refined. Please be patient]*

Contribute

Use the easy, on-line forms to enter salient facts about projects, information (reports, websites, maps), or data (geographic data sets, spreadsheets, etc.)

Feedback

By using the provided feedback forms, the CIIMMS team can stay in touch with what you, the users, want to see on this site.

Prototype Features

CIIMMS will use the features page to focus on new information sources, specific to the Kenai River Watershed. Currently we are featuring some sample information searches relating to the Kenai River watershed.

CIIMMS: BASIC UTILITY

1. What data is available?

    - Simple search using key words, categories

2. Access to the data/information

    - Web links
    - Downloads via metadata or data documentation
    - On-line viewable maps, spreadsheets, etc.

3. Project Bibliographies

    - What projects are happening?
    - What new data is being generated?
    - How can I find out more?

4. How will the user define the region of interest (search by location)? (FY2000)

    - HUC number
    - Watershed names
    - User-defined boxes drawn on the screen

5. Access to on-line mapping capabilities from different servers (AGDC, KBEC, MOA)

6. General data analysis & viewing:

    - Identify specific features (timber harvest units, wells, streams, etc.)
    - Look at associated tabular data (print, export)
    - Measure distance between features, identify lat/long location, ...

7. Specific data analysis (Beyond FY2000)

    - Water quality, quantity

        -Clean Water Act reports
        -Chemistry analysis
        -Streamflow, historical and current, hydrograph capabilities
        -Certification of NPDES permits

    - Biological

        -Habitat analysis, downstream effects
        -Queries on features, i.e. where are the anadromous streams within one mile of the selected contaminated site

RESOLUTION
of the
Exxon Valdez Oil Spill Trustee Council
concerning the Involvement of Alaska Natives in the Gulf Ecosystem Monitoring Program

WHEREAS, the *Exxon Valdez* Oil Spill Trustee Council passed a resolution concerning the Restoration Reserve and Long Term Restoration Needs in March, 1999, which designated an estimated $115 million of the restoration funds remaining in 2002 to be used for research, monitoring, and general restoration, including community based restoration efforts; and

WHEREAS, the resolution also included language directing the Restoration Office and the Chief Scientist, under the direction of the Executive Director, to develop a long term research and monitoring program; and

WHEREAS, the Restoration Office has developed a draft Gulf Ecosystem Monitoring Program which acknowledges that the elements of community involvement, traditional ecological knowledge, stewardship and education are important components of any long-term program, but need further development; and

WHEREAS, the Native villages affected by the oil spill desire to be more greatly involved in the planning and implementation of the Council's long-term research program and have advocated for creation of a set-aside fund from the Restoration Reserve for community-initiated projects; and

WHEREAS, the Native villages are in the initial stages of developing their natural resource management capabilities through technical training and the development of regional and tribal natural resource management plans and believe that over time, these programs can and should be coordinated with the GEM Program;

THEREFORE BE IT RESOLVED that the *Exxon Valdez* Oil Spill Trustee Council hereby recognizes the time, effort, hard work, and dedication the Native villages have committed in support of a set-aside fund for community-initiated projects and their interest in participating in the development and implementation of the Council's long-term program;

BE IT FURTHER RESOLVED that the *Exxon Valdez* Oil Spill Trustee Council hereby expresses its commitment to fully involve Alaska Native villages, as well as other residents and communities of the spill region, in developing a program that includes community involvement, traditional ecological knowledge, stewardship and education.

Dated this 22nd day of October, 1999, in Juneau, Alaska.

DAVE GIBBONS
Trustee Representative
Alaska Region
USDA Forest Service

BRUCE M. BOTELHO
Attorney General
State of Alaska

MARILYN HEIMAN
Special Assistant to the Secretary
for Alaska
U.S. Department of the Interior

STEVEN PENNOYER
Director, Alaska Region
National Marine Fisheries Service

FRANK RUE
Commissioner
Alaska Department of
Fish and Game

MICHELE BROWN
Commissioner
Alaska Department of
Environmental Conservation

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401, Anchorage, AK 99501-3451 907/278-8012 fax:907/276-7178

MEMORANDUM

TO: Public Advisory Group Members

FROM: Molly McCammon
Executive Director

DATE: October 19, 1999

RE: Meeting on October 26, 1999

Enclosed are your materials for the October 26 meeting in Anchorage. There are three main items on the agenda: a briefing and discussion of the GEM (Gulf Ecosystem Monitoring) Program, a briefing and discussion of the Small Parcel Protection Program, and a preview of the prototype for the Cook Inlet Information Management System (CIIMS) database. The Trustee Council will be discussing the first two items at a work session in Juneau on Friday, October 22. I'll be able to report back to you next week on the results of their discussions.

One item I was not able to follow up on from your July meeting was setting up a teleconference prior to this meeting to discuss the proposed Community Fund. We've been consumed until late last week in getting a new draft of the GEM Program ready for review. Phil Mundy and I have some additional thoughts and ideas on this that we'd like to share next week. I hope to see you all then.

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noon	lunch on your own	
1:30 p.m.	Public Comment	
2:00	GEM discussion continues	

	Small Parcel Process	Molly McCammon Sandra Schubert, Director of Restoration
	Set next meeting	
4:00	Adjourn	

Exxon Valdez Oil Spill Trustee Council

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AGENDA
EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL MEETING **10/15/99**
October 22, 1999 @ 10 a.m. 1:45 pm
NOAA CONFERENCE ROOM #455 JUNEAU FEDERAL BUILDING
645 G STREET, ANCHORAGE

DRAFT **DRAFT**

Trustee Council Members:

BRUCE BOTELHO/CRAIG TILLERY
Attorney General/Trustee
State of Alaska/Representative

MICHELE BROWN
Commissioner
Alaska Department of Environmental Conservation

MARILYN HEIMAN
Special Assistant to the Secretary for Alaska
U.S. Department of the Interior

DAVE GIBBONS
Trustee Representative
U.S. Department of Agriculture
Forest Service

STEVE PENNOYER
Director, Alaska Region
National Marine Fisheries Service

FRANK RUE
Commissioner
Alaska Department of Fish & Game

Teleconferenced in Anchorage, EVOS Restoration Office, 645 G Street, Suite 401
Federal Chair

1. Call to Order 10 a.m.
   - Approval of Agenda
   - Approval of August 9,1999 and September 9, 1999 meeting notes

2. Executive Director's Report - Molly McCammon
   - Public Advisory Group Field Trip Report
   - Administrative Issues
     - Financial Report
     - Status of Investments
   - Habitat Protection Status Report
   - 2000 Annual Workshop

3. Public Comment Period 10:30 a.m.

4. Presentation on the Gulf Ecosystem Monitoring (GEM) Program

5. Lunch Provided During Executive Session (on Habitat Protection if needed)

6. Presentation and discussion on Small Parcel Process

DRAFT

* indicates tentative action items

Adjourn - 5 p.m.

raw

Meeting Summary

A. GROUP: *Exxon Valdez* Oil Spill Public Advisory Group (PAG)

B. DATE/TIME: July 15-16, 1999

C. LOCATION: Anchorage, Alaska

D. MEMBERS IN ATTENDANCE:

Name	Principal Interest
Chris Beck (7/15)	Public-at-Large
Sheri Buretta (7/15)	Subsistence
Dave Cobb	Public-at-Large
Chip Dennerlein (7/16)	Conservation
Dan Hull	Public-at-Large
James King	Public-at-Large
Chuck Meacham, Chair	Science/Academic
Brenda Schwantes	Public-at-Large
Stacy Studebaker	Recreation Users
Chuck Totemoff	Native Landowners
Howard Valley	Forest Products
Ed Zeine	Local Government
Bruce Bruseth for John Harris	Alaska State House of Representatives (*ex officio*)

E. NOT REPRESENTED:

Name	Principal Interest
Rupert Andrews	Sport Hunting and Fishing
Torie Baker	Commercial Fishing
Pam Brodie	Environmental
Eleanor Huffines	Commercial Tourism
Mary McBurney	Aquaculture
Loren Leman	Alaska State Senate (*ex officio*)

F. OTHER PARTICIPANTS:

Name	Organization
John French	Public
Hugh Short	Trustee Council Staff
Molly McCammon	Trustee Council Staff
Doug Mutter	Designated Federal Officer, Dept. of Interior
Sandra Schubert	Trustee Council Staff
Claudia Slater	AK Department of Fish and Game
Ray ReLonde	UAF/MAP
Bob Spies	Chief Scientist, Trustee Council
Gene Therriault	Alaska State House of Representatives

Cherri Womac	Trustee Council Staff
Kevin Callahan	Patton Boggs

G. SUMMARY:

The meeting was convened July 15 at 1:05 p.m. by Chuck Meacham, Vice-Chairperson. After roll call, the January 22, 1999 Meeting Summary was approved.

Molly McCammon reported on Trustee Council (TC) activities. She reviewed the action the TC took on the Restoration Reserve (the resolution and budget sheets were mailed to PAG members). Of the estimated $170 million to be in the Reserve by October 2002, $55 million will be for habitat protection (mostly small parcels) and $115 million will be for research, monitoring, and general restoration. This distribution has made it easier to work towards getting Congressional action to allow the TC to invest funds outside the Court System to gain a higher rate of return.

The PAG discussed the reserve. The current boundaries of the Court Settlement still apply. McCammon said the current approach for the Reserve projects (to start in FY 2003) is to focus on an ecosystem level approach in the marine environment in the spill area. Projects still need to relate to resources and services injured by the spill or connected to the overall marine ecosystem. No decision has been made about reopening the Settlement to obtain additional funds from Exxon.

Jim King noted that research is what highly trained academics do, and monitoring is what agency technical types do. He questioned the relation to normal agency work. Stacy Studebaker said flexibility is needed in spending so that other potential impacts to injured resources could be addressed.

Sheri Buretta asked about the availability of $20 million for community based projects. She wants to involve local people in funding decisions. Chuck Totemoff stated that community projects can provide new sources of food and should be continued. Brenda Schwantes asked if we have moved toward people and economic issues. McCammon replied that dealing with injured resources was still the requirement of the Settlement. Dave Cobb said he would like to see the TC support using $20 million of the Reserve for community based projects. Chris Beck would like to discuss other options before voting on this. Totemoff wondered if $20 million was enough. It is not clear what the definition of "community based" is.

McCammon said that Representative Therriault introduced a resolution (mailed to PAG members) supporting improved investment of funds and use of Reserve funds for research and possibly endowed University chairs. University of Alaska President Hamilton has also voiced support for this resolution. McCammon said the focus now is on developing a long-term plan and then looking at whether endowed chairs would be useful in implementing it. Therriault said that he was pleased with the steps the TC had taken. He said many in the legislature felt enough land had been purchased and now the focus should be on studying the ecosystem to better understand our resources.

McCammon reported that the Murkowski bill to change how EVOS funds are invested is still

in Congress after two years of effort. She hopes it will pass this year so that it can be implemented by January 2000. EVOS funds could be managed by a State fund or private investment manager. The $170 million Reserve estimate is now based on a 5% interest rate.

McCammon gave an update on the habitat protection program. The Eyak and Afognak Joint Venture deals are done. The TC is still working with Koniag on an expanded conservation easement for the Karluk and Sturgeon Rivers. The status of small parcels is included on the spreadsheet attached to the Restoration Resolution mailed to PAG members.

McCammon discussed the work being done to prepare a draft of the Gulf Ecosystem Monitoring (GEM) program (see handout #2), which would provide for long-term monitoring of the marine ecosystem. A fall workshop is planned with PAG members. This program needs to be ready by FY 2003. The National Academy of Sciences has agreed to review the program design if funded by the TC. The staff are looking at other monitoring efforts in the area and how they interrelate. Bob Spies noted that long-term cycles in the Northern Gulf of Alaska affect resources and human uses. The program would be geared toward answering specific questions and developing tools for managers to use for better management and stewardship. McCammon estimated $5 million per year would be available for this at a minimum, including administration costs.

Dan Hull said that it is important to use existing information (especially for human activities) and incorporate this into GEM. Beck agreed, stating that impacts of human activities should be monitored. Meacham suggested a PAG workgroup might be of help. King suggested University Chairs could do some of this work. Schwantes said she did not know if this was the way to go. Meacham suggested the program description talk about how products can be meaningful to people and involve communities. King questioned the lack of involvement of the University. Spies explained that he had spent time at UAF in developing the first draft and that a university representative would be at the next meeting.

King said that financial expertise would be useful to advise on how to manage the Reserve funds. Studebaker asked about the future of the PAG. McCammon said that was a topic for future discussion.

Cobb outlined the suggested $20 million community based project funds as an "earmarked" intersection of funds for research, monitoring and general restoration projects. He said they should meet the criteria for project approval. $20 million is about 14% of the $115 million portion of the Reserve. Buretta said that communities often cannot successfully compete for funds. Ed Zeine agreed. Schwantes said community funds must be separate or they will be "lost." Studebaker noted that a problem is underutilization of local people in projects. Howard Valley said that there will always be more projects than funds to go around. McCammon asked about the need for geographic balance in fund allocation. Meacham stated that scientists have an advantage over communities in proposing projects–an incentive is needed to get more community involvement.

The following was discussed extensively by the PAG: setting aside an amount of the Reserve for community based projects where proposals compete and must meet the standard criteria for approval, but if all of the earmarked funds do not get used in a fiscal year for community based

projects, those funds would stay available for future community based projects. Spies suggested someone needed to work with communities on proposal preparation.

Formation of a workgroup was discussed. McCammon suggested perhaps a teleconference before the October GEM workshop.

After a recess, PAG members attended the 7:00 p.m. public hearing on the Draft FY 2000 Work Plan.

The meeting reconvened July 16 at 8:30 a.m.

McCammon introduced the FY 2000 Draft Work Plan (mailed to PAG members). The target amount is about $8-9 million for projects. Current recommendations for proposals are to fund 59 projects, defer 17 projects until current work is completed, and to not fund 57 proposals.

McCammon noted the recent loss of several staff: Jeff Lawrence, Eric Myers, and Stan Senner. Senner's position is the only one to be filled.

Spies went through the Draft Work Plan, by cluster, identifying projects in the fund, fund contingent, and defer categories.

McCammon noted that a weakness with herring research is that there is no one expert pulling all the information together and synthesizing it.

Chip Dennerlein supported naming halibut in project 478, since this is important research. Project 557 has merit–overwintering information is key. Studebaker thinks that winter research is often not done, and 557 would be a good project. Spies said they will reexamine 557. Cobb suggested adding king crab surveys to the spot shrimp surveys project. Totemoff suggested that landowners as well as tribes needed to be involved in project 052. Schwantes suggested a scholarship program to get local communities involved. Dennerlein suggested a mentor program or workshops to improve local participation. He also asked if a follow-up was possible to verify results of Kenai River bank stabilization projects.

McCammon said that project 605 was to upgrade the EVOS web site to make information more available (see handout #5). She asked for comments on this project and on project 100 (see handout #4), the administrative budget. Next year will see a cut in PAG costs by holding two meetings by teleconference and by eliminating the PAG field trip. There will be two in-person meetings. Next year's proposed meeting schedule (see below) was reviewed. Issues for PAG discussion include: GEM, long-term small parcel program, long-term governance, and future public input.

The field trip itinerary (see handout #6) was discussed.

Meacham listed FY 2000 projects that PAG members felt needed additional attention:

00487 pink salmon straying
00396 shark study

00557 overwinter food studies
00482 PSP testing
00052 community involvement

King praised the EVOS staff for their good work and an outstanding process. Studebaker said she would like to see tree-ring analysis part of the long-term monitoring effort, and an examination of contaminants in the North Gulf of Alaska. Zeine said he appreciated the process. Meacham suggested the PAG give a commendation to Myers and Senner for their good work at EVOS.

The meeting adjourned July 16 at 12:10 p.m.

H. FOLLOW-UP:

1. PAG members are to get their fall schedules to Cherri Womac so she can schedule the fall field trip, tentatively set for September 7-8.
2. McCammon will prepare a commendation for Myers and Senner to be signed by members of the PAG.
3. McCammon will schedule a teleconference on community based projects prior to the October GEM workshop.

I. NEXT MEETINGS:

September 1999 Field Trip
October 1999 Workshop on GEM
January 2000 EVOS Annual Workshop
Early-June or Mid-July 2000 Meeting on FY 2001 work plan

J. ATTACHMENTS: (Handouts, for those not present)

1. Summary of Areas of Agreement re. Restoration Reserve (PAG June 2, 1998)
2. GEM Working Group
3. Clarence Petty letter to the TC
4. Project Management (Project 00250) Budget
5. Project Number 00605 Draft Proposal
6. Tentative PAG Filed Trip Itinerary

K. CERTIFICATION:

_____ _____

PAG Chairperson **Date**

TRUSTEE COUNCIL ACTION (8/9/99) / FY 00 WORK PLAN

Proj.No.	Project Title	Proposer	Lead Agency	New or Cont'd	TC Approve 8/9/99	Deferred to December	FY01 Recom.	FY02 Recom.	Total FY00-02
00391	CIIMMS: Cook Inlet Information Management/Monitoring System	K. Zeiner/ADNR, J. Hock/ADEC	ADNR	Cont'd 2nd yr. 2 yr. project	$0.0	$600.0	$0.0	$0.0	$0.0

Project Abstract

The Cook Inlet Information Management/Monitoring System (CIIMMS) will provide a wide range of users the opportunity to share and access valuable information and data about the Cook Inlet watershed and Cook Inlet-related activities. CIIMMS potential users include educators, scientists, students, researchers, resource managers, private organizations and individual citizens. CIIMMS will provide an interactive website for the Cook Inlet community to efficiently and effectively contribute, identify and access relevant information from a distributed network of providers.

Chief Scientist's Recommendation

This is an ambitious project to develop and test a Cook Inlet information management system. The project received funding in FY 99 to develop a prototype, which has not yet been completed or evaluated. There continues to be concern, therefore, about the schedule proposed for this project. The very large budget proposed here is not adequately justified, and exceeds the expected FY 00 level. The budget needs to be broken out by function, and much more detail for the large subcontract is needed. Further, it is hard to justify a commitment to this very large effort without completion and evaluation of the prototype promised in FY 99. Finally, for the amount of funds requested, the link to EVOS injury and recovery objectives is very weak. Defer at original budget level pending completion and evaluation of the prototype promised in FY 99.

Trustee Council Action

Defer decision on funding this project until the prototype called for in FY 99 has been completed and evaluated through the Trustee Council's established peer review process as well as by potential users. Following prototype evaluation, the Detailed Project Description may need to be revised. The budget will need to be revised so that it does not exceed the projected amount ($600.0); an amount less than $600.0 may be determined to be appropriate once the prototype and the Detailed Project Description have been reviewed. Long-term funding sources for CIIMMS still need to be identified.

Cook Inlet Information Management/Monitoring System

Project Number:	00391
Restoration Category	Monitoring
Proposer:	ADEC/ADNR
Lead Trustee Agency	ADEC/ADNR
Cooperating Agencies	USEPA, USGS, USFS, ADF&G
Alaska SeaLife Center	N/A
Duration:	1 Year (2nd year of 2 year project)
Cost FY 99:	$335.0
Cost FY 00:	$794.1
Geographic Area	Cook Inlet
Injured Resource/Service:	All

ABSTRACT

The Cook Inlet Information Management/Monitoring System (CIIMMS) will permit a wide range of users with the opportunity to share and access valuable information and data about the Cook Inlet watershed and Cook Inlet-related activities. CIIMMS potential users include educators, scientists, students, researchers, resource managers, private organizations and individual citizens. CIIMMS will provide an interactive website for the Cook Inlet community to efficiently and effectively contribute, identify, and access relevant information from a distributed network of providers.

INTRODUCTION

The Cook Inlet Information Management/Monitoring System (CIIMMS), Project 99391 was funded in FY 99 to conduct a User Needs Analysis and develop a prototype system as an evaluation tool useful for development of a final set of system specifications. Deliverables associated with the FY99 effort include:

1. User Needs Analysis – completed February 28, 1999.
2. Identification and Preliminary Prioritization of Datasets – completed February 1999.
3. Prototype – expected completion date, August 31, 1999.
4. Preliminary System Specifications – expected completion date, September 30, 1999.

To ensure CIIMMS is a valuable tool for a diverse community of information users and providers, the CIIMMS Project Team conducted an extensive User Needs Analysis that included:

- Compiling a database of probable users and/or information suppliers.
- Distributing a comprehensive 60-question survey to all contacts in the database, compiling and analyzing the results.
- Conducting project briefings and discussion groups in communities and organizations in the watershed.
- Conducting follow-up interviews with various survey respondents and participants.

The investigations of the User Needs Analysis covered the following topics:

- Inventory of products and/or output generated
  1. Impetus for information management efforts (e.g., mission statement, directive, work plan).
  2. Common information requests and/or analyses.
  3. Final products or output generated from Cook Inlet information/information management.
- Future activities
  4. Impetus for future activities.
  5. Summary of future activities.
  6. Information and data types and associated software, hardware, and telecommunication capabilities required to meet future activities.
- Information/data description
  7. Types and sources of data/information used and/or processed.
  8. Means of accessing information (telephone, email, ftp etc.).
- Information processing.
  9. Format and processing steps for information/data received.
  10. Format and processing steps for information/data generated.
- Vision or wish list for information management.
- Inventory of software, hardware, and telecommunications capabilities.

Information gained from these investigations was provided to participants at a User Needs Workshop held in January of 1999. Over 100 people attended the workshop to validate survey results and discuss the following questions:

- What questions should CIIMMS address?
- Which users should CIIMMS accommodate?
- What information should be included in CIIMMS?
- What should CIIMMS accomplish (system functions)?
- What products should CIIMMS be able to generate?
- What system design should CIIMMS adopt?
- How can we make CIIMMS happen?
- What kind of user interface should CIIMMS have?
- What information should be included in CIIMMS?

The results of this extensive user needs analysis forms the basis for a prototype implementation plan, scheduled for completion by April 30, 1999 Results of the user survey and workshop (Post Workshop Report) as well as the detailed prototype implementation plan (CIIMMS Implementation Plan) can be found on the CIIMMS web site at www.oilspill.state.ak.us. The implementation of the prototype focuses on short term priorities identified in the User Needs Analysis process in a limited geographic area, the Kenai River watershed (see Appendix A: "Design Summary for CIIMMS Prototype").

Short term priorities scheduled for inclusion in the prototype include the following features:

- Categorical indexes for Cook Inlet information inventory
- Keyword and advanced metadata searching
- Restoration project activities
- Ability to view, download, and print static maps and web documents (for not more than 10 priority data themes selected for use in the prototype)
- Metadata records linked to actual data and summary information (e.g., fact sheets), data quality documentation
- Hotlist of all related offsite links
- Form for suggesting information and links to add to clearinghouse
- Metadata entry tool to populate clearinghouse
- Training materials and a CIIMMS user manual

In the Initial Production Phase of CIIMMS (FY 00), with the prototype "framework" in place, the CIIMMS project team will focus on making additional datasets and information available to the CIIMMS community. The specifications for this phased-in approach to data and information integration will be implemented according to the specifications developed from the results of the prototype evaluation. Medium term priorities, as identified at the January 1999 user needs workshop, will be integrated into the CIIMMS system during FY 2000 (CIIMMS year 2).

Medium-term priorities include the following :

- Expansion of access to data and information, *including traditional ecological knowledge*, building on the few datasets available via the prototype, to include data for various watersheds throughout the Cook Inlet basin;
- Population of the metadata databases (both spatial and non-spatial metadata) for priority datasets for various watersheds throughout the Cook Inlet basin;
- Develop a web-accessible visualization tool.

NEED FOR THE PROJECT

Statement of Problem

The Cook Inlet watershed is a large and complex ecosystem containing a diverse and abundant biota subject to intense physical forces as well as increasing human influences. A majority of Alaska's population lives, works, and recreates in and adjacent to this watershed. Cook Inlet is an area where leasing, exploration, development, and production of oil and gas resources are on-going and important activities. In 1996 the Minerals Management Service offered about 1.98 million acres for leasing (MMS 1996). In the same year, the State of Alaska, Dept. of Natural Resources, offered for lease approximately 1,063,423 acres of State-owned onshore and offshore land for petroleum exploration and development (ADNR 1996). Timber harvest, mining, commercial, sport, personal-use and subsistence fishing and urban development are also taking place within this watershed. This area is important to both Alaska residents and tourists for recreation.

Communities and industry operating in the watershed generate waste streams that may be entering, degrading, and affecting the recovery of resources/services. Monitoring populations of injured resources/services and effective management of their habitats that will facilitate their recovery requires a watershed-based management approach that encompasses entire ecosystems. This approach requires managers and scientists to "distinguish between natural and human-induced changes in the marine ecosystem" (Spies 1997). Pollution-caused water quality degradation, for example, could impact sensitive species or their habitats thereby exacerbating the injury and adversely affecting recovery. Toxic levels of contaminants can make fish and shellfish unfit for human consumption. Even the presence of pollutants below toxic levels can affect the public's perception of quality and safety, thereby affecting their purchasing habits for fish and shellfish. "Toxic materials can damage or stop the biological processes occurring in the aquatic ecosystems, including long-term inhibition of growth, reproduction, and migration of organisms, and have adverse effects on the rate of degradation of biodegradable contaminants" (Novotny and Olem 1994).

Each year, industry, government, the scientific community and citizen watchdog groups generate and use large quantities of information about this area and its resources. Typically this information is used to focus on a single resource, issue, or problem and data management techniques are used that are specific to that need. Watershed management, on the other hand, has a scope that

requires evaluation of a much broader spectrum of factors within a defined geographic area. In most large, intensively used and managed watersheds, such as Cook Inlet, some stakeholders collect and analyze samples and generate data, while others rely on data to monitor resources, conduct research, or make management and policy decisions.

Management and planning for development within these large areas calls for participation by federal, state and local governments as well as the public. Multiple stakeholders and scientists from many disciplines may be involved and need access to relevant data used in making and or reviewing management and policy decisions. Potential users of CIIMMS include Federal, State, borough, and municipal government agencies, industry, scientists, the environmental community, and public oversight groups with an interest or mandate to manage the watershed. Many of these entities have already generated datasets relevant to management of the watershed that may be considered for inclusion in the system.

Projects that are characterized by complex data relationships, such as recovery monitoring of species populations and ecological processes, need efficient data access, integration and analysis. This is also true of ecosystem-level research projects, watershed management and monitoring, and planning and regulation of development activities conducted over large geographic areas. These activities become more efficient when relevant data is accessible, related and integrated. Managers are more likely to make decisions which benefit injured resources and services and their associated habitats if they can access and visualize information about resources and relationships between resources and proposed development.

B. Rationale/Link to Restoration

"Realistic ecological assessment" of the recovery of resources/services injured by the *Exxon Valdez* oil spill "requires long-term monitoring of salient patterns and processes at appropriate spatial and temporal scales using sound sampling design and statistical analyses" (Michener 1997). This strategy was echoed by the Chief Scientist (Spies 1997) in his description of a "...permanent, adaptive, interdisciplinary monitoring and research program that would track, and eventually help predict ecosystem changes and provide a basis and mechanism for long-term restoration, enhancement, and wise management of marine resources in the northern Gulf of Alaska."

This plan is supported by the Trustee Council's increased emphasis on "integration and synthesis of what has been and is being learned from various restoration projects and the earlier work conducted during the damage assessment phase." As Stated in the Ecosystem Synthesis section of the 2000 RFP (Trustee Council 1999): "The integration and synthesis of project results will enable the Council, the scientific community, and the public to view the effects of the oil spill and the long-term restoration and management of injured resources/services in broad, ecological contexts. Having the benefit of these perspectives not only aids interpretation of past results in regard to injury and recovery, but also provides an improved framework for development of long-term restoration, research, monitoring, and management plans."

CIIMMS will contribute toward recovery of the *Exxon Valdez* oil spill injured resources and services by facilitating management and planning within the Cook Inlet watershed by improving access to information relative to injured resources/services and their habitats in the Inlet. CIIMMS

can provide a tool to help make Trustee Council funded research readily available to resource managers.

CIIMMS will help recovery of injured resources/services by facilitating management and monitoring efforts by:

1. Providing access to more complete resource information to decision-makers and the public.
2. Provide maps, publications, and data pertinent to injured species' habitats, movement corridors and environmentally sensitive areas.
3. Provide EVOS researchers and agency resource managers the ability to easily access and view a variety of metadata and datasets.
4. Provide information to regulators to help them review permit applications with recovery of injured resources/services in mind.
5. Provide a framework for analysis capabilities with base map and resource data, via a web accessible visualization tool.
6. Provide an easy tool for EVOS researchers and agency resource managers to contribute and share information on projects, reports, data, and funding sources, for coordination purposes.

C. Location

Design and development components of the project will take place in Juneau and Anchorage. Project benefits will be realized throughout the Cook Inlet watershed. Communities that may be affected by the project include Anchorage, Homer, Kenai, Nanwalek, Nikiski, Ninilchik, Port Graham, Seldovia, Soldotna, and Tyonek.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

To ensure that the proposed system will deliver the appropriate information in a format useful to stakeholders in the watershed and to ensure effective technical system implementation, a CIIMMS Advisory Group will be established to provide direction and feedback.

Membership of the advisory group will initially be derived from an existing group, known as the Cook Inlet Coalition, and supplemented by representatives from other stakeholder groups. The Cook Inlet Coalition is an organization facilitated by EPA to encourage the exchange of information and coordinate management and research efforts in Cook Inlet.

Ultimately, the advisory group membership will be representative of the following:

- A broad array of stakeholders to ensure that all potential users of CIIMMS information, from public citizens to government agencies, are represented

- Providers of spatial and non-spatial data (*all* data-providing and information-generating agencies and organizations should be represented, to the degree that this is possible)
- Providers of summary level information, such as public outreach materials
- Participants involved in all aspects of resource information management, from using information to creating databases.

A meeting of the Cook Inlet Coalition, in order to discuss the CIIMMS Advisory Group, is scheduled for May 11, 1999.

Traditional Ecological Knowledge

A medium-term priority of the stakeholders which surfaced at the CIIMMS user needs analysis workshop was the need to provide a tool for collecting traditional ecological knowledge (TEK), as well as providing access to it. Medium-term priorities for the CIIMMS project will be implemented during FY 2000.

A. Objectives

To provide a way for the Cook Inlet community (resource managers, scientists and researchers, educators, students, industry, and individual citizens) to identify, share and access valuable data and information about the Cook Inlet watershed from a distributed network of data and information providers.

B. Methods

The method and tasks outlined below encompass the design and development of a web-based information system, utilizing a hybrid centralized/distributed database design for both primary data and summarized information. Metadata for non-geospatial data will reside primarily on the CIIMMS site and geospatial metadata will be stored and accessed from the two Alaska clearinghouses currently in use for that exact purpose.

The proposed approach for implementing the Initial Production Phase of the Cook Inlet Information Management/Monitoring System includes the following steps:

Step 1: Continue evaluation and testing of CIIMMS prototype (deliverable 99391).

Step 2. Review preliminary system specifications (deliverable 99391).

Step 3: Develop final system specifications and implementation plan.

Step 4: Apply prioritization model for access/acquisition of additional datasets.

Step 5. Finalize data and metadata standards

Step 6: Provide guidance and metadata assistance to CIIMMS' data providers

Step 7: Expand number of distributed sites for access

Step 8: Design, develop and deploy visualization tools

Step 9: Develop a long range implementation, training, and maintenance plan.

Step 1. Continue evaluation of CIIMMS prototype.

Evaluation of the prototype developed as part of FY 99, 99391 will continue through the first quarter of this fiscal year in order to ensure that a large cross-section of the user community is given the opportunity to provide feedback. Training of potential users and subsequent evaluation of prototype functionality will be carried out by staff of DNR, DEC, and Cook Inlet Regional Citizen's Advisory Council.

The prototyping cycle is an iterative process that introduces the prototype to CIIMMS participants and allows the Project Team to observe use patterns and solicit additional input from potential users. Initial review of the prototype will result in a preliminary analysis of training and access needs for various user groups. The development and evaluation of the prototype will require numerous reviews by project participants. Throughout this iterative process, deficiencies will be identified and enhancements incorporated into system specifications.

The prototyping process will include criteria for measuring success. Some of the criteria or evaluation questions include:

- Can CIIMMS effectively and efficiently provide a way for Cook Inlet users to identify, access, and contribute to Cook Inlet data and information, for the purpose of addressing specific resource questions?
- Does CIIMMS appeal to the diversity of users, their styles, and information needs?
- Is a geographically distributed database feasible in the Cook Inlet area where there is a multitude of users and contributors operating under different circumstances?
- Is CIIMMS feasible given the hardware, software and telecommunications capabilities of Cook Inlet stakeholders?
- Is CIIMMS easily accessible to users? Can data be accessed and acquired in a reasonable timeframe?
- Is desired data available and in a useable format?

Step 2. Review preliminary system specifications.

Preliminary system specifications developed as part of project 99391 will be posted on the CIIMMS web site for review and comment by the user community. The CIIMMS Advisory group will also meet to review and carefully analyze the preliminary system specifications and develop specific recommendations for incorporation into the final set of system specifications. Follow-up meetings with stakeholders will be conducted by the project team in order to ensure representation of the entire user community.

Step 3. Develop final system specifications and implementation plan.

After short-term functions are accepted in the pilot phase (see Appendix A: "Design Summary for CIIMMS Prototype"), the Initial Production Phase will be implemented. This phase will occur between October 1, 1999, and September 30, 2000. During this phase, all short- and medium-

term functions will be operational for the entire Cook Inlet watershed (see pages 3-4 for listings of short- and medium-term priorities).

The CIIMMS design will employ a hybrid centralized/distributed system, more centralized in the early stages, and then migrating towards a more distributed design. In the beginning, a few distributed sites plan to be accessible via CIIMMS. As agencies and organizations become more successful at providing access to their own data and information using emerging web technologies, CIIMMS will provide guidelines and technical support to enable the migration to a more distributed system. These pioneer sites will provide guidance to organizations interested in providing data and information access via CIIMMS.

CIIMMS data standards will be established through cooperation with the Alaska Geographic Data Committee and the CIIMMS Advisory Group. These standards will lay the technical foundation for CIIMMS to eventually incorporate new distributed technologies. Such technologies will allow the CIIMMS community to access and view spatial and tabular data without special software or having to download the data.

Step 4. Apply prioritization model for access/acquisition of additional datasets

Workshop discussions confirmed that there is a wide range of individuals, organizations, academic institutions, and government agencies that contribute to and use Cook Inlet information. This diverse user group generates and seeks access to all levels of information, including public documents, research and management documents, summarized public documents, processed data and primary data.

Through the CIIMMS User Needs Questionnaire and the User Needs Workshop two lists of user priorities for data were generated. The User Needs Questionnaire ranked 132 different data types/categories for short, medium and long term priority. From this list, User Needs Workshop participants selected a prioritized list of 37 of their top data needs. The list of user priorities is a heterogeneous set of data types, databases and data categories. In order to prioritize data sets to be included in CIIMMS, the following tasks have been or will be completed:

1) the user priorities from workshop were aligned with actual data sets in the CIIMMS data inventory; the result of this alignment is available upon request;
2) two sets of criteria (primary and secondary) will be applied sequentially to the aligned data list to further rank the data for inclusion into CIIMMS. The primary and secondary criteria are listed below:

   Primary criteria:

   - Importance to the success of the project
   - Resources needed to acquire the data
   - Effort required incorporating the data in CIIMMS
   - Update/long term maintenance requirements
   - Availability of information from multiple levels of the information pyramid
   - Geographic extent

Secondary criteria:

- Duplication and redundancy
- Scale
- Accuracy
- Status
- Currency
- Format
- Organization
- Adherence to data standards

These two sets of ranking criteria will be applied to the data sequentially. The first set will be used to create a prioritized list of data and data types for inclusion in CIIMMS. The second set of criteria will be used to select between data of the same type. Using the prioritization scheme as guidance, access to the datasets will be incorporated into CIIMMS.

Step 5. Finalize Data and Metadata Standards

Although a variety of standards exist, all potential users and contributors have not adopted a comprehensive standard. Identification and adoption of standards by all users is a contentious issue because it affects all levels of data collection, analysis and reporting. Since data brought into this system will come from a myriad of sources it is important to develop project specific standards that will facilitate access and use of the system.

The CIIMMS project team will start with data standards for water quality, since data standards for water quality are driven largely by the US Environmental Protection Agency (EPA). EPA is currently working closely with US Geological Survey to evaluate and standardize common sampling and analytical methods related to water quality. Data *quality* issues have been addressed for the Kenai River watershed by The Nature Conservancy. See *Framework for Water Quality Monitoring of the Kenai River*[1] for details. The project team will investigate how this "framework" might be applied to the Cook Inlet basin. The production of a water quality data dictionary is a deliverable for this step, and will provide a template for additional applicable data themes.

Based upon user needs and input, project staff will adopt standards for process and content as required to meet user needs. The Cook Inlet Coalition/CIIMMS Advisory Group will provide ongoing review and feedback as these water quality standards are developed. These standards will set a target for data generators to meet. Current standards will be used where they already exist.

The starting point for developing CIIMMS metadata guidelines was a review of existing guidelines such as those developed for EPA's Chesapeake Bay program. The Chesapeake Bay Metadata Guidelines were developed through extensive stakeholder consensus-building within a watershed community of comparable geographic size to Cook Inlet, and the CIIMMS project

[1] The Nature Conservancy, 1998. "Framework for Water Quality Monitoring of the Kenai River."

wants to take advantage of this work that has already been done. Key aspects of these guidelines include:

- Guidelines incorporate required fields from FGDC (Federal Geographic Data Committee) Metadata Standards, while permitting usage of NBII biological metadata fields and optional FGDC fields. See *Content Standards for Digital Geospatial Metadata Workbook*[2] for details.
- Guidelines extend beyond geospatial data sets to address many other kinds of non-geospatial data and information that the Cook Inlet users hope to be able to access.
- Fields are organized to minimize data entry for non-geospatial information by using three successively comprehensive tiers of requirements: (level 1) fundamental bibliographic metadata for all information types, (level 2) specific fields for tabular data sets, and (level 3) comprehensive geospatial metadata for GIS related data layers.
- A controlled lexicon of watershed-related terms, local place and organizational names are used to limit the domain of subject, place, and source keywords, thereby simplifying the domain of field-specific search terms.

Metadata entry burdens might be minimized by considering another tier to the existing Chesapeake guidelines (i.e. level 0), that could be used by non-technical users to enter short references to non-geospatial information, like fact sheets, press releases, and the like.

The Chesapeake Bay existing metadata guidelines will be revised for Cook Inlet and posted to the CIIMMS website. The controlled lexicon for subject keywords will be simplified since such a complex system for keywords won't be required for the Cook Inlet basin. These subject keywords, data inventory classes, and other fields which have been built for the Chesapeake Bay will be modified to accommodate the data and information of Cook Inlet.

Step 6: Provide guidance and metadata assistance to CIIMMS' data providers

Using the CIIMMS web-accessible metadata entry tool, the project team and strategic members of the CIIMMS Advisory Group will provide metadata training, and metadata entry services where needed in order to populate the CIIMMS metadata database. Where metadata for geospatial datasets are created, they will be uploaded to the AGDC (Alaska Geospatial Data Clearinghouse) or ASGDC (Alaska State Geospatial Data Clearinghouse), whichever is deemed appropriate.

A considerable effort will be made by the CIIMMS project team to document even non-digital data, so that it may be made discoverable via CIIMMS. Guidelines will be provided, as well as technical assistance where necessary, to help make priority data sets accessible via CIIMMS.

Step 7. Expand number of distributed sites for access.

Primary and high priority datasets that are in compliance with documentation and process standards will be made accessible to the system. Other compatible datasets, accompanied by metadata files, will be linked to the system as time and budget constraints allow. Updates to

[2] Federal Geographic Data Committee. "Content Standards for Digital Geospatial Metadata Workbook (Describes the June 8, 1994 version of the metadata standard) Workbook Version 1.0, March 1995.

existing datasets and new datasets will be evaluated for compliance with standards and brought into the system over time.

Project participants recognize the complexity of data management tasks including data cleanup, QA/QC, conversion, integration and documentation. These tasks are elements of the overall approach for incorporating required datasets into the system. An accurate assessment of the scope of work and resources required to carry out data conversion first requires identification, evaluation, and prioritization of essential datasets, and establishment of data, and documentation standards. It is reasonable to expect that a substantial effort may well be invested in these activities. Data priorities must guide the conversion effort within budgetary constraints. The estimated budget provides conservative controls on a potentially vast undertaking.

Step 8. Design, develop, and deploy visualization tools.

The objective of providing a set of visualization tools is to aid users in determining the usefulness of the data for a specific purpose. The current technology for visualization tools on the web is a moving target. Because the development of the prototype is driving the need and design specs for a visualization tool, it is difficult to define what technology will be used to build this functionality. Guidelines for tool design will include the following:

- the tool must be easy to use;
- it should take into account the very latest web technologies (i.e. distributed technologies);
- it should utilize/integrate current off-the-shelf products;
- it should be browser-based;
- user shouldn't have to download data to use the tool.

The visualization tool will be developed after the priority datasets, based on the user needs analysis and the CIIMMS prioritization scheme, and or/metadata have been made available through CIIMMS.

Step 9. Develop a long range implementation, training, and maintenance plan.

A plan will be developed for maintaining the system and transferring, relating, integrating and updating data over the long run. The plan will include staffing, training, hardware and software, application and networking recommendations. Deliverables associated with Step 9 include CIIMMS System Documentation, Training Manual, and On-line User's Guide.

ADEC has committed to the long-term maintenance of the information management/monitoring system subsequent to completion of this project. To this end DEC has committed the following hardware and software resources to this project at a cost of $25,000. The CIIMMS Database Server will be a Compaq 2500 SQL Server with three 9 gigabyte SCSI Drives (RAID5) and 128 Megabytes of memory. The CIIMMS Internet Server will be a Compaq with three 4.5 gigabyte SCSI Drives (RAID5) and 128 Megabytes of memory. Both systems will be backed up nightly. The system will be housed at the Alaska Department of Environmental Conservation in Anchorage, Alaska. The operating system for the CIIMMS Database Server will be Windows NT. The CIMMS metadata database will be developed in Microsoft SQL Server 7.0. The Internet

Server will run Microsoft's Internet Information Server (IIS) on Windows NT. In addition to CIIMMS these servers may run additional ADEC processes.

The ADNR Commissioner has committed the agency to maintaining the associated GIS coverages supporting this application as part of their on-going role in maintaining a National Geospatial Data Clearinghouse node at ADNR. Staff have been identified to work directly with the contractor to ensure that a complete understanding of the system resides with the agencies and that long-term maintenance requirements are reasonable.

C. Cooperating Agencies, Contracts and Other Agency Agreements

The Alaska Department of Environmental Conservation and the Alaska Department of Natural Resources will be jointly responsible for project implementation, drawing upon the expertise within each agency. Both agencies will work cooperatively with technical consultants in the areas of hardware and software upgrade requirements, data acquisition and translation support, application development, and staff training. ADEC will focus primarily on maintenance of the CIIMMS website and server, development and incorporation of DEC databases for access by CIIMMS, and water quality issues and database design (see Step 9, page 12). ADNR will lend assistance in the areas of geo-referenced data issues, visualization tools, and resource management issues.

ADEC will assist the technical contractor in the design and development of the relational database engine. In keeping with its objective, to develop a state-wide watershed approach, ADEC will operate and maintain the information-monitoring system subsequent to completion of this project. This long-term commitment will allow the Trustee Council, the scientific community, resource managers and the public to access information on the recovery of injured resources and services.

ADNR has established a National Geospatial Data Clearinghouse node at the Alaska Department of Natural Resources. The "Alaska State Geospatial Clearinghouse" (ASGDC) has provided an electronic pathway to meet public and inter-agency demands for state and local geospatial data. Data is documented according to the FGDC requirements to ensure consistency and discovery on line. The ADNR Clearinghouse project focuses on and will complement the Alaska Geographic Data Clearinghouse (AGDC) site developed and maintained by USGS. (The CIIMMS search tools will access geospatial metadata from both clearinghouses.)

Alaska Department of Fish & Game will participate with the CIIMMS project in order to incorporate critical habitat areas, anadromous fish stream data, and the conversion of the regional guides for southcentral Alaska. Many of these datasets were identified during the User Needs Analysis Workshop as high priorities. Efforts to get ADFG data into a format that's compatible with public access via CIIMMS include metadata creation, data conversions, database updates and web accessibility. ADFG data that was published on the EVOS Research and Restoration CD-ROM, along with other EVOS data (seabirds, bald eagles, etc.) will be made accessible through the ADNR Alaska State Geospatial Data Clearinghouse.

As a member of the CIIMMS project team, US Geological Survey (USGS) will chair the CIIMMS Advisory Group, ensuring there is a bridge between technical, management, and end-

user concerns. They will provide technical and practical assistance in system design, implementation, and will help ensure that the system will remain usable in the future. USGS water databases are available, but are not currently retrievable via the web. If web accessibility to the water databases is deemed un-doable by the USGS (using their own servers and processes) within the CIIMMS funding and time constraints, USGS will tabulate commonly requested water information and/or data for web retrieval via CIIMMS.

As a collaborator on the project, EPA will provide technical assistance in system design as well as access to the EPA Contractor responsible for designing similar systems in other states. As part of the overall EPA and ADEC objective of a state wide watershed approach, emphasis will be placed on assuring that the project is complementary to the concept of a state-wide "Environmental Information Clearinghouse." EPA will also serve as the facilitator for involvement in the project of other Federal natural resource agencies and will contribute its organizational and leadership skills to ensure continued Cook Inlet Coalition and the CIIMMS Advisory Group involvement. EPA has also agreed to make all of its Water Quality and Permits databases available to the Cook Inlet Information Management/Monitoring System.

The US Forest Service will provide technical assistance in project design in order to ensure agency concerns and project compatibility issues are addressed. USFS will contribute staff resources as needed to address management and scientific needs of the agency in the development of this project.

A consultant will be utilized to facilitate creation of a metadata database and structural framework for the eventual integration of water quality data, EVOS related data, environmental data, etc., into a web-accessible visualization tool. The technical consultant is key to the success of this project. We are working with EPA and will utilize Science Applications International Corporation (SAIC), a National Level of Interest Contractor under contract to EPA with extensive experience in projects of this nature. Similar projects have been implemented by this contractor in Colorado, Montana, Chesapeake Bay, and Jordan.

The contractor will perform most data integration, application development, and user interface development. Where applications can be purchased off-the-shelf, CIIMMS will do so, in order to ensure that future upgrades to the system are automatic, and not dependent on the contractor. This strategy will ensure that contractual dollars are spent on areas where the contractor already has extensive experience, enabling us to benefit from knowledge and products they have developed elsewhere. This strategy will also ensure that project development goes beyond a single agency approach. Alaska agency staff familiar with the data, its limitations, location, and structure will be responsible for most routine data management tasks as well as local coordination and dissemination of information. Agency staff will also be closely involved in application development, data integration and user interface development in order to ensure that maintenance of the system can be accomplished without contractor support.

SCHEDULE

Initial Production Phase (Year 2)
Measurable Project Tasks for FY 2000 (October 1, 1999 -September 30, 2000)

October 1999	Evaluation of CIIMMS prototype continues. Refinement of prototype ongoing. (Step 1, page 8)
October 1999	Review of Preliminary System Specifications. (Step 2, page 8)
December 1999	Finalize System Specifications and Implementation Plan (Step 3, page 8)
January 2000	Implementation of Final System Specifications. Initiate integration of prioritized databases, related information and associated metadata; continue agency staff training as an ongoing evaluation tool. (Steps 4-8, pages 9-12)
August 2000	Access to specified databases completed. Data documentation (metadata) completed.
August 2000	Develop On-line User's Manual, Technical Specifications/System Documentation, including Long-Term Maintenance. (Step 9, page 12)
August 2000	Training and public outreach.
September 2000	Completion of Initial Production Phase of CIIMMS

Project Milestones and Endpoints

Initial Production Phase (Year 2)
(FY 99 October 1, 1999 to September 30, 2000)

October 1999	Schedule meeting of Cook Inlet Coalition/CIIMMS Advisory Group to present preliminary system specifications.
November 1999	Prototype Evaluation Comments Due.
December 1999	Final System Specifications and Implementation Plan Due.
July 2000	CIIMMS Water Quality Data Dictionary

August 2000	Integration/Access to databases, information and metadata, etc.
August 2000	On-line User's Manual and Technical Specifications/System Documentation (including long-term maintenance plan).
August 2000	Staff Training and Public Outreach.
September 2000	Completion of Initial Production Phase of CIIMMS

Completion Date September 30, 2000.

NORMAL AGENCY MANAGEMENT

Resource agency management mandates in the Cook Inlet watershed do not specifically address recovery monitoring or management of injured resources/services or their habitats. Only projects that have been funded by the *Exxon Valdez* Oil Spill Trustee Council have focused on injured resources and services as an objective. Although pollution tracking, permitting, and regulatory activities are normal agency management activities, they are not carried out with the benefit of research specifically addressing injured resources and associated services.

Agency regulatory actions are generally focused on single resource management strategies or individual project implementation. These actions are not necessarily focused on watershed management. Ecosystem or watershed-level management requires access and integration of a diverse array of data from disparate sources. In order for agencies to consider the impact of management and regulatory actions on injured resources and services and their associated habitats, the agencies must be able to integrate and utilize the data and information collected about these resources. Agencies do not normally consider, or have the capability to consider, the impact of management and permitting decisions on injured resources and services.

A comprehensive approach to restoration of injured resources/services with habitats in Cook Inlet would include not only affected species populations, but also consideration of relevant ecological elements on a watershed scale. From a technical perspective, management at the watershed level allows for evaluation and control of pollution and development impacts that would affect recovery of injured resources/services.

In the case of land managers responding to requests for permits in Cook Inlet tidelands, as required by statute, the CIIMMS would allow staff to access, and eventually view existing human uses in the area as well as information concerning habitats of injured resources and services. A decision could be made that factors in the potential impact such an activity could have on injured resources or services. If the location requested by the applicant is deemed unsuitable, state law requires that an alternative must be located or proposed. CIIMMS could be used to direct permitting toward less sensitive areas.

Internet access to data and information used by agencies for permitting and planning decisions would allow the public to become better informed and thereby better able to comment and provide input to federal and state decision-makers. At the present time it is very difficult for the

public and even individuals in other government agencies to locate and access data and information even though the agencies are obligated to make this information available, i.e. FOIA requests.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Key Principal Investigators will be surveyed and asked to evaluate and test the system for usefulness and the ability to accommodate results of their research. It is extremely important that key information derived from EVOS studies be included in this system if end users are to be able to include information relative to injured resources and services in their decision making processes. In addition, coordination with SEA, APEX and NVP, will avoid duplication of effort and ensure that pertinent data and information from those projects can be incorporated into this system.

A project being proposed for FY00 entitled "An Evaluation of the Data System for the Long Term Monitoring Program," will provide valuable background information for the CIIMMS project because web technology and web-based analysis tools are advancing at such a fantastic rate of speed. The collaboration of the CIIMMS project team with the principle investigators on the above mentioned project will be important.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Based on results of the User Needs Analysis phase of CIIMMS, which included the January 1999 User Needs Workshop, the scope of this project has been narrowed to address more specific needs of Cook Inlet users with regard to *access* to data *and information*, as opposed to the actual *integration* of data.

The CIIMMS vision is to enable a wide-range of users (not just scientists and agency personnel) to share and access valuable information about the Cook Inlet watershed and Cook Inlet-related activities. Available information will range from primary data (geospatial, tabular) to reports, project descriptions, and other documents across a variety of themes, such as habitat, land-use, resource management, pollution, and water quality. CIIMMS will provide an interactive website for the Cook Inlet community to efficiently and effectively contribute, identify, and access relevant information from a distributed network of providers.

This process of accessing information and building a distributed network of data/information providers, via the web, is an iterative one. There is a plan, but the practice of adaptive management will be crucial to the success of CIIMMS. We must be open to user input, changes in technology, and able to alter, within reason, the specifications put forth in this document.

PRINCIPAL INVESTIGATORS

Jeff Hock

Jeff Hock has a Bachelor's degree in Environmental Sciences from the University of Virginia with significant coursework in civil engineering. He has been employed in various capacities with the State of Alaska since 1975 in both the Alaska Department of Fish & Game and the Department of Environmental Conservation. As an Ecologist with the ADEC Division of Environmental Quality he has been involved in the design and implementation of a variety of monitoring projects and has extensive experience in quality assurance, project plan development and review, and sampling methodology. He has been instrumental in exploring and implementing new technologies within the Division of Environmental Quality including, modeling software, rapid bioassessment protocols, satellite telemetry, global positioning technology, geographic information systems, and automated water quality data acquisitions and telemetry systems. Mr. Hock's responsibilities also include developing and implementing ADEC's watershed framework by working with local stakeholders, and participating on various statewide water quality planning committees.

Russell Kunibe

Russell Kunibe has an MS and BS in Physiology from UC Davis and has 9 years of experience with the Department of Environmental Conservation both as an Environmental Specialist and as an Analyst Programmer. He is currently responsible for CIIMMS coordination within ADEC. He has served as the department representative to the Statewide GIS committee and Webmasters committee, and was responsible for the initial development of the ADEC website. He has managed the Spill Prevention and Response Division's data management tasks.

In addition Mr. Kunibe has a working knowledge of the Cook Inlet and Prince William Sound areas. He successfully owned and operated his own commercial fishing, boat charter, and dive shop businesses in Homer prior to the *Exxon Valdez* Spill. During the response to the *Exxon Valdez* Spill, Mr. Kunibe managed the DEC Field Office in Homer.

Patty Bielawski

Patty Bielawski has extensive experience as an environmental scientist specializing in facilitating resolution of natural resource program and policy issues; permitting; and analysis of environmental and resource legislation and regulation. She has worked in the private sector as a consulting environmental scientist (BPX, AOGA) and in the public arena as a special assistant to the Commissioner of the Department of Natural Resources (present) and Senior Project Review Coordinator for the AK Division of Governmental Coordination. Ms. Bielawski has a B.S. in Biology from the University of Santa Clara, with specialized training in Environmental Regulation and Legislation, Resource Conservation and Recovery Act, Hazardous Waste Bioremediation, and North Slope Terrestrial Studies.

Her current position as Special Assistant to the Commissioner of the Department of Natural Resources has involved extensive interagency project management efforts and will be invaluable in the implementation and coordination of the scientific aspects of this project.

Kelly Zeiner

Kelly Zeiner has a Master of Science in Spatial Information Science and Engineering from the University of Maine, Orono, and a Bachelor's Degree in Management Information Systems from Northeastern University, Boston, MA. She has extensive experience with Arc/Info, ArcView, and a variety of programming languages (AML, DIBOL, COBOL, BASIC) and computer operating systems (UNIX, Windows). As part of her graduate program she designed and taught a series of 3-day ArcView/Avenue course exercises and lectures at the University of Maine. This experience is invaluable in communicating with potential system users, managers, and scientists and interpreting and understanding their information and analytical needs.

Prior to her experience with ADNR, Ms Zeiner was employed for five years in the private sector and worked in business programming application development. Responsibilities related to programming included user needs analysis, systems design, coding, testing, and implementation of new and in-place applications.

Ms. Zeiner has been employed at DNR since 1992 and has extensive experience with *Exxon Valdez* Oil Spill data and project demands. Final products of her work on EVOS related projects include applications ("EVOS Oil Spill Research & Restoration Information Project"), maps, slides, and reports on analyses performed. Ms. Zeiner has also designed and built a prototype application using ArcView 3.0 for viewing and querying ADNR's statewide parcel-level database, including an SQL connection to a massive land records database. In addition, Ms. Zeiner has designed a prototype application based on the State of Florida's Oil Spill Contingency Planning tool using ArcView 3.0 adapted for use in the State of Alaska.

Leslie Patrick

Leslie Patrick has a MS in Science Management and BS in Geology from the University of Alaska. She has been employed in various capacities with the USGS since 1975. Many of her current responsibilities focus on ensuring that project planning and results adapt to modern technology while retaining scientific integrity. Her career experiences span scientific, technical, supervisory, administrative, and management functions. She has been categorized by titles such as project hydrologist, database manager, computer programmer, GIS specialist, systems analyst, project coordinator, operations manager, and facilitator. Whatever the actual function, she has served as a catalyst of change, moving from old processes to new.

KEY PERSONNEL

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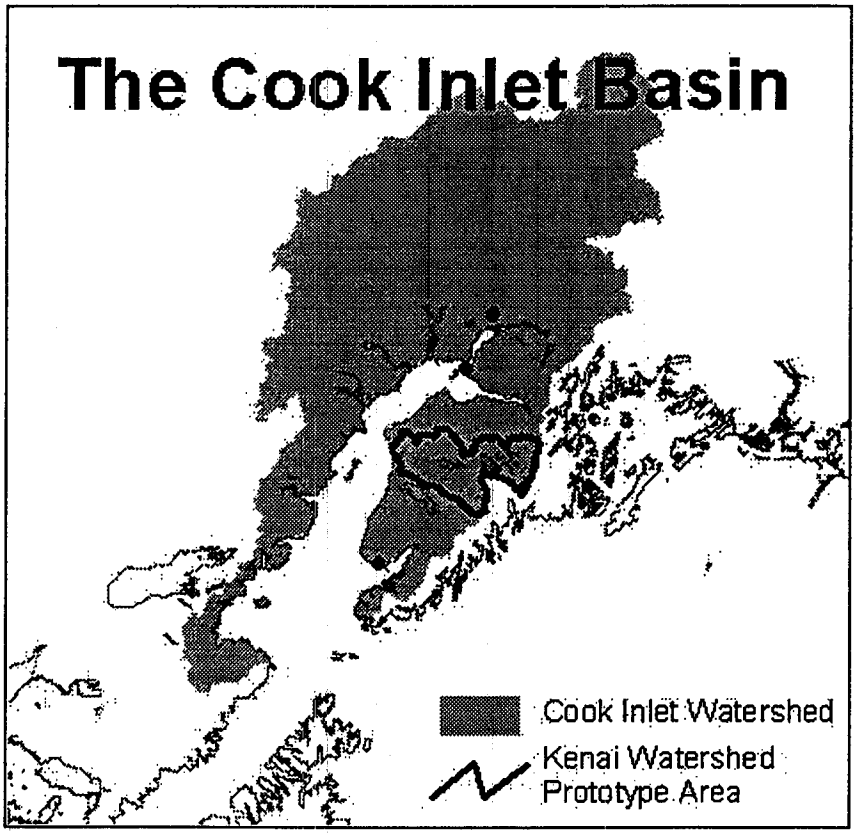
APPENDIX A
DESIGN SUMMARY FOR CIIMMS PROTOTYPE

Geographic Scope	Kenai River Watershed (see above map)
Information Types	Users' highest short-term priorities
Information Sources	ADEC, ADF&G, ADNR, Kenai Peninsula Borough Planning Department, USGS, and others
Functions	Users' short-term functional priorities and groundwork for medium-term functional priorities
Information Features	
-- *Identifying*	• Categorical indexes for Cook Inlet information inventory • Keyword and advanced metadata searching • Restoration project activities
-- *Accessing*	• Ability to view, download, and print static maps and web documents • Metadata records linked to actual data and summary information (e.g., fact sheets), data quality documentation • Hotlist of all related offsite links
-- *Contributing*	• Form for suggesting information and links to add to clearinghouse • Metadata entry tool to populate clearinghouse
Evaluation Tools	• User feedback form • Counters to track number of visits to each page



APPENDIX B
IN KIND CONTRIBUTIONS

DNR Secretarial and Administrative Support	3	117	$2,733.93
DNR Graphics Support (Contractual Amount)	1	28.5	$1,000.00
DNR LRIS Uncompensated Support	2	32.5	$3,380.00
Workshop Attendees	90	17	$61,200.00
EPA Staff	3	194	$10,599.08
EPA Contractual			$24,000.00
USGS Staff	1	25	$2,043.50
Briefings	104	3	$10,920.00
Interviews	30	3	$3,150.00
Questionnaires(require 2-8 hours to complete)	69	5	$12,075.00
DEC	5	131.8	$5,023.59
Travel			**$1,679.64**
Contractual			**$12.35**
Supplies			**$305.00**
Equipment			**$5,235.90**
Total Project Contributions as of March 1, 1999			**$143,357.99**

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000	PROPOSED FY 2000 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
			$214.0	$58.1	$449.2	$7.6	$65.2	
Personnel	$166.7	$369.1						
Travel	$4.0	$21.9						
Contractual	$130.0	$297.0						
Commodities	$0.2	$2.0						
Equipment	$0.0	$30.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$300.9	$720.0			Estimated FY 2001	Estimated FY 2002		
General Administration	$34.1	$74.1						
Project Total	$335.0	$794.1			$34.0	$0.0		
Full-time Equivalents (FTE)	0.0	5.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0			$0.0	$0.0		

Comments:

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Lead Agency: ADEC/ADNR

FORM 2A
MULTI-TRUSTEE
AGENCY
SUMMARY

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000						
Personnel	$74.4	$145.6						
Travel	$2.9	$16.6						
Contractual	$0.0	$6.0						
Commodities	$0.2	$0.5						
Equipment	$0.0	$23.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$77.5	$191.7			Estimated FY 2001	Estimated FY 2002		
General Administration	$11.2	$22.3						
Project Total	$88.7	$214.0			$9.0			
Full-time Equivalents (FTE)		2.4						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Environmental Conservation

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
Jeff Hock	Environmental Specialist IV	20	2.0	7.2		14.4
Russell Kunibe	Analyst Programmer IV	20	12.0	6.9		82.8
TBD	Student Intern	12	12.0	2.3		27.6
Nadeem Siddiqui	SQL Database Administrator	22	1.0	7.4		7.4
TBD	IIS Server Manager	20	2.0	6.7		13.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		29.0	30.5	0.0	
					Personnel Total	$145.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					0.0
Travel to Anchorage to work with cooperators and conduct training	0.5	12	36	0.2	13.2
Travel to Kenai to work with cooperators and conduct training	0.1	2	6	0.2	1.4
Travel to Homer to work with cooperators and conduct training	0.2	2	4	0.2	1.2
Travel to Mat-Su to work with cooperators and conduct training	0.0	2	4	0.2	0.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$16.6

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Environmental Conservation

FORM 3B
Personnel
& Travel
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
CIIMMS Z39.50 search engine maintenance	6.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$6.0

Commodities Costs:	Proposed
Description	FY 2000
Office Supplies (paper, toner cartridges, etc. for report preparation)	0.3
Computer support supplies (CD's, diskettes, cabling)	0.2
Commodities Total	$0.5

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Environmental Conservation

FORM 3B
Contractual & Commodities DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
Spatial Database Engine for DEC SQL Server	1	15.0	15.0
WEB Management Software	1	3.0	3.0
WEB Development Software (Graphics, FrontPage, Database Interface, PDF Creation)	1	2.5	2.5
WEB HTML search software	1	2.5	2.5
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$23.0

Existing Equipment Usage: Description		Number of Units	Inventory Agency
4 Computer Workstations with Software contributed by DEC,	$14,000		
DEC SQL Server w/Software, contributed by DEC	$15,000		
Laptop PC, contributed by DEC,	$3,500		
Internet WEB Server, contributed by DEC	$10,000		
Total DEC Equipment Contribution	$42,500		

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Environmental Conservation

FORM 3B
Equipment
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000						
Personnel	$86.0	$112.0						
Travel	$0.7	$4.1						
Contractual	$130.0	$291.0						
Commodities	$0.0	$0.0						
Equipment	$0.0	$7.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$216.7	$414.1			Estimated FY 2001	Estimated FY 2002		
General Administration	$22.0	$35.1						
Project Total	$238.7	$449.2			$15.0			
Full-time Equivalents (FTE)		1.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY00

Prepared:
4/16/99

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Natural Resources

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
	Analyst Programmer III	18	12.0	6.0		72.0
	Analyst Programmer IV	18	4.0	5.8		23.2
	Special Assistant	23	2.3	7.3		16.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		18.3	19.1	0.0	
					Personnel Total	$112.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					0.0
Travel to Homer, Kenai, Soldotna	0.2	8	8	0.2	3.2
Travel to Juneau	0.5	1	2	0.2	0.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.1

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Natural Resources

FORM 3B
Personnel
& Travel
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Contractual Costs:		Proposed
Description		FY 2000
Data Conversion, Cleanup, Documentation		12.0
Consulting Services for development and implementation of Final System Specifications		279.0
Develop final set of system specifications	$10.0	
Implementation of system specifications including refinement of CIIMMS interface	$50.0	
Metadata gateway, search tools	$9.0	
Access to distributed data systems, interface, and access tools.	$95.0	
Detailed plan for long term maintenance.	$40.0	
Development and deployment of visualization tools	$50.0	
Training manuals, system documentation, data dictionary	$25.0	
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$291.0

Commodities Costs:		Proposed
Description		FY 2000
	Commodities Total	$0.0

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Natural Resources

FORM 3B
Contractual & Commodities DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
			0.0
			0.0
Additional storage capacity for existing UNIX server	1	2.0	2.0
MetaManager Software	1	5.0	5.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$7.0

Existing Equipment Usage: Description		Number of Units	Inventory Agency
DNR contribution of existing hardware, software, and other data management infrastructure with a value of:	$55.0		
2 Workstations, software, and peripherals	$10.0		
2 PCs and software	$6.0		
Total ADNR equipment contribution:	$71.0		

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Natural Resources

FORM 3B
Equipment
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$49.2
Travel		$0.0
Contractual		$0.0
Commodities		$1.5
Equipment		$0.0
Subtotal	$0.0	$50.7
General Administration		$7.4
Project Total	$0.0	$58.1
Full-time Equivalents (FTE)		0.7
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$2.5			

Dollar amounts are shown in thousands of dollars.

Comments:

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Fish & Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
	Cartographer	16	3.0	5.0		15.0
	Analyst Programmer	20	2.0	6.7		13.4
	Habitat Biologist	18	3.0	6.2		18.6
	Research Analyst II	16	0.5	4.3		2.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		8.5	22.2	0.0	
					Personnel Total	$49.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Fish & Game

FORM 3B
Personnel
& Travel
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FY 2000
Network charges, database storage and transfer media, phone, fax, software upgrades	1.5
Commodities Total	$1.5

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Fish & Game

FORM 3B
Contractual & Commodities DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2000
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Fish & Game

FORM 3B
Equipment
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel	$6.3	$6.3
Travel	$0.4	$0.4
Contractual		$0.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$6.7	$6.7
General Administration	$0.9	$0.9
Project Total	$7.6	$7.6
Full-time Equivalents (FTE)		0.1
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$2.5			

Dollar amounts are shown in thousands of dollars.

Comments:

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
						0.0
Lowell Surring	Wildlife Biologist	12	1.0	6.3		6.3
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.0	6.3	0.0	
					Personnel Total	$6.3

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					0.0
Travel to Soldotna, Kenai, Homer	0.1	1	2	0.15	0.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.4

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3B
Personnel
& Travel
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FY 2000
Commodities Total	$0.0

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3B
Contractual & Commodities DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3B
Equipment
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$56.0
Travel		$0.8
Contractual		$0.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$56.8
General Administration		$8.4
Project Total	$0.0	$65.2
Full-time Equivalents (FTE)		0.4
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$5.0			

Dollar amounts are shown in thousands of dollars.

Comments:

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US DOI, USGS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
						0.0
Leslie Patrick	Assistant District Chief, Water Resources Division					0.0
	Supervisory Hydrologist	13-6	5.0	11.2		56.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		5.0	11.2	0.0	
					Personnel Total	$56.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					0.0
Travel to Homer, Kenai, Soldotna	0.2	2	2	0.2	0.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.8

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US DOI, USGS

FORM 3B
Personnel
& Travel
DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FY 2000
Commodities Total	$0.0

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US DOI, USGS

FORM 3B
Contractual & Commodities DETAIL

Prepared:
4/16/99

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY00

Project Number: 00391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US DOI, USGS

FORM 3B
Equipment
DETAIL

Prepared:
4/16/99

Draft Gulf Ecosystem Monitoring (GEM) Program: Long-Term Monitoring, Research, and Stewardship in the northern Gulf of Alaska, FY 2003 and beyond

Review Draft

Circulation of this draft for the purposes of review is encouraged. Please direct comments by e-mail, gem@oilspill.state.ak.us, use the mailing address below or call 907-278-8012. Comments received by November 1, 1999 would be most useful. A new draft is expected on or before December 16, 1999. This draft is not for citation or attribution.

October 22, 1999

Exxon Valdez Oil Spill Trustee Council
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907-278-8012

Table of Contents

Executive Summary

To be written later

Program Narrative

To be written later, but we may not need it, if we do a good job on the Executive Summary

I. Introduction

A program rooted in the science of a large-scale ecological disaster is uniquely suited to form the foundation for ecosystem management. Knowledge and experience gained during ten years of biological and physical studies on the aftermath of the *Exxon Valdez* oil spill confirmed that a solid historical context is essential to understand the sources of changes in valued natural resources. Toward this end in March 1999 the *Exxon Valdez* Oil Spill Trustee Council (Trustee Council) dedicated a minimum of $115 million for long-term monitoring and research in the northern Gulf of Alaska (GOA). The new research fund is expected to be in place and functioning by October 2002. The fund is expected to function as an endowment, with an annual program funded through investment earnings. The goal is for the fund to be invested in a manner that allows for inflation-proofing and possible growth of the corpus. (See Appendix A for the full text of the Trustee Council resolution.)

In making the decision to allocate these funds for long-term program of monitoring and research, referred to herein as the Gulf Ecosystem Monitoring program, the Trustee Council explicitly recognized that complete recovery from the oil spill may not occur for decades and that through long-term observation and, as needed, restoration actions, injured resources and services are most likely to be fully restored. The Trustee Council further recognized that conservation and improved management of these resources and services would require a substantial ongoing investment to improve understanding of the marine and coastal ecosystems that support the resources as well as the people of the spill region. Improving the quality of information available to resource managers should result in improved resource management. In addition, prudent use of the natural resources of the spill area without unduly impacting their recovery requires increased knowledge of critical ecological information about the northern Gulf of Alaska that can only be provided through a long-term research and monitoring program that would span decades, if not centuries. There are both immediate needs to complete our understanding of the lingering effects of the oil spill and long-term needs to understand the sources of changes in valued natural resources.

A. Lingering Effects of the EVOS and Future Needs

The lack of information about the status of the marine resources prior to the spill was, and in some cases remains, a serious impediment to understanding the impact of human activities, both planned and unplanned. In spite of the current shortage of information on some species, a large body of new information has been assembled during the course of research following the oil spill. Much was learned about the plants and animals of the northern Gulf of Alaska (Figure 1) and their relationships to one another

and the physical environment. Even more important than the science so far assembled may be the improved understanding of the magnitude of our ignorance of physical and biological systems. Today, more than ten years after the *Exxon Valdez* oil spill, although it is reasonably clear that some of the injured natural resources and the services that depend on them have not fully recovered, the fate of others is still not known (Table 1). Of the twenty-six resources and three services reviewed by the Trustee Council in March 1999, only two were categorized as clearly "recovered," while six were placed in the category of "not recovering." The fact that most resources and all services were placed in the "recovering" category may reflect a lack of knowledge concerning the status of the resources and services at the time of the oil spill. That five resources were in the category of "recovery unknown" underscores the point that a solid historical context is essential to understand the sources of changes in valued natural resources. Studies are underway to learn more about cutthroat trout, Dolly Varden, Kittlitz's murrelets, and rockfish (EVOSTC 1999).

The main concerns about lingering effects of oiling relate to the potential effects of pockets of residual oil in the environment. Studies in the laboratory have shown that contact with petroleum hydrocarbons from weathered oil can kill or harm early life stages of pink salmon and Pacific herring. It is not yet known, however, whether such effects are actually occurring to any significant degree in Prince William Sound (PWS) or at other localities with residual oil. Tissue samples from higher vertebrates, such as sea otters and harlequin ducks, also indicate possible ongoing exposure to petroleum hydrocarbons in PWS. The effects of this exposure are not well established at the level of individual animals or at the population level.

Additional concerns about lingering effects of the spill include the ability of populations to overcome the demographic effects of the initial oil-related losses and the interaction of the effects of the oil spill with the effects of other kinds of changes and perturbations in the marine ecosystem. Sea otters around northern Knight Island are an example of a species with prolonged demographic effects. Examples of possible interactive, or cumulative, impacts are the combined effects of the oil spill and the 1998 El Niño event on common murres in the Barren Islands and the implications of changes in the availability of forage fishes on recovery of seabirds, such as the pigeon guillemot, from the effects of the oil spill.

As the Trustee Council moves from the restoration program to the Gulf Ecosystem Monitoring program, studies of lingering oil spill injury and recovery will be drawn to a conclusion in the near-term, to be increasingly replaced by long-term environmental monitoring and studies of ecosystem processes based on long-term monitoring. Studies that permit integration of our understanding of the biological processes of the entire marine ecosystem of the spill area, in the context of climatic and anthropogenic forces are made possible by the data provided by long-term environmental monitoring provided by many programs, including GEM.

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 services considered to be recovering: Commercial fishing, Passive use recreation and tourism, and Subsistence.

B. Background

On March 24, 1989, the *T/V Exxon Valdez* ran aground on Bligh Reef in Prince William Sound, Alaska, spilling almost eleven million gallons of North Slope crude oil. It was the largest tanker spill in United States history, contaminating about 1,500 miles of Alaska's coastline, killing birds, mammals and fish, and disrupting the ecosystem in the path of the spreading oil. The damage assessment studies were concluded in 1992, although some of the lines of investigation were continued under the subsequent Restoration Program. More than $100 million was devoted to 164 separate and related damage assessment studies.

In 1991 Exxon agreed to pay the United States and the State of Alaska $900 million over ten years to restore, replace, enhance or acquire the equivalent of natural resources injured by the spill, and the reduced or lost human services they provide (Memorandum of Agreement and Consent Decree). Under the court-approved terms of the settlement, the *Exxon Valdez* Oil Spill Trustee Council was formed to administer the restoration funds. Restoration activities undertaken by the Trustee Council have been guided primarily by the *Exxon Valdez* Oil Spill Restoration Plan, which was adopted by the Trustee Council in 1994. In its Restoration Plan (EVOS Restoration Plan, 1994), the Trustee Council laid out a program with five categories of restoration activities: monitoring and research, general restoration, habitat protection, restoration reserve, and public information/administration.

From 1991 to date (through Fiscal Year 2000), the Trustee Council has approved the expenditure of approximately $155 million for research, monitoring, and general restoration projects. Up to an additional $16 million is designated for these purposes in FY 2001-02. In its restoration program, the Trustee Council has focused primarily on knowledge and stewardship as the best tools for fostering the long-term health of the marine ecosystem, rather than on direct intervention.

Most prominent among the projects funded by the Trustee Council are three ecosystem-scale projects, known primarily by their acronyms: SEA, NVP, and APEX. The Sound Ecosystem Assessment (SEA) is the largest project undertaken by the Trustee Council, funded at $22 million over a seven-year period. This project is formulating interacting numerical models designed to simulate the dynamic processes influencing the survival and productivity of juvenile pink salmon and herring rearing in Prince William Sound. SEA has provided new insights into ocean currents, nutrients, mixing, salinity, and temperatures and how these physical factors influence plant and animal plankton, prey, and predators in the food web.

The Nearshore Vertebrate Predator project (NVP) is a six-year, $6 million study of factors limiting recovery of four indicator species that inhabit nearshore areas. The project is looking at oil exposure, as well as natural factors such as food availability, as

potential factors in the 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) concentrates on the productivity and recovery of seabirds based on the availability of forage fish as a food source. This eight-year, $10.8 million project is looking at wide-ranging ecological changes in an effort to explain why some species of seabirds are not recovering.

The three ecosystem projects, SEA, NVP, and APEX, are in the final stages of data analysis and report writing in FY 2000. The Trustee Council's emphases in FY 2000-02 will be to continue monitoring the recovery status of species injured by the oil spill, research factors that may be persisting in limiting recovery, conduct research that should lead to long-term improvements in resource management, disseminate restoration results, complete some general restoration efforts, and prepare for GEM.

Restoration projects have also been conducted on key individual species injured by the oil spill. The 1994 restoration plan identifies recovery objectives (measurable outcomes of restoration) and restoration strategies (plans of action) for each of the species known to have been injured by the oil spill. These objectives and strategies are regularly reviewed and were updated in 1996 and 1999.

As an example, nearly $14 million has been spent on the restoration of pink salmon. The recovery objective for pink salmon states that recovery will have occurred when population indicators, such as growth and survival, are within normal bounds and there are no statistically significant differences in egg mortalities in oiled and unoiled streams for two years each of odd- and even-year runs in Prince William Sound. When last measured (1997), higher egg mortality persisted in oiled compared to unoiled streams. Strategies currently being employed to achieve recovery of pink salmon are: research and monitor the toxic effect of oil (including examining the natal habitat of pink salmon in Prince William Sound for evidence of oil contamination), provide management information (for example, conducting genetic studies related to survival), and supplement populations (on select streams).

Roughly $6 million has been spent on the restoration of Pacific herring. The recovery objective for herring states that recovery will have occurred when the next highly successful year class is recruited into the fishery and when other indicators of population health are sustained within normal bounds in Prince William Sound. Increased biomasses of herring were identified in 1997 and 1998. However, the population has yet to recruit a highly successful year-class. Current strategies for achieving recovery are: investigate causes of the crash (in particular, disease) and investigate ecological factors that may be affecting recovery (such as effects of oceanographic processes on year-class strength and adult distribution).

Over $5 million has been spent on the restoration of marine mammals, primarily harbor seals. The recovery objective for harbor seals states that recovery will have occurred when their population is stable or increasing. The latest data, which is for the period 1989-97, indicates that harbor seal populations have declined on average 5 percent annually. The current restoration strategy for harbor seals is to continue to research and monitor populations (with research efforts focused primarily on food availability).

During the course of its investigations, the Trustee Council collected information on hundreds of species of animals and plants, including sockeye salmon, cutthroat trout, black oystercatchers, river otters, mussels and kelp. Occurrence and distribution of constituents of spilled oil and naturally occurring hydrocarbons were documented. Oceanographic data such as temperature and salinity were also collected. As of 1999, more than three hundred articles had been published in scientific journals in the United States and all over the world, numerous theses and dissertations (Appendix C), and hundreds of project reports.

In addition to monitoring, research, and general restoration projects, protecting habitat has been a major restoration tool. The Trustee Council has committed roughly $376 million to protect about 650,000 acres important for restoration of injured resources. Many species injured by the oil spill nest, feed, molt, winter, and seek shelter in the habitat protected through the Trustee Council's habitat protection and acquisition program. Several other species live primarily in the nearshore environment and benefit from the protection of the nearby uplands.

In addition to the activities described above, each year since FY 1994 the Trustee Council has placed $12 million into the Restoration Reserve. The general purpose of the reserve is to ensure that there are funds available for restoration activities after the final payment is received from Exxon in 2001.

C. Human Uses and Activities

The influence of human use and activities provides an important context for development of the GEM program. Within the oil spill area and the nearby population centers of Anchorage and Wasilla live 54 percent of the state's 621,000 permanent residents. When the resident population is combined with over one million tourists each year, it becomes clear that the natural resources of the spill area cannot be immune to the pressures associated with human uses and activities. The private sector economy of Alaska is heavily dependent on extraction of natural resources, primarily oil and fish, followed by timber, minerals and agricultural products.

Within the area affected by the oil spill (Figure 1) there are about 70,000 full time residents, while two to three times that number use the area seasonally for work or recreation. Numbers of residents and seasonal transients are relatively small compared to

the millions of people outside the GOA region who are involved in commerce and consumption of its natural resources, especially oil, fish and tourism. While this section describes the people of the northern Gulf of Alaska and their use of resources, it should be remembered that population growth outside the region fuels increasing demands for human uses and activities within the region.

1. Prince William Sound

Prince William Sound lies to the north of the Gulf of Alaska and to the west of Cordova. About 7,000 people live in the Prince William Sound area. The largest communities in Prince William Sound -- Cordova, Valdez and Whittier -- are all coastal and predominantly non-Native, although Valdez and Cordova are home to Native corporations. Chenega Bay and Tatitlek are Native villages. All five communities are accessible by air or water and all have dock or harbor facilities. Only the ports of Valdez, in the north, and Seward (just outside the western entrance to PWS, see Kenai Peninsula, below) now link Prince William Sound to the State's main road system, but this will change in 2000. The Alaska Railroad presently carries automobiles, boats and passengers to and from Whittier, a coastal community on the banks of Prince William Sound, north of Seward, which is just outside the Sound (Figure 1). A road scheduled for completion in 2000 will allow cars to drive directly to Whittier. Since Whittier is much closer by road to Anchorage than Valdez or Seward, automobile access undoubtedly means increased human uses of Prince William Sound.

The economic base of the five communities in the Sound is typical of rural south-central Alaska. Cordova's economy is based on commercial fishing, primarily for pink and red salmon. As the terminus of the Trans-Alaska Pipeline, Valdez is dependent on the oil industry, but commercial fishing and fish processing, government and tourism also are important to the local economy. The Prince William Sound Science Center and its Oil Spill Recovery Institute provides a base for scientific research in Cordova. Large oil tankers routinely traverse Prince William Sound and the northern Gulf of Alaska to and from Port Valdez. In addition to working as oil industry employees, Whittier residents also work as government employees, longshoremen, commercial fishermen and service providers to tourists. The people of Chenega Bay and Tatitlek augment commercial fishing, aquaculture and other cash-based activities with subsistence fishing, hunting and gathering.

2. Kenai Peninsula

The Kenai Peninsula on the northwest margin of the Gulf of Alaska separates Cook Inlet from Prince William Sound (Figure 1). The central peninsula is on the main road system, so much of it is only a few hours by car from the major population centers of Anchorage and Wasilla. About 49,000 people live on the Kenai Peninsula. About two-thirds of the region's population live in the central part of the Kenai Peninsula in the

vicinity of the cities of Kenai and Soldotna. The economy of this area depends on the oil and gas industry, commercial fishing, tourism, and forest products. This area was the site of the first major Alaska oil strike in 1957, and it has been a center for oil and gas exploration and production since that time. The Kenai River and its tributary, the Russian River, are major sport fishing rivers, attracting tourists from Anchorage and all over the world. The ports of Kenai and Homer are home to major commercial fishing fleets for salmon, and Homer supports vessels that fish for herring, shrimp, crab, and groundfish species such as halibut. Marine sports fishing is a major attraction for the tourist industry in Kenai, Seward, and especially in Homer.

The southern Kenai Peninsula contains the cities of Homer and Seldovia and the Native villages of Nanwalek and Port Graham. Homer, on the north side of Kachemak Bay, is the southern terminus of the state's main road system on the peninsula. Seldovia, Nanwalek and Port Graham, all located south of Kachemak Bay, are accessible only by air and sea. Homer is the economic and population hub of the southern part of the peninsula and depends on commercial fishing, tourism, and forest products. Nanwalek and Port Graham are largely dependent on subsistence hunting and fishing, and village corporation enterprises such as the salmon hatchery and logging enterprise at Port Graham.

Seward is a seaport on the eastern Kenai Peninsula nearby the western entrance of Prince William Sound. It is the southern terminus of the Alaska Railroad, which transports marine cargo and passengers to and from Anchorage. Seward can be reached by car from Anchorage by the Seward Highway and from Kenai, Soldotna and Homer by the Sterling Highway. Tourism is an important and growing part of Seward's economy. Cruise ships dock at Seward's harbor and commercial vessels take passengers on tours of the nearby Kenai Fjords National Park. The Alaska SeaLife Center on the waterfront in Seward is both a tourist destination and a marine research facility. The Qutekcak Corporation operates a hatchery that produces clams and scallops for a growing aquaculture industry in Prince William Sound and southeastern Alaska.

3. Kodiak Island archipelago

The Kodiak Island archipelago lies to the west of the northern Gulf of Alaska. This region includes the city of Kodiak and the six Native villages of Port Lions, Ouzinkie, Larsen Bay, Karluk, Old Harbor and Akhiok. About 14,000 people live in this region, although the population swells in the fishing season. Communities on Kodiak Island are accessible by air and sea. Approximately 140 miles of state roads connect communities on the east side of the island.

The economy is heavily dependent on commercial fishing and seafood processing. Kodiak is one of the world's major centers of seafood production, and it has long been among the largest ports in the nation for seafood volume or value of landings. Residents of the Native villages largely depend on subsistence hunting and fishing. Kodiak Island is also home to a commercial rocket launch facility that held its first successful launch in 1999. The 27-acre Kodiak Launch Facility is 25 miles southwest of the city of Kodiak at Cape Narrow. Commercial timber harvest occurs on Afognak Island, which is north of Kodiak Island. The U.S. Coast Guard Station near Kodiak is a major landowner and employer.

4. Alaska Peninsula

Alaska Peninsula lies to the far west of the northern Gulf of Alaska (Figure 1). Five communities on the south side of the Alaska Peninsula were affected by the *Exxon Valdez* oil spill: Chignik, Chignik Lagoon, Chignik Lake, Ivanof Bay and Perryville. The population of the area is about 400 year-round, but doubles during the fishing season. All five communities are accessible by air and sea. Numerous airstrips are maintained in these villages and scheduled and chartered flights are available. There are no roads connecting these villages. ATVs and skiffs are the primary means of local transportation.

The cash economy of the area depends on the success of the fishing fleets. Chignik and Chignik Lagoon serve as a regional salmon-fishing center, while Dutch Harbor, southwest of Perryville and somewhat outside the spill area, is a major center for crab and marine fish. In addition to salmon and salmon roe, fish processing plants in Chignik produce herring roe, halibut, cod and crab. About half the permanent population of these communities is Native. Subsistence on fish and caribou is important to the people who live in Chignik and Chignik Lagoon.

Chignik Lake, Ivanof Bay and Perryville are predominantly Native villages and maintain a subsistence lifestyle. Commercial fishing provides cash income. Many residents leave during summer months to fish from Chignik Lagoon or work at the fish processors at Chignik. Some trap during the winter, and all rely heavily on a diverse array of subsistence food sources, including salmon, trout, marine fish, crab, clams, moose, caribou, bear, and porcupine.

D. Global Climate Change

Global climate change is an essential context for development and implementation of the GEM program. Uncertainty over the extent to which the forces of climate drive the abundances of plants and animals in marine ecosystems has long been with us. Human activities appear to have both short- and long-term consequences for the amount of biological production of birds, fish and mammals, but to what extent are these perceived consequences really the result of climate change? A basic guiding principle for

GEM program development and implementation is that the nature-nurture enigma can only be resolved through analysis of long time series of appropriate physical and biological measurements.

The ability to measure global climate change and to understand its possible roles in biological production in the North Pacific has increased dramatically in the past decade. The climate of the North Pacific is known to change fairly sharply over periods of decades, centuries and millennia, in concert with climatic processes in other parts of the world, such as the north Atlantic. Some of these changes have been correlated through time with sharp changes in production and relative abundance of species of sea birds, salmon and other fishes, marine mammals, shrimp and crabs (see Section IV). The timing of changes in climate also appear to coincide with changes in the production and species composition of the plankton on which all these species feed, directly or indirectly. That mechanisms of biological production respond directly to the physical forces of climate change is known as the bottom-up control hypothesis, because climatic effects are thought to start at the bottom of the food chain and work their way up.

Global climate change is important for understanding how humans impact biological production. Is global climate change solely responsible for the ups and downs of the animal populations humans use and manage? Long-term population declines are apparent in animal populations that depend on the ecosystems of the Gulf of Alaska (GOA) such as cormorants, kittiwakes, fur seals, Steller sea lions, harbor seals, red king crab, and sablefish, among others (see Section IV). Are these declines the result of bottom-up control forced by climate change, or are they due to top-down control through removals of breeding animals and prey species by fisheries, mortality and depression of reproduction by oil and other pollutants, alteration of critical habitat and other human activities, or is it some complex interaction of both? Some populations that show long time trends, up or down, or sharp rapid changes in abundance, are actively managed through harvest restraints, such as fish (salmon, sablefish, pollock, halibut, arrow tooth flounder, Pacific Ocean perch) and marine mammals (seals, sea lions, whales, otters). The extent to which harvest restraints may be effective in establishing or altering trends in abundance of exploited species can only be understood within the context of climate change.

E. Fishery and Ecosystem Management

Understanding the concerns about the effectiveness of fishery management and the need to implement ecosystem management is key to making the GEM program responsive to resource management agencies and the public. Circumstances have converged to raise serious questions about the effectiveness of fishery management, and to raise demands to expand fishery management into ecosystem management. On a worldwide basis, many fisheries are fully exploited or depleted, and pressures on marine fisheries resources are increasing and are expected to increase further as human

populations increase. Within the North Pacific, all living marine resources on the high seas off Alaska except halibut were subject to very heavy and unregulated exploitation by international fishing fleets until the mid-1970's. Starting at various times in the mid-1970's and 1980's, steep declines have been noted in the Bering Sea and Gulf of Alaska in populations of fur seal, harbor seal, murres, kittiwakes, and the Aleutian Island pollock. Declines in Steller sea lion were serious enough for the species to be listed under the U.S. Endangered Species Act in 1990.

A combination of state, federal and international laws and agreements developed between 1923 and 1976 brought all marine fisheries within 200 miles of the Alaskan coast under protection of state and federal harvest limitations, and some limitations on harvests were extended beyond 200miles. Are the current fishery management programs, so recently imposed, going to be sufficient to allow sustainable human use of Alaska's living marine resources? Fishery management programs for single species such as Pacific halibut and Bristol Bay sockeye salmon, have been instrumental in sustaining human use over multiple human generations. On the other hand, the recent collapses of other regulated marine fisheries in Alaska and elsewhere have led to a growing realization that the management of a fishery is not the same as management of an ecosystem. Regulatory programs were in place at the time of collapse of the fishery for red king crab in the Gulf of Alaska, the fisheries for coho salmon off southern British Columbia and Oregon in the northeastern Pacific, and the fishery for cod on Georges Bank in the northwestern Atlantic, to cite but a few of the many available examples. It appears that factors beyond the scope of single-species management approaches can cause fishery management programs to have unintended consequences, such as contributing to the decline of the managed species.

As a consequence of the checkered history of fishery regulatory efforts, there continue to be serious concerns among scientists and the public about how fishing of all kinds may impact species being intentionally and unintentionally harvested, as well as the functioning of the ecosystem as a whole. Fishery management has a history of use of single-species models that do not account for the ecosystem , or groups of similar species. Even in the case of sustainable single-species fishery management, the supporting models often do not account for the ecosystem, except as a constant source of food or predation, and hence cannot explain sudden collapses. For example, managers did not anticipate the collapse in the Bristol Bay sockeye salmon fishery of 1998. Consequently, our inability to understand the reasons behind changes in the productivity, diversity and functional relationships in large ecosystems ultimately limits the use of current fishery models to making short-term predictions during periods of stable oceanic and climatic conditions.

So what is ecosystem management and why would it be an improvement over fishery management? Understanding the functioning of the ecosystem as a whole is a basic requirement of ecosystem management. Ecosystem management requires a functional understanding of the dynamics of the ecosystem – knowledge of how the

system produces the valued resources and what must be conserved to sustain healthy populations and a robust ecosystem. Unfortunately, available information appears inadequate to answer even the most basic ecosystem management question of whether the loss of upper-trophic-level-carbon through removal of catches of target and non-target fish species serves to reduce the long-term productivity of the ecosystem.

The case has been made in the scientific literature for climate-driven control of groundfish, salmon, seabird and crab populations in the northeast Pacific (see section IV). Indeed, examples are available to indicate that management of all species associated with the marine waters of Alaska would benefit from improved application of ecological knowledge to their management. For example, in the 1970s several species of pandalid shrimps dominated the shelf ecosystem as sampled by bottom trawls in the northern Gulf of Alaska. Suddenly, starting in about 1977, the shrimp were replaced by flatfish and cod-like fish in the mid-trawl catches. Such an abrupt change inevitably gave rise to questions about the role of fishing in the decline and the extent to which natural changes in the ecosystem made the shift inevitable. We do not have clear answers to these questions. If it had been known in the 1970s that the pelagic fisheries could be expected to undergo long-term cycles on the scale of 20 years or more, then their managers may have altered harvest strategies and the harvesters might have been better prepared for the economic consequences.

Ecosystem management is under development. Since 1995 the North Pacific Fishery Management Council, which manages, or coordinates management with the State of Alaska, in all marine waters of Alaska has received a statement of "ecosystem considerations" in its annual status report on groundfish populations in the Bering Sea, Aleutian Islands and Gulf of Alaska. Ecosystem management may be in its infancy, but it is widely being recognized among professionals as the heir to fishery management (see NPFMC 1999).

Given the limited state of current knowledge on ecosystem management and the precipitous declines in species of interest, it is prudent for regulators and the public to be wary of the potential for harvests of a single species to directly and indirectly effect the rest of the ecosystem, including other fish, seabirds, marine mammals, benthic communities and habitats. It seems reasonable to conclude that the combination of direct and indirect effects of fishing must in some way change ecosystems, but the magnitude and direction of these effects is largely a matter of speculation. Given the limitations imposed by current knowledge, it is also reasonable and prudent to be skeptical about the ability to sustain Gulf of Alaska fisheries over the long-term without better information. Lack of information is probably the greatest source of concern.

F. Marine Habitat Protection

The management and conservation of habitats in the marine environment is not well advanced compared to such efforts in terrestrial environments. For instance, in the oil-spill area the protection of about 650,000 acres of upland habitats by the Trustee Council is in addition to the protections available to large areas of land already in public ownership. With the exception of a few cases where tidelands are privately owned, marine habitats cannot be purchased as uplands can be. An additional problem is that relatively little is known about which areas are important to which species and at what seasons. The life histories and habitat requirements of many marine species are not well understood, making it difficult to develop appropriate conservation and management strategies.

Protection has already been afforded to marine habitats in some cases by excluding gear types that are thought to be injurious to habitat. For example the eastern GOA is now closed to trawling and dredging to protect crabs and their habitats. In addition there are numerous trawl and dredge closure areas in the vicinity of Kodiak, the Alaska Peninsula and Aleutian Islands. Marine areas containing marine mammal feeding grounds and adjacent to haul-out areas have also been closed to commercial fishing in parts of the Bering Sea, Aleutian Islands and Gulf of Alaska. Given the amount of marine habitats already subject to closure, more information on how to define critical marine habitats is essential to balancing fishing opportunities and protection of habitat.

While lack of information plagues even the discussion of marine habitat protection, there seems little question that pressure on marine habitats will continue to increase. For example, the impending road connection between Anchorage and the Prince William Sound port of Whittier is expected to vastly increase public visitation to northwestern Prince William Sound. The Whittier road is expected to generate increases in requests for permits for facilities (e.g., boat fuel and other supplies) on shorelines, tidelands, or nearshore waters and other potential actions that may impact marine habitats and the fish and wildlife populations that rely on these habitats.

Some sensitive locations and seasons are easily recognized, such as during the breeding season at well-documented seabird nesting colonies, but many other information needs are poorly satisfied. For example, through the Trustee Council's restoration program's large-scale ecosystem projects, we are starting to understand the full annual cycle of the Pacific herring, including identification of over-wintering habitats and requirements for juvenile herring. This type of information is crucial to long-term protection of herring stocks. There is much more to be learned about the habitat requirements of herring, to say nothing of other forage fishes, such as capelin and sand lance, which are key to healthy seabird and marine mammal populations.

G. Contaminants, water quality and watersheds; food safety

The presence of industrial and agricultural contaminants in aquatic environments has resulted in worldwide concerns about potential effects on marine organisms and on human consumers. Polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and organochlorine pesticides, such as DDT and its derivatives, are widely distributed around the world in marine and coastal waters and in the rivers and watersheds that feed freshwater into these environments. Such pollutants can be transported great distances by winds and ocean currents following their accidental releases from industrial and agricultural sources. In addition, mercury and other metals, such as inorganic arsenic, cadmium, and selenium, are naturally present in the environment at low concentrations, but anthropogenic sources can contribute additional quantities to the environment.

The geophysical and climatologic characteristics of the northern Gulf of Alaska tend to protect much of this region from deposition of environmental contaminants. However, recent evidence of persistent organic pollutants and heavy metals accumulating in adult sockeye salmon in the gulf indicate that pathways do exist. (sockeye salmon work).

Some of these contaminants, such as PCBs and DDT, can bioaccumulate in living marine organisms. For example, research on killer whales following EVOS revealed that some marine mammal-eating transient killer whales sampled in Prince William Sound carry concentrations of PCBs and DDT derivatives that are many times higher than those in fish-eating resident whales. The sources and harmful effects, if any, of these contaminants are not known. It has been established, however, that these contaminants are passed from nursing female killer whales to their calves.

There is also concern about potential effects of contaminants on people, especially people who are heavily dependent on subsistence resources, such as fish, waterfowl, and marine mammals. At higher levels of exposure, many of the chemicals noted above can cause adverse effects in people. Following the oil spill, there was much concern about hydrocarbon contamination in subsistence foods, and sampling programs for food safety were sustained through 1994. There continues to be concern about food safety in relation to the oil spill and more generally among Alaskan Natives in coastal communities.

Little is known about the distribution and concentrations of contaminants in the northern GOA. The State of Alaska, for example, does not monitor environmental pollutants in the marine environment nor in marine organisms on a regular basis. Similarly, there is no ongoing program for sampling food safety in subsistence resources in coastal communities, although the oil spill provided the opportunity to sample subsistence resources in the affected areas. Subsistence food safety testing was conducted from 1989 through 1994 in conjunction with damage assessment and

restoration activities following the oil spill. In addition, restoration activities included a resource abnormality study, which provided an opportunity for subsistence users to send in samples of abnormal resources for examination by pathologists in federal fiscal years 1994 – 1996. The samples were not examined for hydrocarbons or other contaminants.

A small-but-systematic effort to gather data on environmental contaminants in the oil-spill area could provide valuable "early warning" information to local residents and other consumers, especially subsistence users, and alert scientists to contaminants that may affect fish and wildlife populations. A relatively low cost program to acquire samples of fish, birds and mammals from existing projects throughout the spill area for contaminants testing could help define the origin and extent of contaminants in the environment. Synthesizing the multitude of small and large efforts throughout the GOA would certainly be useful.

H. Community involvement, traditional knowledge, education and stewardship

Residents of coastal communities have a direct interest in scientific and management decisions and activities concerning the fish and wildlife resources and environments on which they depend for their livelihoods and sustenance (Huntington 1992). While many residents have a great deal of historical and contemporary experience with and knowledge of the marine environment and resources, that information is often not documented, communicated, or used (Brown-Schwalenberg et al. In press). The failure to recognize and make use of local expertise has often caused a great deal of frustration among community residents. When the people affected by management and conservation actions are involved in designing and carrying them out, those actions are likely to be better focused and more effective (Huntington 1992, 1998a). Encouraging community involvement in making decisions, documenting and using traditional and local knowledge, and educating young people and community residents are important elements in the long-term stewardship of coastal and marine resources.

I. Coordination, Synthesis, and Information Transfer

There are many different programs and projects that involve monitoring, research, and management of marine resources in the Gulf of Alaska. These programs and projects are carried out by government agencies, such as the National Marine Fisheries Service, by universities, such as the University of Alaska, and by international bodies, such as the International Pacific Halibut Commission. Among these agencies and institutions, missions, responsibilities, and priorities vary by program and project, yet each of them concerns the study, management or conservation of marine resources in the gulf. There is potential for overlap and duplication among these programs and projects, but probably a more serious concern is a lack of coordination and integration, which means foregoing opportunities for increased efficiency, focus, and joint action that would benefit marine

resources and stakeholders. Thus, there is both need and opportunity for coordination, joint planning and setting of priorities and program details, such as cruise schedules.

A second, related problem arises from the fact that multiple programs gather data on marine resources in the GOA but there is little integration and synthesis of the results. The resulting lack of broad context can make interpretation of individual data sets problematic or inaccurate. Further, lack of integration and synthesis prevents natural resource managers and stakeholders from obtaining a "big picture" perspective on what is happening in the GOA.

A third problem is the difficulty in communicating results in useful ways to people who would benefit by having the information. Although the scientific literature is an effective means of disseminating research results within academic circles, journals are generally not an effective way to share information with natural resource managers and stakeholders, who often lack time, ready access, or training to make use of the information available in technical journals. Thus, there is need to convey the interpreted and synthesized results of monitoring and research projects to managers and stakeholders in a timely, accessible, and understandable manner. Lack of an effective mechanism or mechanisms to do so can compromise the success of a program like GEM.

II. Vision for Gem and Northern Gulf of Alaska

A. Mission

The mission of the Gulf Ecosystem Monitoring (GEM) program is to foster a healthy and biologically diverse marine ecosystem in the northern Gulf of Alaska through greater understanding of how its productivity is influenced by natural changes and human activities. In pursuit of this mission, the GEM program will sustain the necessary institutional infrastructure to provide scientific leadership in identifying research and monitoring gaps and priorities; sponsor monitoring, research, and other projects that respond to these identified needs; encourage efficiency in and integration of Gulf of Alaska monitoring and research activities through leveraging of funds, interagency coordination and partnerships; and involve stakeholders in local stewardship by guiding and carrying out the program.

B. Goals

Specific programmatic goals are to:

- track lingering oil-spill injury, as needed;
- detect and understand annual and long-term changes in the marine ecosystem, distinguishing natural variability from human influences;
- improve fish and wildlife management through the development and application of new information and technologies;
- provide integrated and synthesized information on the status, trends and health of fisheries, seabirds, marine mammals, and other marine resources;
- provide baseline information on water quality and on contaminants in fish and wildlife consumed by people; and
- support the identification of important marine habitats and of basic life history and habitat requirements of marine species.

Specific institutional goals are to:

- identify research and monitoring gaps currently not provided by existing programs;
- leverage funds from other programs;
- set priorities for research and monitoring ;
- synthesize research and monitoring to advise setting priorities;
- keep track of work relevant to understanding biological production in GOA

C. Geographic Scope

Consistent with the Trustee Council's November 1994 *Restoration Plan*, the primary focus of the GEM program is within the oil-spill area, the northern GOA, including Prince William Sound, Cook Inlet, Kodiak and the Alaska Peninsula (Fig. 1). Recognizing that the marine ecosystem impacted by the oil spill does not have a discrete boundary, some monitoring and research activities will necessarily extend into adjacent areas of the northern GOA. Partnerships with other funding sources will also allow participation in projects having geographic boundaries outside the northern GOA.

D. Funding potential

The intent of the Trustee Council is to fund the GEM program beginning October 2002 with the funds allocated by the Trustee Council for long-term research and monitoring, estimated to be approximately $115 million. The Trustee Council intends to manage these funds as an endowment, with the annual program funded by investment earnings. Currently, the *Exxon Valdez* Oil Spill settlement funds are required by federal law to be invested in the U.S. Treasury, and specifically by the terms of the court order, within the Court Registry Investment System in the U.S. Treasury. This requirement seriously restricts the investment potential of the fund. The average Treasury Bill rate for the past five years has been approximately five percent. Given a $115 million corpus, the fund could be expected to have approximately $5.75 million available in interest earnings to fund the entire program, including administrative costs. This would likely preclude the Trustee Council's ability to inflation-proof the fund, or to allow other scenarios that would allow the corpus to grow.

The Trustee Council is in the process of seeking legislative relief in Congress from the investment restriction in order to allow the funds to be invested in a prudent manner. Similar endowments such as the State of Alaska Permanent Fund, the State of Alaska retirement fund, the University of Alaska Foundation and others earn on average considerably more than five percent per annum, yet are still invested in a prudent manner. Given the past record of the stock market, investment returns of 18-20% and higher are typical. However, even before this, most foundations were averaging 8-10% rate of return. This size of a return would allow the Trustee Council to inflation proof the fund. For example, an 8% rate of return on a $115 million fund, would realize $9.2 million in earnings. Assuming a 3% inflation rate, $3.45 million would go towards inflation proofing, with $5.75 million available to spend. In five years, with inflation proofing, $6.47 million would be available to spend. This investment scenario would allow for a stable program over time. The Trustee Council would also have the option of funding a more reduced program in the early years in order to build the corpus.

It is also the long-term goal of the Trustee Council to have the research fund established in such a manner to allow for additional deposits and donations to the fund

from other sources in order to increase the corpus. This would likely take some form of state and/or federal legislation, and possibly a change in the consent decree.

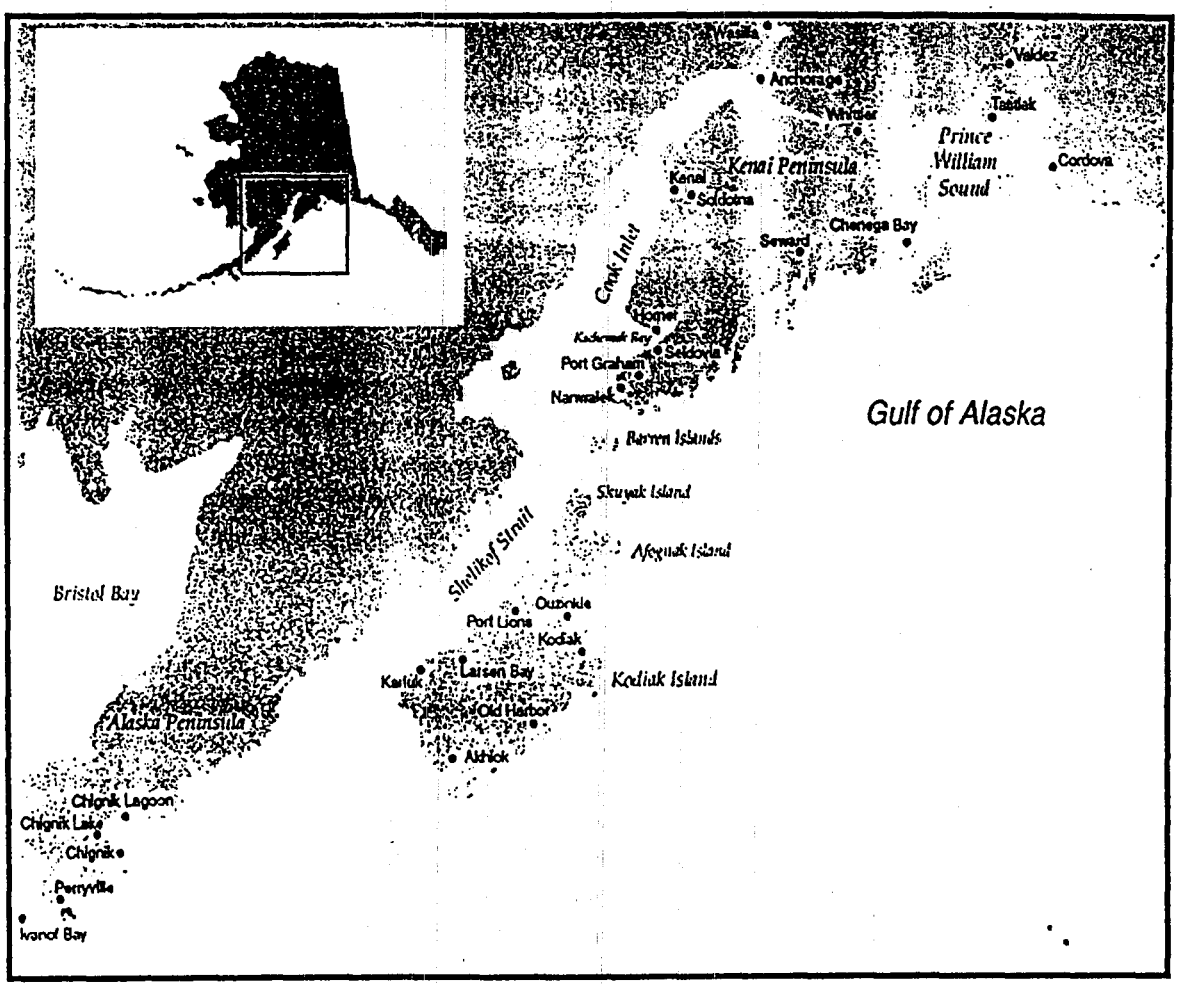
E. Governance

Under existing law and court orders, three State and three federal trustees were designated by the Governor of Alaska and the President to administer the restoration fund and to restore resources and services injured by the oil spill. The State of Alaska Trustees are the Commissioner of the Alaska Department of Environmental Conservation, the Commissioner of the Alaska Department of Fish and Game, and the Attorney General. The federal trustees are the Secretary of the Interior, Secretary of Agriculture, and the Administrator of the National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

The Trustees established the Trustee Council to administer the Restoration Fund. The state trustees serve directly on the Trustee Council. The federal trustees have each appointed a representative in Alaska to serve on the Trustee Council. These currently are the U.S. Interior Department's Special Assistant to the Secretary for Alaska; the Alaska Director of the National Marine Fisheries Service; and the Supervisor of the Chugach National Forest for the Department of Agriculture, although this position in the past has been held by the Alaska Regional Forester. All decisions by the Trustee Council are required to be unanimous. It is expected that the current Trustee Council will continue to make policy and funding decisions for the GEM program.

It has been suggested that at some time in the future a new board or oversight structure could be established to administer or guide the research and monitoring fund. It is also possible that an existing board, either under its current structure or with minor modifications, could take over management of the fund. However, use of a new governance structure would require changes in law and the applicable court decrees; and it is not anticipated in the near future. Any change in governance would need to be justified.

FIGURE 1. MAP OF THE OIL SPILL AREA



III. Structure and Approach

The GEM scientific program will consist of two main complementary components: long-term ecological monitoring and shorter-term targeted research. A core of long-term monitoring measurements are intended to track ecosystem changes on the scale of decades. Shorter term research will be used to clarify functional relationships within the ecosystem. The GEM program will be designed, carried out, and evaluated with the benefit of independent scientific peer review and the participation of natural resource managers, stakeholders, and residents in coastal communities. The selection, design, and execution of projects will be coordinated with and complementary to ongoing programs and projects of government agencies and other institutions. The use and application of traditional and local knowledge will be encouraged, as will the participation and education of young people in coastal communities. The synthesis, interpretation, and dissemination of what is learned about the status, trends, management, and conservation of marine resources will be a priority throughout the program. Periodic "State of the Gulf" workshops, invitations to submit proposals, and reports to the public will be part of GEM's adaptive management process and means for public outreach.

A. Long-term Monitoring

The core of GEM is long-term ecological monitoring to document productivity and seasonal, interannual, and interdecadal changes in the shelf and coastal ecosystems of the northern GOA, including PWS, lower Cook Inlet, and the Kodiak Archipelago-Shelikof Strait area. Monitoring productivity in relation to ecological changes will lead to an understanding of the influences on the health and productivity of key species of fish and wildlife and will improve the ability to distinguish natural and man-made causes of change and predict ecological trends. In turn, this information can be applied by a variety of stakeholders for the use, management, and conservation of marine resources.

The monitoring program will be designed to test scientific hypotheses over the time scale of a century. Because funds are limited, GEM must take advantage of existing, ongoing programs and projects carried out by federal and state agencies and other institutions. Trustee Council funds will be used to support core measurements that are essential to taking the pulse of the northern GOA and that are not being obtained reliably on a sustained basis through other programs. In addition, GEM will supplement existing programs and projects, taking additional measurements to obtain the necessary spatial and temporal coverage. Individual monitoring projects will be awarded on a competitive basis and carried out under long-term commitments by the most appropriate and qualified persons from government agencies, universities, and the private sector.

Monitoring data from GEM will be analyzed and integrated into predictive ecosystem models. Synthesized results will be shared with stakeholders and the public

through periodic "State of the Gulf" workshops and reports. As information becomes available, it will be accessible via the Internet. The design and results of GEM monitoring will be scientifically peer reviewed and the program fine-tuned accordingly at five-year intervals. Results from the research program should inform the monitoring program, so that it may be changed or augmented to reflect the most accurate, up-to-date understanding of the functional processes that should be monitored and the technologies available to monitor those processes. There will always be a dynamic balance between the need for continuity and making the monitoring program most reflective of our latest understanding of how the system functions and where and when it is best measured.

B. Shorter-term Focused Research

The long-term monitoring element of GEM will be complemented by strategically-chosen research projects with relatively short-term goals. This research will have several primary purposes. These purposes are to:

- follow up on issues related to any lingering effects of the *Exxon Valdez* oil spill;
- explore questions and concerns that arise out of interpretation of the monitoring data, and
- provide key information and tools for management and conservation purposes (including determining basic life histories and identification of important areas, habitats, and ecological processes).

It is premature to identify specific projects to be carried out in the research component of GEM. It is possible, however, to discuss the types of research that will be carried out and to offer specific examples of potential projects.

1. Lingering injury from the oil spill

Research specifically related to the effects of the *Exxon Valdez* oil spill may be prominent in the first few years of the GEM program, but the need for this type of research will likely diminish over time. Types of research likely to be conducted include exploring the effects of hydrocarbon exposure on the survival and reproduction of fish and wildlife resources and the identification of pathways of such exposure. For example, if contaminants monitoring indicates the induction of P450 enzymes in harlequin duck livers in response to exposure to petroleum hydrocarbons, a two-pronged research approach might be to determine whether the survival or reproduction of harlequin ducks is compromised by the exposure to hydrocarbons and to identify the pathway of exposure, such as through oiled mussel beds or other forms of residual shoreline oiling. Another example would be to explore interactive effects of ocean conditions, disease, and

exposure to petroleum hydrocarbons on Pacific herring. There also may be need to carry out some general restoration projects, such as small-scale fisheries enhancements (e.g., stream-channel improvements), that relate directly to restoration of EVOS injury.

2. Exploring questions with or generated by monitoring data

As the effects of EVOS fade and as GEM matures, research projects will increasingly arise from the results and needs to improve the long-term monitoring program. Many different types of research may arise by this means. Some of this research will involve special analyses and modeling of data obtained through the core monitoring program (including current and retrospective data). Other projects, such as those exploring mechanisms of change or ecological processes, will require additional work in the field or laboratory. Several examples will help frame the types of research projects that may be appropriate.

For example, the results of GEM monitoring may indicate correlations between certain climatic and physical oceanographic processes. This correlation between climatic and oceanographic processes then can be explored in depth through retrospective analyses of GEM data and a predictive model can be constructed. It may then be necessary to supplement regular GEM measurements with special measurements in the field in order to more fully resolve the nature of the relationship and the mechanism involved. If successful, this type of research might deliver increased predictive capability for both users and managers of marine resources, such as for commercial fisheries.

As another example, data from GEM may indicate that fundamental environmental changes are occurring, such as changes in ocean temperatures. It is known that such changes can have major impacts on the biological composition of the ecosystem (e.g., increases in bottom fish and reductions in crustaceans), but it may not be clear whether the origin of the environmental change is natural or anthropogenic, and the mechanisms of the biological effects may not be known. Analyses of GEM monitoring data should help researchers tease apart whether the environmental changes are cyclic or the result of global climate warming related to man's activities, and research in controlled settings may help identify the mechanisms by which changes in ocean temperature actually affect living organisms (e.g., disruption of reproductive cycle). Both types of research will help resource managers and stakeholders better understand, predict, and possibly respond in some way to environmental change in the northern GOA.

3. Management and conservation

Finally, GEM research may include projects designed to provide information and tools to improve management and conservation of marine resources. Examples of this type of research would include improving techniques, tools, or technology for stock assessments of fisheries resources, gathering basic information on species life histories,

genetic stock identification of marine mammal, seabird, or fish populations, and experimental work on the ecological effects of different levels, locations, and seasons of fisheries harvests.

The Trustee Council's habitat protection program has focused on the terrestrial habitat of numerous marine species by protecting about 650,000 acres of upland habitats, including 1400 miles of shoreline and 300 anadromous fish streams. Research carried out as part of GEM can be focused on the identification of sensitive areas and seasons in the marine environment so that this information can be considered in the development of management and conservation strategies in the marine environment.

C. Traditional Knowledge, Community Involvement and Local Stewardship

The Trustee Council believes that encouraging local awareness and participation in research and monitoring enhances long-term stewardship of living marine resources. Traditional and local knowledge can provide important observations and insights about changes in the status and health of marine resources (Huntington 1998b). Community involvement is needed to document and design applications of traditional and local knowledge to research and monitoring projects. The inclusion of appropriate traditional and local knowledge and the involvement of communities in the northern GOA region is appropriate throughout the GEM program. Local monitoring, documentation, and stewardship projects must be linked wherever possible with other monitoring, research, and conservation projects under GEM to promote sharing of information and ideas. Scientific steering committees, composed of academic, agency and local representatives, can identify and oversee opportunities for productive collaboration. The "State of the Gulf" workshop and other forums can bring together a variety of participants in the various aspects of GEM to stimulate discussions and spark new ideas.

The actual mechanisms for achieving this goal are not fully developed. Several approaches have been tried in the EVOS restoration program and elsewhere in Alaska and other northern regions, and GEM will draw on these experiences to design specific processes for involving communities and their expertise (Brown-Schwalenberg et al. In press; Huntington, In press; Fehr and Hurst 1996; Hansen 1994; Brooke 1993). One approach, the Youth Area Watch, has proven to be an effective and popular means of involving and educating young people and their home communities about EVOS research. Similar projects may be developed as part of GEM in coastal communities throughout the oil-spill area.

D. Science Management

By necessity, the administration and management of GEM must be cost efficient. Equally important, however, is the need for a high caliber scientific program. To this end, a senior staff scientist will serve on the Trustee Council staff and work with the

executive director, Trustee Council, the scientific community, natural resource agency managers, and stakeholders to implement and evaluate GEM. Independent peer review, mostly on a volunteer basis, will be vital to the process. Special review panels may be convened to critique particular aspects of the program. Periodically, the entire program will be reviewed for the quality of its science and its benefit to the public with respect to its mission. The program will function within an adaptive management cycle, including a "State of the Gulf" workshop, an invitation to submit proposals for the coming fiscal period, peer and public review, Trustee Council action, and reporting on recent results. The period for the adaptive management cycle is to be determined.

1. Principles and Policies

The GEM program will be administered consistent with policies adopted by the Trustee Council and set forth in the November 1994 *Restoration Plan* (pp. 11-18). In general, these policies can be characterized as follows: Competition for restoration funds is encouraged, and priority is given to strategies that involve partnerships. Projects are subject to open, independent scientific review, and restoration must include meaningful public participation, including the synthesis and dissemination of project results. Finally, consistent with the November 1994 *Restoration Plan*, it is the intent of the Trustee Council to not fund projects that are considered "normal" activities of government agencies.

Specifically with respect to management of the scientific aspects of GEM, the following additional principles and policies are proposed as germane:

a. The geographic scope of the program will focus on the spill area as defined in the *Restoration Plan* (Fig. 1). Some monitoring and research activities, however, will extend more broadly in the northern GOA in order to encompass important climate, oceanographic processes, and biological phenomena.

b. The program will be designed and operated as a long-term endeavor. Monitoring projects will be designed on long time scales, but will reviewed at 5-year intervals. Research projects and other activities will be reviewed annually or biennially. Adaptive management on an appropriate time scale is essential, and periodic review by an outside entity, such as the National Research Council, may be appropriate.

c. The program 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 Exxon Valdez Oil Spill Restoration Office.

d. Monitoring and research activities must be of the highest scientific caliber, with ongoing outside peer review and participation by the best scientists from a variety of institutions. Funds for monitoring and research projects will be awarded on a competitive basis.

e. Over the long term, the results of the program must be useful to natural resource agencies, stakeholders, and the public, who also must be involved in its design, evaluation, and application.

f. The program should take advantage of different institutions, facilities, and capabilities throughout the region. These institutions should contribute expertise, services, and funds toward programs and projects that support GEM's mission. In some cases, these institutions will receive funds to carry out elements of the program. Efforts to share costs should be encouraged and rewarded.

g. To the maximum extent possible, the program will be coordinated and directly coupled with both ongoing and limited-duration monitoring and research endeavors that support GEM's mission. However, the program will strive to carry out work that cooperating institutions are not capable of or are unable to carry out.

h. Overall, the program aims to serve as a vehicle for jointly evaluating, setting, carrying out, and synthesizing marine science priorities and results in the northern GOA, with links, as appropriate, to work in other parts of the north Pacific (e.g., Bering Sea).

i. All projects must be carried out on a cost-effective basis, and there must be public access and accountability in regard to all projects and project results.

j. Participation by students and local residents will be actively encouraged.

k. Data and biological or other samples obtained through GEM and cooperating programs must be archived and maintained subject to appropriate standards and readily accessible to the scientific users and the public.

l. Finally, the results of the program must be analyzed, interpreted, synthesized, and disseminated on a regular basis for the benefit of resource managers, stakeholders, the wider scientific community, and the public.

2. Proposed elements of GEM science management

a. Scientific leadership and peer review

A senior staff scientist, hired by the executive director and residing in Alaska, will provide in-house scientific counsel and leadership to GEM and the Trustee Council. Over time, but probably not initially, the senior scientist may serve as executive director of the Trustee Council. The senior scientist will work with the Trustee Council and executive director, in consultation with the scientific community, natural agency managers, and stakeholders, to plan, implement, and evaluate the long-term program.

One means of obtaining the needed consultations will be the public advisory group, which is required under the terms of the settlement. The composition and nature of this group with respect to long-term implementation of GEM needs further consideration.

Independent peer review will be an essential feature of the GEM process, and there are different models for managing this process. For example, the process could be managed entirely by the senior staff scientist or it could rely more on the services of a consulting science advisor. Regardless, 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. Such reviews will be sought on a mostly voluntary basis from qualified scientists who are not also carrying out projects funded by the Trustee Council. In general, the individuals involved will change as topics, needs, and availability change. Review functions will be carried out in writing, by telephone, and occasionally on site or in person. From time to time, special review panels will be convened to evaluate and make recommendations about aspects of the program.

b. Process

Starting in FY 03, the basic process will function on an adaptive management cycle along the lines of the current restoration program. This process will have the following elements or steps:

-A periodic "State of the Gulf" workshop at which the results during the previous cycle are discussed, information is integrated across disciplines, and needs and opportunities for the next year are considered. Project investigators, selected peer reviewers, resource managers, stakeholders, and the public are invited to this meeting.

-A periodic *Invitation to Submit Proposals*, which will specify the types of proposals that are priorities for consideration in the coming fiscal period. Research proposals are envisioned to be of finite duration and to have short-term goals (e.g., 2-5

years). Monitoring projects will be evaluated and renewed on longer time scales (e.g., once every 5 years) and any given *Invitation* may or may not invite proposals for new or ongoing projects. The *Invitation*, however, will be the vehicle for notifying the scientific community and others that monitoring projects will be considered in a given fiscal year. The Trustee Council must annually approve funding for each monitoring and research project, although revised project proposals would not necessarily be required each year.

-Proposals received in response to the *Invitation to Submit Proposals* will be circulated for *ad hoc* peer review. Peer review comments and recommendations will be summarized and provide a basis for preliminary recommendations on the projects included in annual work plans.

-The executive director will prepare a draft annual work plan to advise the annual fiscal program of the Trustee Council. The draft annual work plan will be circulated for public review and comment. Following close of the public comment period, the executive director will prepare final recommendations on the annual work plan for consideration and action by the Trustee Council.

-Annual and final reports will be required for all monitoring and research projects, and all such reports will be reviewed to evaluate whether the investigators are making satisfactory progress toward project objectives. Selected annual reports may be sent for comment by independent peer reviewers, depending on need, the maturity of the project, and other factors. All final reports will be sent for outside peer review, and comments from the independent peer reviewers must be addressed in the final versions of final reports. All annual and final reports will be archived at the Alaska Resources Library and Information Service (ARLIS) and affiliated institutions.

- Publications in peer-reviewed literature are expected of program participants

- From time to time, special peer review panels may be convened to meet with project investigators and others in workshop formats to fully explore particular topics, problems, or projects. These sessions may involve evaluations of projects that have been completed or are in progress, interpretation and synthesis of data, and explorations of potential future work.

c. Coordination with other programs and projects

Coordination with other programs and projects is absolutely essential to the success of GEM. GEM is being designed to supplement and support existing science programs. Another key to success is identifying and filling gaps in existing monitoring programs, identify key research priorities, and help foster research and monitoring projects within other agencies and institutions that are in concert with the GEM mission. In developing the GEM program, substantial effort has gone into identifying the relevant

scientific agencies and their present and historical scientific databases (see IV. B. Existing Agency Programs and Projects and Appendix Table 1).

E. Data Management, Synthesis and Public Information

Development of detailed plans to address needs in the areas of data management, synthesis, and public information will require additional time and resources. In the interim, however, the basic approaches to meeting these needs can be outlined as follows. Development of a policy on data, including its storage, publication and chronology of distribution is a key task that needs to be completed prior to funding of projects.

1. Data Management

The current EVOS restoration program does not have an overarching data management strategy or plan, although some individual projects (e.g., Sound Ecosystem Assessment) have had sophisticated systems for managing and exchanging data. The investigators for each project sponsored by the Trustee Council are responsible for preparing written final reports, which must describe the data obtained in the project and the format of the data, identify the permanent custodian of the data, and indicate the availability of the data. The final reports containing the data summaries are available from the Alaska Resources Library and Information System (ARLIS) 907-272-7547. With respect to data on hydrocarbons, copies of all such data are reviewed and then archived in a hydrocarbon database maintained at the National Marine Fisheries Service Auke Bay Laboratory in Juneau, Alaska. In addition, it is the policy of the Trustee Council that, consistent with state and federal laws, any data resulting from any project to which the Trustee Council has contributed financially are in the public domain and as such must be available to the public.

It is absolutely essential that data management needs for GEM be addressed fully before gathering of new long-term monitoring data is initiated. To the extent that GEM will incorporate existing data sets, it also is essential that provision is made to seamlessly link existing and new data. As preliminary steps, it will be necessary to:

- review existing EVOS policies and practices with respect to data management at programmatic and project levels;
- compile detailed information about the location and status of data sets ("metadata") for at least those projects that are likely to be relevant to GEM; and
- assess federal and state agency data management policies and standards, practices, and programs to identify requirements that pertain to GEM and opportunities to address GEM data management needs on

a cooperative basis with Trustee agencies or other appropriate agencies and institutions.

On the basis of these preliminary steps, we will then develop a draft data management plan and policy. A research project under Dr. Charles Falkenberg was initiated in FY 00 deal with the data management issues issues described in this section. The fundamental aim of the plan will be to ensure that GEM data, especially long-running streams of monitoring data, will be maintained and archived in ways that are permanent, cost effective, technically appropriate, and readily accessible to scientific users, resource managers, stakeholders, and the public.

The GEM data policy will require individual investigators and sponsoring agencies and institutions to turn over all data in electronic formats and supporting documentation, consistent with applicable data standards, to a custodian agency or institution within a certain time after the data are obtained (probably within one year), at which point the data are available to all public users. Although different data sets may be archived and maintained at different agencies or institutions, depending on the subject, it is expected that such data will be available at a central GEM website via Internet links to other websites. Implementing the GEM data management plan and policy will require the services of a dedicated data manager, perhaps on a shared basis with a Trustee agency or other agency or institution.

2. Synthesis

In order for GEM to be successful, it will be necessary to integrate, synthesize, and interpret monitoring and research results to form and present a "big picture" of the status of and trends in the GOA ecosystem. There will be different ways that the necessary syntheses can be achieved, and different ways to convey this information to users. What is important is for the needed information to be conveyed in formats that are accessible to and useful for a variety of users, including scientists, resource managers, stakeholders, and the public.

One approach to synthesizing an array of ecological data is modeling. Useful models of 3-dimensional water circulation, plankton production, juvenile pink salmon survival, Pacific herring overwintering, the energetics of colony-nesting seabirds, and carbon mass-balances in Prince William Sound exist or are in advanced stages of development. These models show great promise as a means of integrating large volumes of data in a way that yields insights about how marine ecosystems work. These models also offer a means of identifying knowledge gaps or making predictions about climate forcing, oceanographic currents, biological productivity, and the ecological effects of human activities. The models cited above mostly address the Prince William Sound ecosystem. To the extent that these models relate to GEM hypotheses, it may be worthwhile to invest additional resources in further testing and application in Prince

William Sound or to extend their scope to other areas within the oil-spill region or to the northern GOA more broadly.

A periodic "State of the Gulf" workshop will be another means of reviewing and integrating information across disciplines to achieve greater insight into the status of and trends in the northern GOA ecosystem. At such forums, project investigators and others will present results and exchange information for the benefit of scientific participants, but also for the benefit of resource managers, stakeholders, and the public. The format will be similar to the annual restoration workshops in the current EVOS program. More targeted workshops may also be appropriate.

3. Public Information and Involvement

The importance of public participation in the restoration process was specifically recognized in the Exxon settlement and is an integral part of the agreement between the state and federal governments. The Memorandum of Agreement and Consent Decree approved by the court specify that:

> ...the Trustees shall agree to an organizational structure for decision making under this MOA and shall establish procedures providing for meaningful public participation in the injury assessment and restoration process, which shall include establishment of a public advisory group to advise the Trustees...

The Trustee Council is committed to public input and public outreach as vital components of the long-term GEM program. The question is how this should be achieved. The existing Public Advisory Group (PAG) has 17 members representing 12 interest groups and the public at large, as well as two ex officio members from the Alaska Legislature. It is probably appropriate that the makeup of the PAG be changed to increase the participation of other interests and reduce costs. It is also possible that public input could be sought without a formal advisory group, although this would require an amendment to the consent decree. The Trustee Council will likely develop a series of alternatives in the next two years and then go out for public comment before taking any final action prior to October 2002.

The Trustee Council is a public entity subject to the State of Alaska Open Meetings Act and corresponding federal laws. All meetings are public and include a formal public comment period. A number of additional tools have been developed in the past to promote and encourage public input and participation. These include newsletters, annual reports, public meetings in the spill-affected region, newspaper columns, a series of radio spots, and the Council's website at www.oilspill.ak.us.

Since the GEM program is envisioned as a much smaller program than the current *Exxon Valdez* Oil Spill restoration program, the costs of these outreach efforts has to be

considered before decisions are made on which tools are the best to increase public input and participation. Additionally, the audiences vary widely, and include the greater scientific community both in Alaska and outside the state, Native villages without internet access, high school and college students, fishermen, and federal, state and local government officials. Some tools are obviously more appropriate for specific audiences.

A major tool for disseminating data and interpreted and synthesized results from GEM projects to the public, stakeholders and the greater scientific community will be a GEM website. This site could be along the lines of the Bering Sea and North Pacific Ocean Theme Page (www.pmel.noaa.gov/bering), which is maintained by the National Oceanic and Atmospheric Administration. This website 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 data exchange of data and research is the North Pacific Marine Science Organization, PICES web site, (http://pices.ios.bc.ca/data/weblist/weblist.htm).

IV. Scientific Context

A. Guidance from Prior Programs

1. Comprehensive Investigations and Reviews

There are antecedents of the GEM program to provide guidance. A marine science planning effort 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 Gulf of Alaska, 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 Plan take advantage of existing projects, and 5) a descriptions, time tables and budgets of research and monitoring to be conducted under the Plan. The current GEM document does not address element 5, since that is the ultimate goal of the three-year process of implementation to be completed by October 1, 2002. ARMRP program 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.

- 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.

(ARMRB 1993, pages 13 – 14).

The Bering Sea has received a good deal of recent attention. Concern over long-term declines in populations of high-profile species such as king and tanner crab, Steller sea lion, spectacled eider ducks, common murres, thick-billed murres, red-legged and black-legged kittiwakes (DOI-NOAA-ADF&G 1998b). The vision of the federal-state regulatory agencies of the Bering Sea Ecosystem Research Plan (Draft, 1998a) is consistent with the mission statement of the Trustee Council (see 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." (1998a, p. 5). The overarching hypotheses are consistent with the basic model of the GEM plan (see IV.D.2);

- 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

(DOI-NOAA-ADF&G 1998a, p. 9)

Further, four of the research themes of the Bering Sea Ecosystem Research Plan (DOI-NOAA-ADF&G 1998a), variability and mechanisms in the physical environment, individual species responses, food web dynamics, contaminants and other introductions are closely aligned with the mission basic mission established by the Trustee Council. Note that current research programs for the Bering Sea (DOI-NOAA-ADF&G 1997) often overlap with the programs identified in our survey for the Gulf of Alaska (Appendix A).

2. *Scientific Legacy of the* Exxon Valdez *Oil Spill*

The studies conducted by the trustee agencies and their contractors since 1989 have resulted in over 300 peer reviewed scientific publications, PhD dissertations and Master's theses (Appendix C). 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. The scientific legacy of the oil spill studies includes information on 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, early life history and stock structure in herring, and much more.

In designing its approach to restoration, the Trustee Council recognized the need for basic ecological information. The recovery status of each affected resource (Table 1) is based to the extent possible on knowledge of the resource's role in the ecosystem, in addition to trends in abundance, evidence of continued exposure to oil and other data. It is the ecological knowledge gained in the decade following the oil spill that forms the foundation of the Gulf Ecosystem Monitoring program. Experience gained in compiling this 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.

B. Existing Agency Programs and Projects

1. Introduction

Most major government information gathering programs of the Gulf of Alaska (Appendix Table 1) are divisible into two major categories: large animals or macrofauna (birds, mammals, fish, shellfish) and oceanography (physical, chemical, geological and biological). Biological oceanography most often collects data on small plants and animals, the zooplankton and phytoplankton, and on primary productivity. Primary productivity, often measured as grams of carbon fixed per unit area per unit time, is a basic measure of biological activity. Notably absent are monitoring or assessment programs for large plants, such as kelp and other large marine algae. Sampling efforts for macrofauna are typically focused on the Gulf of Alaska or smaller areas, including Prince William Sound, Cook Inlet, Kodiak and the Alaskan Peninsula, whereas oceanography programs often include the Gulf of Alaska as part of a larger, often global program.

ADF&G, Department of Interior and National Oceanic and Atmospheris Administration and its National Marine Fisheries Service, NOAA/NMFS are the primary monitoring agencies for the macrofauna. National Aeronautics and Space Administration, NASA and NOAA's National Ocean Service, NOS, National Environmental Satellite, Data, and Information Service, NESDIS, National Weather Service, NWS, Oceanic and Atmospheric Research , OAR (Fisheries Oceanography Investigations, FOCI) are the primary sources of oceanographic data.

The projects presented in Appendix Table 1 are actively collecting data. Inactive projects should be included in the future because they contain considerable valuable historical information relevant to the production of plants and animals in the Gulf of Alaska. A summary of the major programs conducted by the United States, State of Alaska, and transboundary organizations follows.

2. US Department of Commerce, National Oceanic and Atmospheric Administration

National Marine Fisheries Service: . Major programs include the triennial trawl surveys for groundfish, becoming biennial surveys beginning in 2001, annual longline surveys primarily for sablefish and rockfish, and the Ocean Carrying Capacity program in the Gulf of Alaska with three cruises a year.

Centers responsible for monitoring within NMFS are the Alaska Fisheries Science Center, Northwest Fisheries Science Center, Southwest Fisheries Science Center, and the Alaska Region. Salmon and rockfish genetic stock identification are conducted at Auke Bay Laboratory, near Juneau, Alaska. Fishing vessel observer programs that collect biological information are conducted out of the Alaska Fishery Science Center in Seattle. Marine mammal survey programs include the Cook Inlet marine drift and set gillnet fisheries mammals observer program, and the Cook Inlet beluga population survey.. Offshore killer whale surveys in the Gulf of Alaska are conducted by the Southwest Fisheries Science Center as part of a coast-wide program. The National Marine Mammal Laboratory and the Office of Protected Resources are cooperators with the U.S. Geological Survey (DOI) and the NIST in conducting the National Marine Mammal Health and Stranding Response Program that will be discussed below under multiagency programs.

Oceanic and Atmospheric Research: OAR is a complex of oceanographic and macrofauna monitoring and evaluation activities that involves NMFS, and other NOAA personnel. The fisheries oceanography program (FOCI) in the Pacific Marine Environmental Laboratory (PMEL) in Seattle has an element in the Shelikof Strait, between Kodiak and the Alaska Peninsula. This and other Gulf of Alaska monitoring projects are conducted by the Resource Assessment and Community Ecology (RACE) division of NMFS (AFSC). PMEL also conducts retrospective fisheries and

oceanographic studies and is involved with Data Rescue. OAR's Climate Diagnostics Center holds the Comprehensive Ocean-Atmosphere Data Set (COADS) with surface marine data since 1854. OAR also houses Fisheries and Oceanography and Bering Sea Ecosystem Studies (CIFAR) and Sea Grant, SG. Some NOAA-sponsored US GLOBEC projects work through CIFAR on funding originating in NOS. Both CIFAR and SG support research projects at universities.

National Ocean Service: In cooperation with the National Science Foundation, NOS supports oceanographic research in the Gulf of Alaska, providing about half the support for the Northeast Pacific subprogram of the US GLOBEC. Substantial programs of the GLOBEC program are retrospective analyses and monitoring studies. NOS is responsible for the Kachemak Bay Ecological Characterization study. NOS also conducts the National Status and Trends Program which currently includes Gulf of Alaska samples in the Mussel Watch contaminants project and formerly included the Benthic Surveillance Project here. With National Institute of Standards and Technology (NIST), specimens are held in the Specimen Banking Project.

National Environmental Satellite, Data, and Information Service: NESDIS holds most of the historical information gathered by NOAA agencies, and current satellite oceanographic, buoy data, and sea ice information. Much of the information is stored at the National Oceanographic Data Center (NODC) and the National Climate Data Center (NCDC). NODC and NCDC cooperate with NASA, the National Weather Service (NWS), 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 a number of United Nations (UN) projects, one of which is the Global Ocean Observing System, GOOS. One element of that uses ships of opportunity to collect global weather and meteorological data (see Global Climate Change Research section IV.B.6 below).

National Weather Service: NWS has real-time weather and oceanographic data at the National Buoy Data Center, and it cooperates with NODC to provide historical monitoring data. NWS programs active in the Gulf of Alaska include the Moored Buoy Program and the Coastal Marine Automated Network (C-MAN).

National Institute of Standards and Technology: The NIST cooperates with USGS, NMFS, and OPR with the National Biomonitoring Specimen Bank.

3. Alaska Department of Fish and Game

The Division of Commercial Fisheries of ADF&G does substantial monitoring of salmon and other andromous fish species, herring, crabs, shrimp and several other invertebrate species, and some species of mammals. ADF&G is responsible for the Gulf of Alaska portion of the Coded Wire Tag database, which contributes to understanding ocean distributions of salmon. ADF&G 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 Gulf of Alaska from southeastern 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. The data permit 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.

ADF&G and cooperating regional aquaculture associations also collect some physical and biological oceanographic data, such as Kodiak near shore sea surface temperatures, Kitoi Bay (Kodiak) zooplankton biomass, and Prince William Sound 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, Wildlife Conservation Division monitors harbor seals in cooperation with NMFS. Note that most ADF&G marine programs serve to provide information to NOAA programs.

4. US Department of the Interior

Fish and Wildlife Service: The Alaska Maritime National Wildlife Refuge monitors 10 seabird colonies annually, 4 of which are in the Gulf of Alaska. The AMNWR also monitors other sites on a periodic basis largely dependent upon availability of funds.

Minerals Management Service: 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.

Geological Survey, Biological Resources Division: BRD maintains a seabird database and a pelagic seabird atlas. Success depends on many other projects from several agencies for data. In addition since the 1970's BRD has an extensive seabird monitoring project at Middleton Island, the MI Marine Biological Station. BRD also is in 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. BRD participates as part of a large multiagency suite of projects discussed below. In addition to biological programs, USGS has extensive expertise in other areas of interest to GEM, such as long time series of measurements of freshwater runoff, and the capability to produce high-resolution maps of the sea floor (Gardner et al. 1998).

5. 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, was established in 1992 among Canada, People's Republic of China, Japan, Republic of Korea, Russian Federation, and the United States of America. PICES coordinates North Pacific (above 30° N) marine information and research in the northern North Pacific 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 (http://pices.ios.bc.ca/data). The long time series data set is a compilation of voluntary submissions from data sources, and it is therefore not exhaustive.

The International Pacific Halibut Commission, IPHC was the first multinational fishery management organization in the North Pacific. The United States and Canada established it 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, and it is 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 (1985), 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, U.S. Canada, Japan and Russia and cooperating nations) coordinate research and harvest of salmon and other andromous species above latitude 33° N outside the 200-mile zones of the signatories. INPFC published long time series of catches for principal groundfish species, crab, shrimp and herring for the signatories, and for cooperating nations, Poland, South Korea, and Taiwan. The INPFC statistical yearbooks (1952 – 1992) contain biological time series on groundfish, crabs, and marine mammals. The NPAFC Statistical Yearbooks (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.

Arctic Monitoring and Assessment Programme (AMAP), is an international circumpolar program which seeks to monitor anthropogenic pollutants in all parts of the Arctic environment (http://www.grida.no/amap/assess/soaer1.htm#amap). Observations extend into the Bering Sea, but not into the Gulf of Alaska as yet. The nations of Canada, Denmark/Greenland, Iceland, Norway, Sweden, the Soviet Union, and the United States entered into the 'Rovaniemi process' that promotes arctic environmental protection in 1989 at as meeting in Rovaniemi, Finland. 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 (June 1991) 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 (http://www.psmfc.org/rmpc/) 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.

6. 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 Climate Change (GLOBEC), World Ocean Circulation Experiment (WOCE), Joint Global Ocean Flux (JGFOS), 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 in the section on transboundary organizations.

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 depends on cross-shelf import of large zooplankton from offshore to nearshore waters (see also section IV. D.2.b). 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 Gulf of Alaska. Another part of IGBP is the Joint Global Ocean Flux (JGFOS), 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 UNESCO, is to be a permanent global system for collecting data, modeling and analyzing marine and ocean processes worldwide. Another IOC sponsored program is World Ocean Circulation Experiment, WOCE, under the auspices of the World Metorological Association. WOCE sponsors a large number of investigations directed at understanding the currents of the world's oceans, including the Pacific and North Pacific. Made with many different types of instruments and platforms, most of the measurements of the WOCE measurements took place earlier this decade. The information is now being used in research programs to create models of circulation and associated physical factors such as temperature.

C. An overview of valued GOA resources and recent changes

1. Fish and Shellfish

The fish and shellfish fisheries of the Gulf of Alaska have been among the world's richest in the second half of the twentieth 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 3 million mt in 1982 (Witherell 1999). Annual numbers of two-year old pollock entering the fishable population (recruitment) from 1981 to 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 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 that were in 1977 and 1995. Biomass of the dominant flat fish in the GOA, the arrowtooth flounder is approaching 2 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 is estimated at 258,000 mt, which is above average for 1974 - 1999 (Witherell 1999). Exploitable biomass of Pacific halibut was also increasing 1974 – 1988, after which it declined slightly. As possibly explained by a combination of climate change and fishing patterns, the status of crab populations, as covered below, are quite poor compared to the relatively strong groundfish populations.

Strength of both salmon and groundfish populations in the northeast 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 Nino 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) (Hare 1996). The ENSO and the PDO were shown to be independent of one another (Mantua et al. 1997).

The opposite responses of groundfish/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 of 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.

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-y 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 of recruitment for 15 crab stocks in the Bering Sea, Aleutian Islands and Gulf of Alaska, time trends in 7 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 7 of the 15 carb stocks. The seven significantly negative correlations between ocean productivity and crab recruitment were from Bristol Bay, Cook Inlet and the Gulf of Alaska. 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 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 favors 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 dominates in years of weak lows and stable water columns. Strong lows mean 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.

No commercial fisheries are allowed for such "forage" fishes as eulachon, sand lance, capelin, and lantern fish. In the absence of commercial catch data, the fluctuations of their populations are not well-known. 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 very 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 (i.e., Atka mackrel, Pacific cod, Pacific hake and walleye pollock) (Franciset 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.

2. Seabirds

The GOA supports large aggregations of colony nesting seabirds: 26 species contribute to an estimated total of 8 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 (Senner, 1999) in the spring. During the summer breeding season, colonial seabirds 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 sea birds that nest and reproduce nearby (e.g., Furness et al. 1997; Phillips et al., 1996).

Seabirds also provide a relatively 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. Since 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 (e.g., Piatt and Anderson, 1996; Hatch et al., 1993)(Fig. X-1). 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 (Piatt, unpublished)

3. Marine Mammals

Three groups of marine mammals occur in the northern Gulf of Alaska, cetaceans (whales and dolphins), pinnipeds (seals, sea lions and walrus), and the sea otter. One species, the Steller sea cow, was extirpated about 1768 (Hood and Zimmerman 1986). The sea cow was an important component in nearshore kelp communities, the largest recent herbivore to have grazed on macroalgae. Most species of marine mammal experienced some level of commercial harvest starting in 1741 when Vitus Bering explored the Bering sea northern GOA area and laid claim to it for Russia. Harvest of marine mammals has been radically reduced in these waters during the twentieth century. Although some low levels of harvest for subsistence purposes still occurs, some species have responded to the cessation of harvest by increasing their numbers. For example, some species of pinniped such as the northern elephant seals have increased dramatically during recent decades. But even with cessation of most harvest, some species such 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 twenty years.

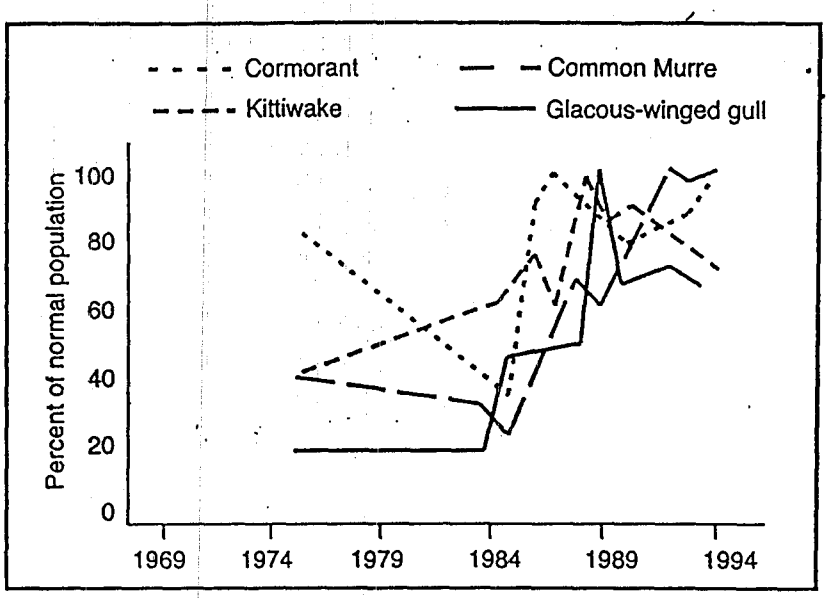
Sea otters, very nearly extirpated from the North Pacific by 1900, have also benefited from the near cessation of human harvest. Since that time the species has increased dramatically throughout most of Alaska, and has itself precipitated profound changes in the structure and function of coastal marine communities of less than 100m depth. During the past decade large declines in sea otter abundance has 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).

Restoration of whale populations could have dramatic effects on the ecosystem. Most mysticeti whales (e.g. fin, minke, and humpback) forage on zooplankton and small schooling fish, and consume large quantities of secondary production. Generally, great whale populations remain depressed and far below historic numbers from the effects of commercial exploitation. The effects of reduced whale abundance on zooplankton and forage fish populations are largely unexplored for the North Pacific. Recovery of depleted whale populations may be predicted during the next century.

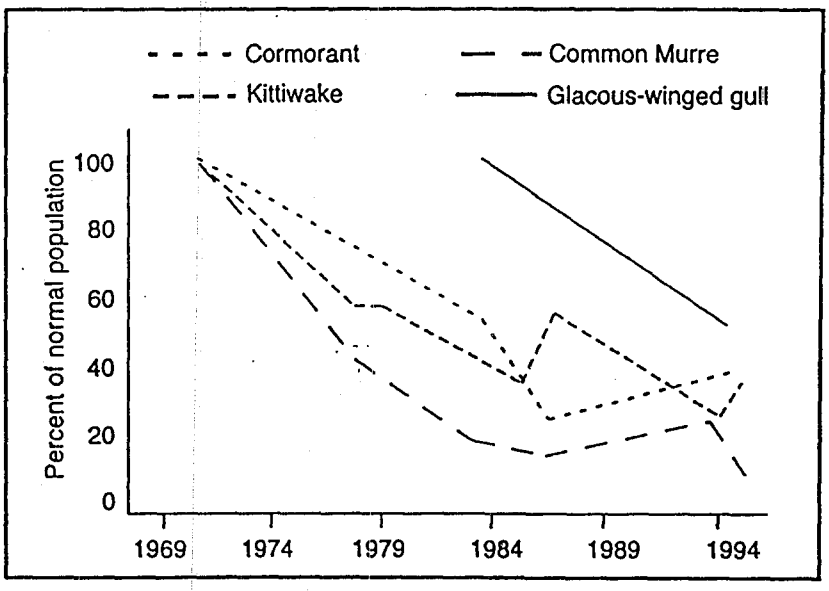
Northern fur seals have been in steep decline in the Bering Sea and their decline may be related to conditions in the GOA (Trites 1992).Although food limitations in the Bering Sea may not be limiting population growth, food limitations in the Aleutians and in the Gulf of Alaska may be creating a population growth bottleneck by causing high mortalities on juveniles during migrations. The bottleneck hypothesis of fur seal abundance control (Trites 1992) illustrates but one of many ecological connections between the Bering Sea and the Gulf of Alaska. Steep declines in harbor seals in the

Gulf of Alaska have been documented in and around Kodiak Island 1956 – 1976 (Pitcher 1990) and in Prince William Sound throughout the 1990's (Figure X-2, Piatt 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 Endangered Species Act, have declined steeply starting in the early 1970's, 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 (Bowen et al. 1999). Current information is not conclusive 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 populaitons.



Gull Island, Outer Cook Inlet



Chisik Island, Cook Inlet

Figure X-1. Long-term decline of seabirds at Chisik Island, Cook Inlet (bottom) and increase at Gull Island, Outer Cook Inlet (top). (Piatt and Anderson, 1996).

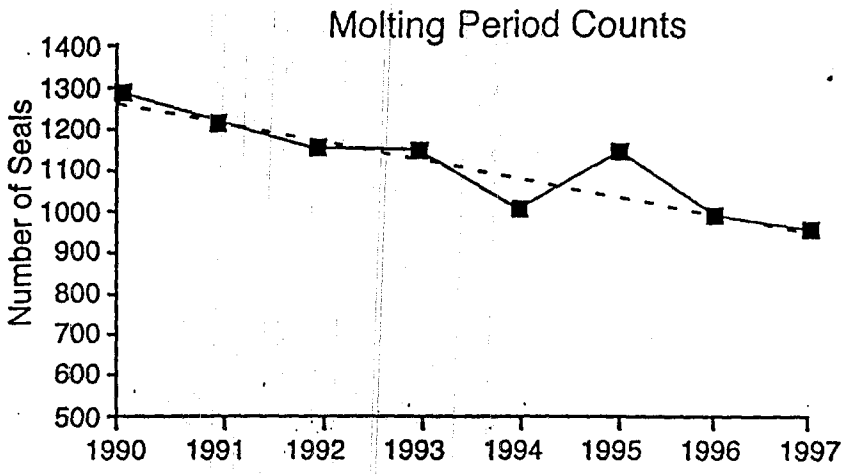


Figure X-2. Population trend of molting seals in Prince William Sound. (Piatt, 1998)

D. Ecological Setting

The primary purpose of the GEM program is to provide a better understanding of how valued marine populations such as fish, shellfish, seabirds and marine mammals are produced. In order to understand how these populations change, what causes them to change, and to provide the means to help predict these changes, we must understand their environment. So, in this section the northern Gulf of Alaska ecosystem is described, beginning with the geological features that define the oceanic and coastal regimes. Next, ocean circulation and how it affects nutrient recycling is described. And, finally, the physical and chemical processes that set the bounds for productivity and control the transport of produced organic matter are discussed. This sets the stage for the conceptual model that is described in the following section.

1. The Gulf of Alaska Ecosystem

The area affected by the *Exxon Valdez* oil spill encompasses a number of different environments within the northern Gulf of Alaska (GOA) marine ecosystem (Fig. X-3). Within these offshore marine, nearshore marine, estuarine, freshwater and terrestrial environments, geological, climatic, oceanographic, and biological processes interact to produce the highly valued natural beauty and bounty. The GOA is: a major source of seafood for the entire nation, as well as for Alaska Natives who rely on it for subsistence and cultural purposes; a part of the "lungs" of the planet for recycling of oxygen and carbon to and from the atmosphere; habitat for diverse populations of fish and wildlife; and a source of beauty and inspiration to those who love natural things.

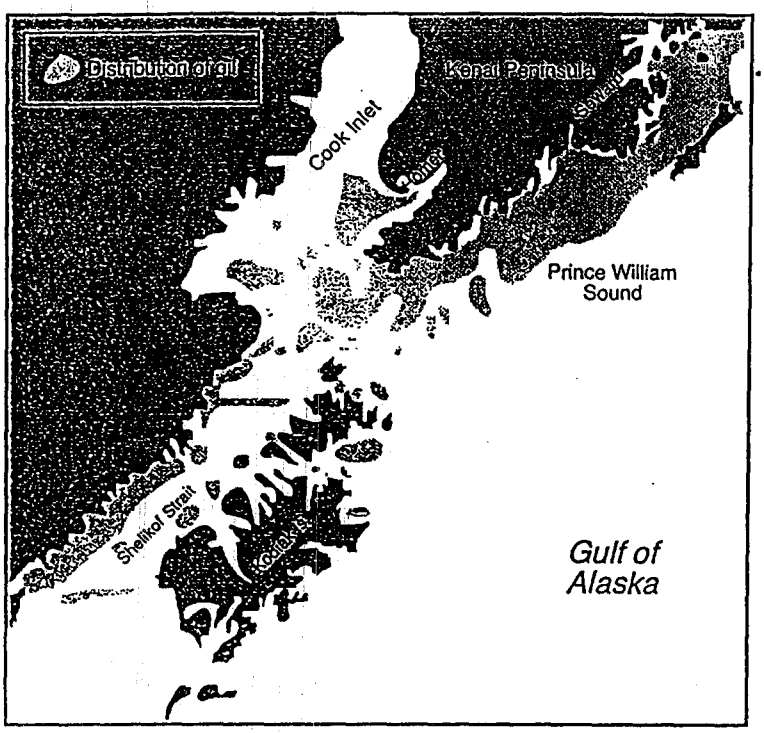


Figure X-3. Map of the *Exxon Valdez* oil spill area.

a. Seabed Topography

The northern GOA contains a large subarctic ocean basin. Its extensive and spectacular shoreline has been and is being shaped by plate tectonics and massive glacial activity (Hampton et al, 1987). The shoreline is bordered by a continental shelf ranging to 200 meters in depth (Fig. X-4). 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 (Figure IV-4). The continental shelf is incised by extensive valleys or canyons (Carlson et al., 1982) that may be important in cross-shelf water movement, and by very large areas of drowned glacial moraines and slumped sediments (Molnia, 1981).

b. 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, 1987). 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 (Fig. X-5a, b). 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; Trenbreth and Hurrel, 1994). The North Pacific Oscillation (NPO), as this cycle is called, appears to be a major source of oceanographic and biological variability.

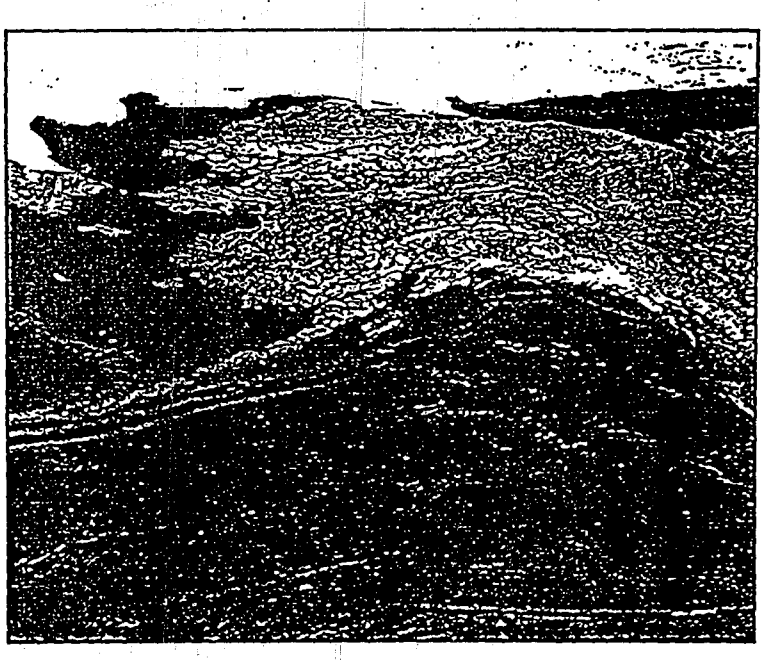


Figure X-4. Satellite radar image of the northern Gulf of Alaska. Continental shelf, seamounts, and abyssal plain can be seen in relief. (Composite image from SEAWIFS Remote Sensing satellite, NOAA).

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 particularly 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 7-10 days (Treidl et al., 1981). 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 (e.g., see White and Clark, 1975)

Mantua et al. (1997) have calculated the Pacific Decadal Oscillation (PDO) index, which tracks the NPO. 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 the PDO was negative and then again for 3 years in the early 1990s (Hare et al., 1999). Fig. X-5 shows winter-time 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 this century (Richardson, 1936; Klein, 1957; Reitan, 1974; Whitaker and Horn, 1982; and Wilson and Overland, 1987). 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).

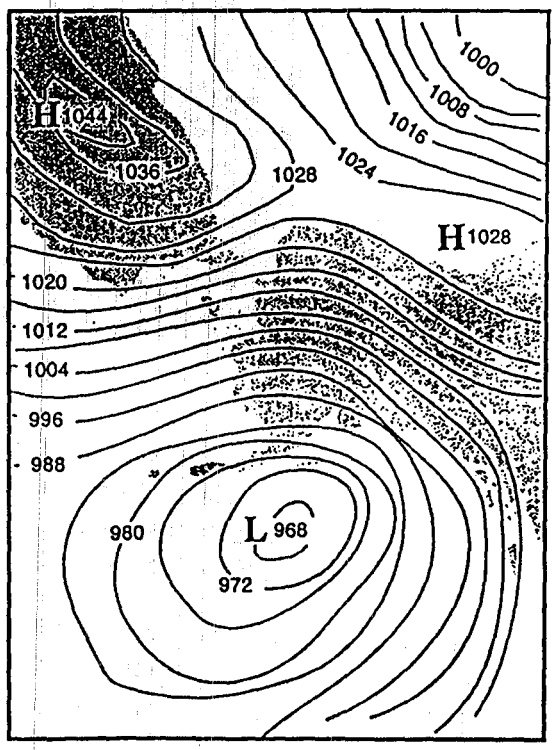


Figure X-5a. Typical winter example of the Alutian low and Siberian high pressure systems. Contours refer to sea-level pressure in millibars. (From Carter, XXXX).

c. Ocean Circulation and Currents

Net surface-water circulation is counterclockwise, or cyclonic, in the GOA (McEwen et al., 1930; Sverdrup et al., 1942) and consists of two major ocean-current systems (Fig. X-6). The nearshore Alaska Coastal Current is a buoyant, eastern boundary current, differentiated from the underlying and offshore water masses by virtue of its lower salinity. The variability in its flow is due to differences in seawater density, less so to winds, and is dominated by large seasonal salinity changes, with greatest freshwater discharge and strongest flow (at least in the central and western GOA) in the fall (Royer 1979, 1981, 1982). Seasonal changes in temperature are less important in influencing flow. Winds from the west, south and southwest, depending on the location in the gulf, tend to push this current shoreward and constrain it to a relatively narrow band (Royer, 1983). The Alaska Coastal Current frequently enters PWS (Niebauer, 1994; Vaughan, unpublished data), dominates the circulation of lower Cook Inlet, and is responsible for one-way net flow to the southwest through the Shelikof Strait (Reed and Schumacher, 1987). During relatively warm climatic periods with above average precipitation (positive PDO), the Alaska Coastal Current is strengthened (Royer, 1983). Major eddies also have been described in the Alaska Coastal Current (e.g., Schumacher et al., 1993) and these may well have significant biological implications (Schumacher and Stabeno, 1993).

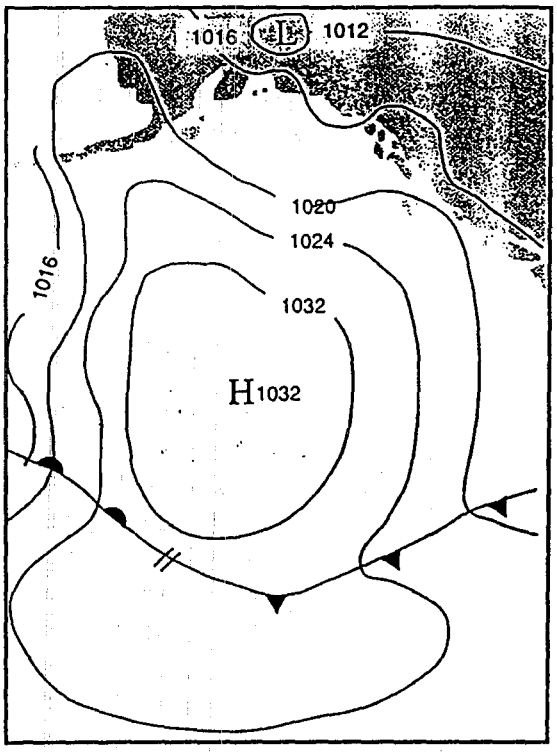
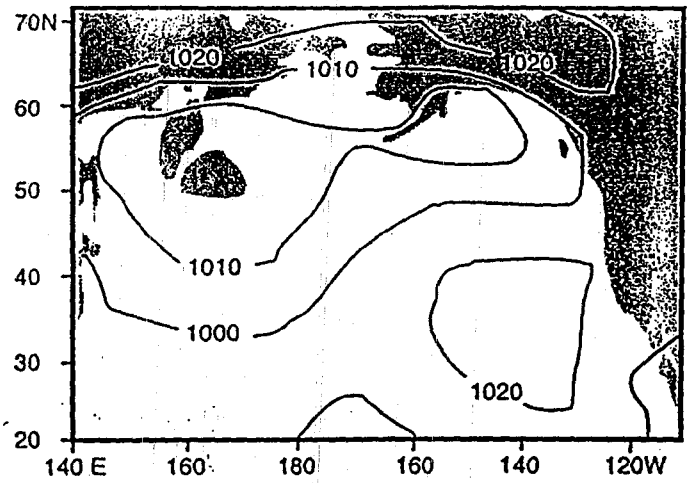
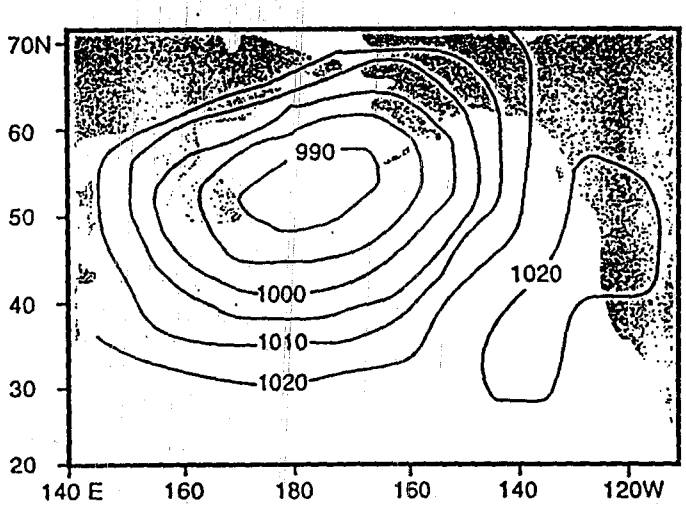


Figure X5b. Typical summer example of the Alutian low and east Pacific high-pressure systems. Contours refer to sea-level pressure in millibars. (From Carter, XXXX).

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 and narrows and strengthens southwest of Kodiak Island into the Alaska Stream, the westward flowing portion of the subarctic gyre (Reed and Schumacher, 1987). This dominant current system often may have computed velocities in excess of 80 to 100 centimeters/second and net transport in excess of 6 $x10^6$ m^3/s. This is particularly so near the outer Alaskan Peninsula and Aleutian Islands, where sharp salinity decreases inshore generate steep geostrophic potentials and fast flows (Reed and Schumacher, 1987).



1972



1977

Figure X-5. Mean sea-level pressure patterns from the winters of 1972 and 1977. (From Emery and Hamilton, 1985).

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 California Current system (e.g., Hollowed and Wooster, 1992). The proposed decadal scale variation in. currents of the northeastern Pacific are shown in Figure X-7. Weak flows of the Alaska Current in the eastern gulf have been associated with years of higher-than-normal salinity (Ingraham et al., 1991). Reed and Schumacher (1987) 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 in to the southern gulf more to the northwest. They suggested that such changes, although not 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.

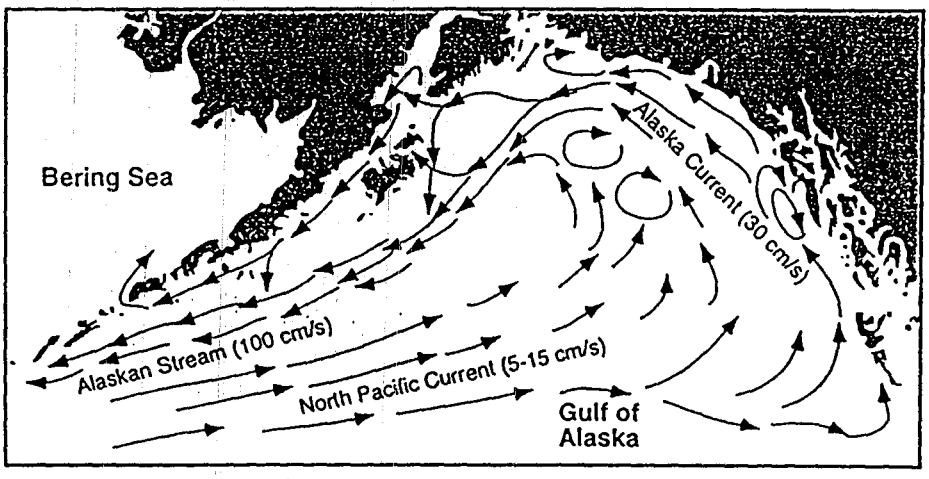


Figure X-6. Currents in the Gulf of Alaska. (McEwen et al., 1930).

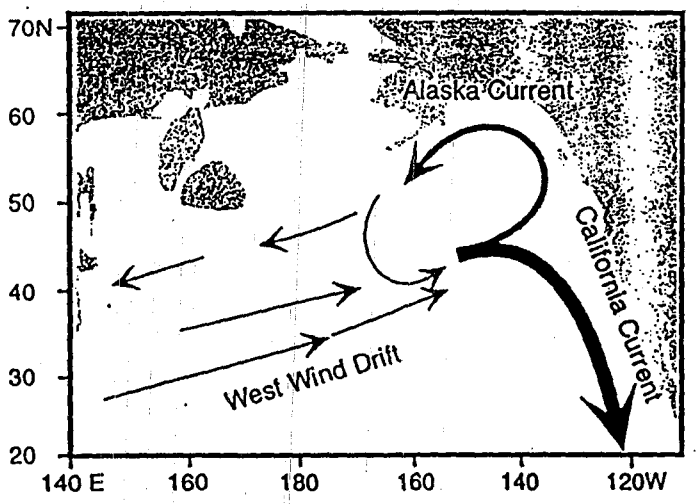
During periods when the NPO favors a more intense, northerly position of the winter Aleutian Low Pressure system, winds in the eastern GOA are stronger (Emery and Hamilton, 1985; Mantua et al., 1997), there is more precipitation and Ekman transport is

greater. Polovina et al. (1994, 1995) showed that after the 1977-1978 spring-summer, the mixed-layer depth in the north Pacific was 10-30% shallower than normal and that this change, with associated changes in temperature, could have resulted in 50% higher rates of primary and secondary production.

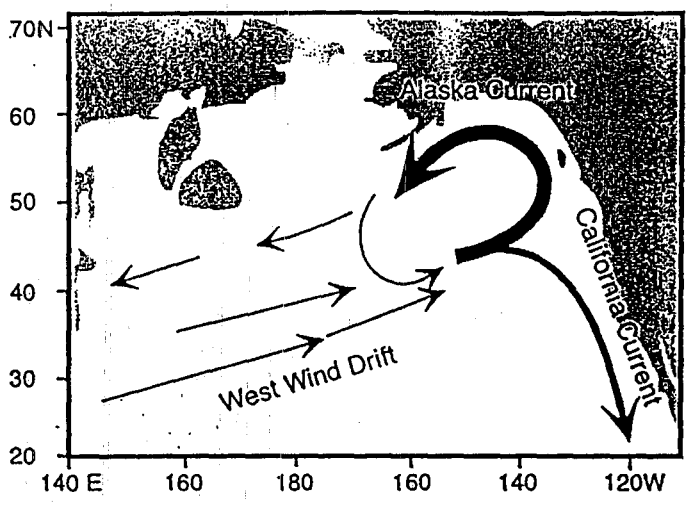
d. Nutrients and Fertility

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 (supporting evidence in the central gulf includes mounding of the oxygen minimum layer [Reid ,1965]; ^{14}C depletion in surface waters [Reeburg and Kipphut, 1987]; and 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 nutrients (nitrates, phosphates and silicates) necessary to support phytoplankton growth are never apparently limiting (Heinrich, 1957; Beklemishev, 1957).



Winter 1972



Winter 1977

Figure X-7. Oceanic circulation patterns in the far eastern Pacific proposed for negative PDO (top) and positive PDO (bottom). (Hollowed and Wooster, 1992).

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. Cross-shelf transport is not as well understood as oceanic water exchange with coastal water bodies. 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.

e. Plankton and Productivity

Some of the basic conditions for phytoplankton growth in the central GOA, based on 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 (e.g., Miller et al., 1991). The reported average annual rate of 170 g $Cm^{-2}y^{-1}$ is one of the highest in the world oceans (Welshmeyer et al., 1993). The most recent nutrient data suggest that nitrate and other nutrients are not limiting in the photic zone (i.e., that area reached by sunlight) during the growing season (Dugdale, 1967; Hattori and Wada, 1972; Miller et al., 1991). Iron has been suggested as limiting factor, but it appears that iron may set the characterisitics of the phytoplankton community, but not be limiting *per se* to the dominant small phytoplanton 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 (e.g., Booth et al., 1993). Recently, Miller et al. (1991) suggested that consideration of the grazing protozoans as an intermediate between phytoplankton and large (*Neocalanus*) copepods 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. Apparently, ammonia recycled quickly from the micro- and macrozooplanknton to the phytoplankton (mainly flagellates), 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 during the growing season (Larrance and Chester, 1979; Chester and Larrance, 1981), but otherwise the broad features of a physically mediated high-latitude bloom are in place inshore as well.

Results of the EVOS-sponsored Sound Ecosystem Assessment project (SEA) project include a model of the water column in Prince William Sound 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.

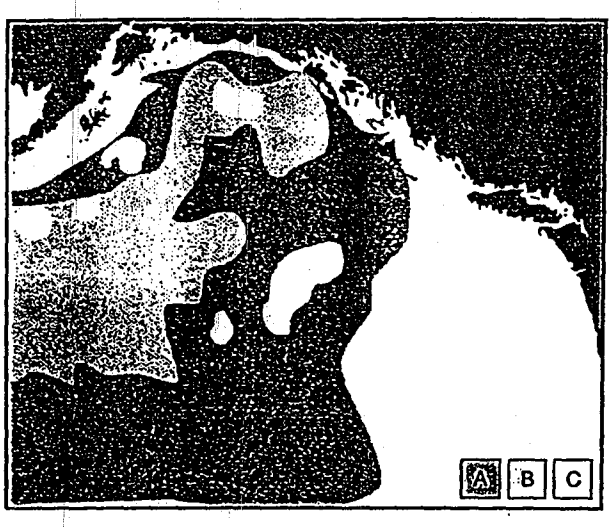
It is generally thought that the more energetic physical environment on the shelf is responsible for sustaining these high rates of primary production, but coastal convergence and the predominately downwelling nature of the hydrography limit opportunities for water renewal from the deep GOA. Offshore fronts associated with the Alaska Coastal Current 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 reflect 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 transfering large amounts of energy from phytoplankton to higher trophic levels (Cooney, 1987; Short unpubl.). Available evidence led Cooney (1984) to postulate 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 estimated $2x10^6$ metric tons estimated from production on the shelf in the Alaska Coastal Current. 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 Fig X-8 biomass of plankton for the spring and summer period are contrasted for a negative PDO period and a positive PDO period, and it can be seen that zooplankton biomass was much greater during the period.

Nonetheless primary and secondary productivity measurements in the GOA are few (e.g., Reeburg and Kipphut, 1987). Similar data on nekton also indicate that this group of organisms also was more abundant after about 1978. Both these observations are consistent with calculations by Polivinia 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 (Pearcy, 1992; Hare et al., 1999; Mantua et al., 1997)(Fig. 8). 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 that does exist (Mackas, personal communication). 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 (e.g., Piatt and Anderson, 1996; Hatch et al., 1993)(Fig. 7). 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 (Fig. X-1, Piatt, unpublished). 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 well 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.

Spring



Summer

Biomass of plankton for the spring and summer period are contrasted for a negative PDO period (top) and a positive PDO period (bottom). Box A represents 100-200 g/1000 m^3 zooplankton biomass, Box B represents 201-300 g/m^3, and Box C represents >300 g/m^3.

f. Benthos

The GOA sea bottom supports a diverse community of bacteria, fungi, algae, some higher plants, invertebrates and fishes, and it varies with changes in substrate characteristics, depth, temperature, light and food supply (O'Clair and Zimmerman, 1987; Feder and Jewett, 1987). Primary production occurs in intertidal shallow subtidal communities. Benthic algal production is locally important in inshore areas of the northeastern Pacific. Productivity estimates for the NE Gulf of Alaska for large kelps (Nereocystis and Laminaria spp. range as high as 37.4-71.9 kg/m^2 /yr wet weight for Prince William Sound, 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. This productivity is very important to maintaining nearshore communities in the areas where it occurs, however 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 to

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 Aleutians Islands and Alaska Peninsula, Kodiak, Cook Inlet, and northeastern Gulf of Alaska (OCSEAP 1990). References above to climate-mediated changes in production regimes and 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 and Kaufman, 1999). Also, variations in cyclonic circulation in the GOA and therefore in gyre Ekman-induced transport of surface water and its associated 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 (e.g., see 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 Alaska Coastal Current 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 record of intertidal community composition in the northern GOA.

2. Conceptual Model: How the System Works

a. Introduction

Every monitoring program by virtue of what, when, and where it samples, is based on some understanding or model of the system it attempts to characterize. Often the model is only implicit in the sampling scheme, but it can be presented as one or more hypotheses. An alternative approach--and the one followed here--is an explicit model of system behavior, containing a series of functional relationships that are expressed as interrelated testable hypotheses or questions about key parts of the system and the relationships among those parts.

Based mainly on the information presented in the background section (section IV.A), a conceptual model of how biological production and diversity vary in the GOA on time scales from years to centuries is presented below (see Fig. X-10 a,b). This model will be followed by a series of questions (section IV.C) that serve to conceptually reduce the system to linked components, each with several potential alternative behaviors.

Some parts of the following model are almost certainly valid and will be verified through further work in GEM and elsewhere. Other portions of this model probably will be rejected or modified based on reinterpretations of existing data or insights from new data. The ecosystem also may change in ways that are not anticipated based on past experience, as happened in the late 1970s. It also should be noted that while much of the focus of the background section was on the North Pacific Oscillation (NPO), the model described below will necessitate yearly measures of most of the parameters to capture any superannual cycle. So, for instance, Enfield (1997) summarized sea surface temperature trends into several coherent multiyear signals that affect the north Pacific Ocean: a 4-5 year ENSO mode, a Pacific interdecadal mode, and a global warming mode that appear to operate on very long time scales. Each of these would be expected to exert ecological effects and would be captured by the proposed program. Likewise, cyclic phenomena arising, for example, out of density-dependent population fluctuations in biological populations also would be captured.

Recognizing that the ecosystem under consideration is extremely complex and composed of tens of thousands of species, it will not be possible for this program to answer all, or even most, of the questions that could be posed about the GOA. However, it is focused on the system behavior that, based on the scientific literature and consultations with experts, seems to be most important for understanding the physical and biological processes responsible for biological production. The program also will be focused to a large extent on representative species in the system, picked on the basis of perceived ecological importance and human relevance, for in the end GEM must be justified on what it can tell us about how we should behave towards the ecosystem.

b. The Model

Any response model must start with the physical influences that drive the system. There are several candidates, which are perhaps not mutually exclusive, for external forcing factors: 1) Kelvin waves with a 4-5 year period underlying El Niño-La Niña phenomena, 2) atmospheric pressure changes with a 20-30 year oscillation (PDO), and 3) an 18.6-year lunar tidal node, and 4) long-term global warming. For purposes of this model, there may be enough confluence in the PDO and lunar cycle so that it is not important to specify which of these explanations (or both) are significantly affecting the ecosystem. Since the mechanisms through which the tidal node may be expressed in system oceanography are not as apparent or extensively elaborated (e.g., see Parker et al., 1995; Royer, 1993), much of the following discussion is based on atmospheric forcing that has been more extensively related to biological change, i.e. PDO. ENSO-related changes are still being described in the literature as a result of the recent events in the late 1990s. The following conceptual model describes the multi-decadal oscillation of production and consumption regimes in response to the PDO.

This model can be summarized as follows: In some decades the GOA is warm and windy with lots of precipitation. Under those conditions, offshore grazers, such as salmon, do well, but inshore grazers, such as seabirds and seals, do not thrive. In other decades, the GOA is cooler and less windy with less precipitation. Under those conditions, salmon do not do as well, but inshore seabirds and seals are favored. In addition, there are particularly warm and cold periods every few years (e.g., warm El Niños in 1983 and 1997), and both the decadal and El Niño-La Niña cycles are superimposed on a long-term warming trend in the north Pacific. The changes in ocean structure in response to climate alter the supply of nutrients, food production and transport. Inshore grazers do well when there is greater imported and local production, and offshore grazers do well when offshore production is good but does not get transported inshore. In addition, the long-term warming of the ocean may limit the extent of offshore habitat available to warm-intolerant salmon.

This model can be described in more detail as follows:

Northerly movement and intensification of the winter-time Aleutian low pressure system results generally in the following interrelated changes, known as positive Pacific Decadal Oscillation (PDO) (Fig. 2a):

1. Acceleration of cyclonic motion in the Alaskan 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;

6. Increased precipitation and coastal runoff;

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 the following differences also characterize a positive PDO:

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 central gulf;

3. There is greater production and standing crops of zooplankton and nekton offshelf and in the central gulf;

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 central gulf is carried shoreward by Ekman transport in much greater quantities, and then is downwelled more strongly before reaching the coast;

6. There is an increased supply 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 physical and biological changes in a negative PDO index period are shown in Fig. 2b, in contrast to those shown in Fig 2a. Much of the model described above already appears in the literature as cited in the background section. However, the proposed inshore-offshore inverse production regimes and the transport and fate of the organic matter produced in response to the PDO, which are described in the context of a physically coherent ocean-climate model and which generally agrees with population trends in higher trophic-level organisms (e.g., salmon, seabirds and harbor seals), has not previously been described. That is, bottom-up controlled food webs in the two regimes respond to climate in generally opposite ways, with positive PDO indices being associated with greater offshore production and weaker nearshore production (1978-1990), and negative PDO indices (1948-1977) being associated with greater onshore production 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 slope 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.

It is proposed that the separation between onshore and offshore production regimes is at the offshore edge of the Alaska Coastal Current. The "ring of plankton"

often seen in sections 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 model 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 nearshore production or 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 Alaska Coastal Current, 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 PDO's makes the water column more stable and that this increased stability promotes greater primary production. Polovina (19) has 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.

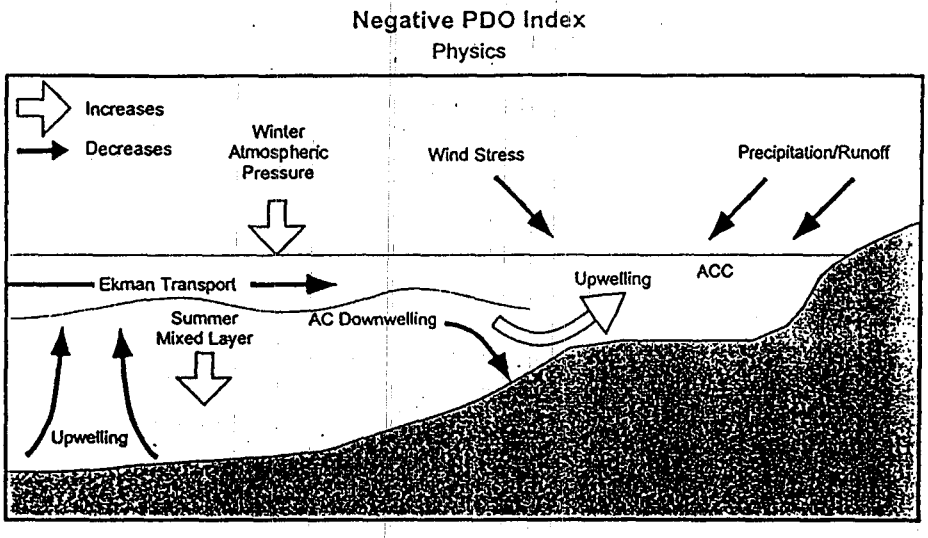
The "optimal stability window" hypothesis is closely related to what is proposed here, with several differences. First because of the tendency for waters of the Alaska Coastal Current to become nutrient limited, we are proposing that increased water column stability during positive PDO's will result in net production decreases, in contrast to the increases expected in the central GOA. Second, while Gargett proposes that greater salmon production results from favorable productcity in coastal waters, where many salmonids spend their firs year at sea, our hypothesis would explain abundanct food on the outer shelf as a result of onshore transport of offshore production, i.e. Cooney's ring of zooplankton production. If increased salmon production results from favorable productivity in coastal waters, where many salmon spend their first year at sea, our hypothesis would explain abundant food on the outer shelf as a result of onshore transport of offshore production, i. e. Cooney's "ring of zooplankton." Is the carbon in the Alaska Coastal Current during a positive PDO due to *in situ* production or onshore transport? Resolving which if either of these two hypotheses is correct depends on knowing the origin of the carbon available to salmon on the shelf.

If the source of increased carbon during a positive PDO is due to onshore transport, 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 there are data available to distinguish which hypothesis is correct.

It should also be recognized that the model presented here attempts to provide a mechanistic explanation of how the largest climate signal (PDO) could cause the biological changes that are correlated with it. It is to be expected that effects of El Nino - LaNina cycles and the long term global warming evident throughout the Pacific will interact in potentially complex ways with PDO cycles. It will be important to expand, modify or totally reverse the model as new insights accumulate.

In addition to 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 (199_) has proposed that global climate warming could drastically restrict the range of sockeye salmon in the next several decades.


Negative PDO Index
Physics
Increases
Decreases
Winter
Atmospheric
Pressure
Wind Stress
Precipitation/Runoff
Ekman Transport
Upwelling
ACC
Summer
Mixed Layer
AC Downwelling
Upwelling

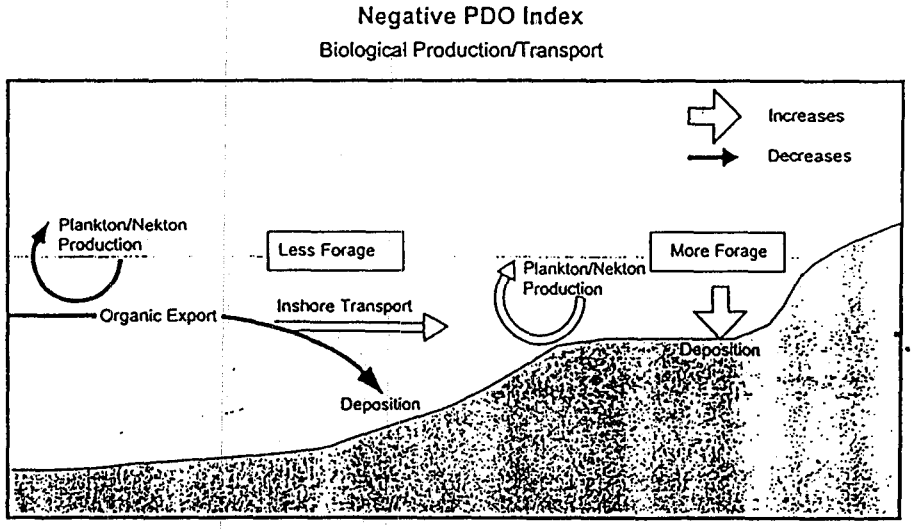
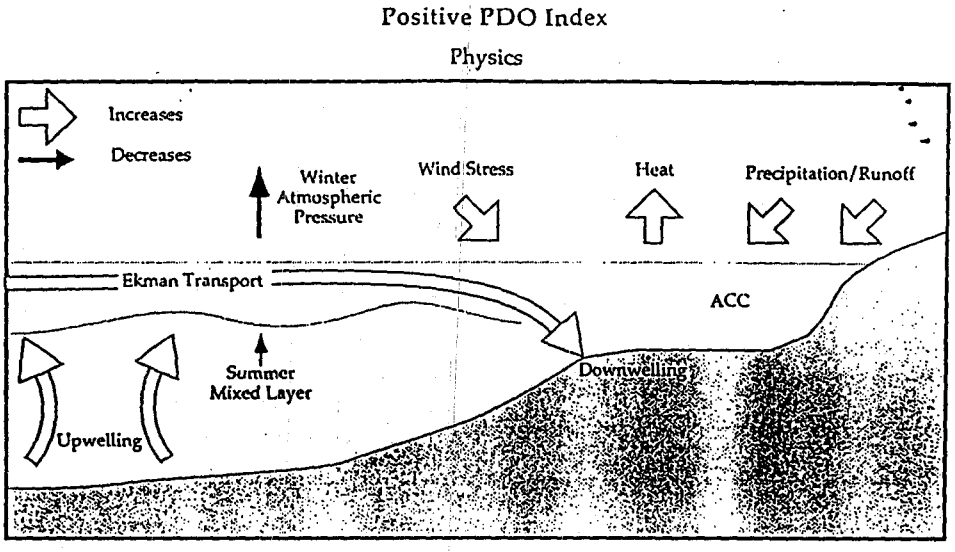

Negative PDO Index
Biological Production/Transport
Increases
Decreases
Plankton/Nekton
Production
Less Forage
More Forage
Plankton/Nekton
Production
Organic Export
Inshore Transport
Deposition
Deposition

Figure X-9a.


Positive PDO Index
Physics
Increases
Decreases
Winter Atmospheric Pressure
Wind Stress
Heat
Precipitation/Runoff
Ekman Transport
ACC
Summer Mixed Layer
Upwelling
Downwelling

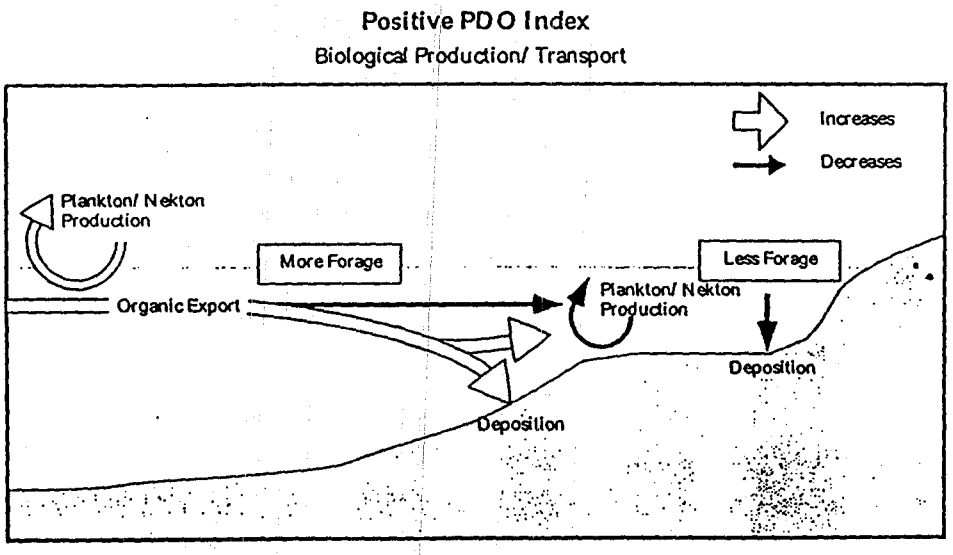

Positive PDO Index
Biological Production/ Transport
Increases
Decreases
Plankton/ Nekton Production
More Forage
Less Forage
Organic Export
Plankton/ Nekton Production
Deposition
Deposition

Figure X-9b.

E. Scientific Questions

In the context of the conceptual model described above, the following questions are meant to capture some of the main uncertainties in how fluctuations in the GOA ecosystem influence the distribution and abundance of valued organisms. The questions do not attempt to capture the entire scope of potential monitoring and research projects, but rather they address discrete aspects of the proposed model and are related to one another. There are other questions that could be posed and other ways to frame the uncertainties, so this should be considered an initial effort. Questions marked with an asterisk (*) are considered fundamental to the core monitoring program. Although a specific model has been postulated to explain ecological change in the northern Gulf of Alaska, the following questions are broad enough to capture major ecosystem changes whatever the mechanisms.

1. Climate, sea-surface interactions and physical oceanography

a. What are the periodic and aperiodic changes in the atmosphere that influence the northern GOA?* Are they predictable ? How will the trend in global warming affect cycles in the future?*

b. What is the annual, interannual, and interdecadal variability in the position and strength of the Alaska Coastal Current?* What is the annual, interannual, and interdecadal variability in the Alaska Current and Alaska Stream?*

c. How is downwelling of onshore-driven water and upwelling of deep water affected by changes in wind and coastal precipitation during different climatic regimes? Does freshwater-induced stratification and wind-induced mixing on the continental shelf change significantly under various climatic regimes?

d. How do fronts and eddies affect biological production and onshore-offshore transport?

e. How do nearshore and shelf exchange processes change over time and what are the biological consequences of such changes?

f. What are the fluctuations in freshwater input to the coastal gulf and how do these changes affect circulation, stratification, and inshore-offshore exchange?

2. Ocean fertility and plankton

a. How are nutrient transport and recycling in the central GOA and on the shelf different in different climate regimes?*

b. What are the relative roles of local nutrient recycling versus deep-water supply and cross-shelf transport in PWS, Cook Inlet and Kodiak Island?

c. Does the intense upwelling in outer Cook Inlet vary significantly interannually or interdecadally ?* Do long-term changes in some tidal nodes (e.g., an 18.6-year nodal cycle) affect nutrient supply in this region?

d. Are PWS, Cook Inlet and the Kodiak shelf net importers or net exporters of nutrients, carbon and energy ?

e. How does the timing, magnitude, duration, and species composition of the spring bloom respond to seasonal and interannual variability in nutrient supply and physical conditions?

f. What is the zooplankton community response to seasonal and interannual variability in phytoplankton? What is the fate of offshelf zooplankton production under different climate regimes?

g. What combinations of physical conditions and primary and secondary production lead to favorable conditions for higher trophic level consumers (fish, birds, mammals), and what is the spatial and temporal variability and frequency of occurrence of these combinations?

h. What are the relative contributions of the net plankton, microheterotrophs, and bacteria in the overall energy budget of the ecosystem?

3. Fish and fisheries

a. What are mechanisms responsible for interannual and interdecadal variations in populations of major species of forage fish (herring, pollock, capelin and eulachon) in the GOA?*

b. What is the balance between nearshore survival of juvenile salmon and survival through the remainder of the life cycle in the GOA in determining fluctuations in salmon returns in the region ?

c. Are there particular combinations of periods of wind-free, onshore transport of deep water with high nutrient content and periods of wind-driven mixing that prevent prolonged stratification of surface water that are optimal for inshore survival of young herring and salmon?*

d. Does enhanced late-season plankton production favor survival of 0+ age class fish?

e. How important to overwintering survival of forage fish are warm winter water temperatures and holdover zooplankton production?

f. What is the long-term effect of salmon hatcheries on the allocation of pelagic food resources in the GOA?

"[Trophic dynamic] Process-oriented studies in the North Pacific ... are urgently needed. Investigations on plankton dynamics and early life histories of fish and shellfish should be undertaken so that mechanisms for subsequently observed changes in fish, shellfish, bird, and marine mammal populations can be understood." (p. 62 Kruse 1998) At-sea research is urgently needed on the biotic implications of these [climatic and nutrient transport] conditions, from effects on primary and secondary producers to effects on invertebrates, fish, birds, and marine mammals through the pelagic and benthic food webs. (p. 55 Kruse 1998)

4. Benthic and intertidal communities

a. How do populations and productivity of benthic and intertidal communities fluctuate interannually and interdecadally?*

b. What conditions cause fluctuations in the fraction of the spring bloom that falls ungrazed to support the benthic fish and invertebrate community?

c. How does nutrient supply to nearshore plants fluctuate?

5. Bird and mammal populations

a. How do populations and productivity of seabirds fluctuate interannually and interdecadally?* Is the availability of fatty forage fishes (e.g., herring, capelin and eulachon) in the shelf environment the main determinant of population success?*

b. How do populations and productivity of harbor seals fluctuate interannually and interdecadally?*

c. Do populations of harbor seals fluctuate with the availability of fatty forage fishes (e.g., herring, capelin and eulachon) in the shelf environment ?

d. How do populations and productivity of sea otters fluctuate interannually and interdecadally?* Does food supply play the main role, or do disease and predation?

e. To what extent does transport of marine nitrogen from the GOA determine or limit the production of terrestrial bird and mammal populations?

f. "[Trophic dynamic] Process-oriented studies in the North Pacific ... are urgently needed. Investigations on plankton dynamics and early life histories of fish and shellfish should be undertaken so that mechanisms for subsequently observed changes in fish, shellfish, bird, and marine mammal populations can be understood." (p. 62 Kruse 1998) At-sea research is urgently needed on the biotic implications of these [climatic and nutrient transport] conditions, from effects on primary and secondary producers to effects on invertebrates, fish, birds, and marine mammals through the pelagic and benthic food webs. (p. 55 Kruse 1998)

6. Anthropogenic and natural contaminants

a. What are the concentrations of bioaccumulated anthropogenic chemicals in the coastal and shelf organisms? *

b. What is the loss rate of residual EVOS hydrocarbons from the spill area?*

c. Are anthropogenic chemicals having adverse effects on the health of marine organisms, especially apex predators with high accumulations of persistent synthetic chemicals?

d. What are the concentrations of bioaccumulated natural toxins, such as domoic acid, in the coastal and shelf environment?

e. Are natural toxins having adverse effects on the health of marine organisms, such as killer whales and other apex predators with high accumulations of persistent synthetic chemicals?

F. Approach to Long-term Monitoring

The main purpose of the GEM program is to pursue and support the collection of a core of long-term measurements sufficient to track ecosystem changes in processes and species of interest on the scale of decades. At the same time, GEM seeks to conduct shorter-term research to clarify functional relationships within the ecosystem so that changes in monitoring programs may be made to reflect the utility of the monitoring programs to research and management. Subject to periodic review, there is a need to maintain a core of measurements taken with enough consistency in time and space to be able to make conclusions about changes that occur several times a century. Results from the research program, however, should also inform the monitoring program, so that it may be changed or augmented to reflect the most accurate, up-to-date understanding of the functional processes that should be monitored and the technologies available to monitor those processes. There will always be a dynamic balance between the need for continuity and making the monitoring program most reflective of our latest understanding of how the system functions and where, when and how it is best measured.

It needs to be emphasized that GEM is unlikely to directly support the bulk of the monitoring necessary to track ecosystem changes in processes and species of interest on the scale of decades. The approach recommended here is to 1) determine the best or "top" hypotheses to explain the interaction of physical and biological processes to produce species of interest, and what data are presently being gathered to evaluate these hypotheses, 2) to conduct statistical and logistical research to determine the monitoring opportunities where GEM may most efficiently contribute to evaluating top hypotheses, 3) leverage GEM funding using the fulcrums of logistic and financial support provided by existing agencies 4) craft a program of monitoring and related research that is appropriate to the cash flow expected from the endowment.

The following are suggested as areas of interest. Where other programs are not now fully addressing these areas, there may be opportunities for the GEM monitoring program.

1. Climate

To measure: intensity and location of the winter Aleutian Low Pressure system; wind speed and direction, air temperature and relative humidity at several key sites; precipitation and coastal freshwater input to the GOA. Possible cooperators: the NOAA (buoy system, National Weather Service), NCAR, USGS coastal stream gauge data; use of existing local precipitation and air temperature records.

2. Physical oceanography

To measure: strength, location and variation of Alaska Current/Stream and Alaska Coastal Current at key sites; variation in the circulation of PWS and lower CI (including eddy formation); the upwelling index along the whole Gulf Coast; synoptic sea surface temperatures periodically throughout the study area and salinity/temperature/density profiles or sections to depth at selected sites. Possible cooperators: NOAA (COP, OCC, FOCI, GLOBEC, buoy data, Coastwatch Remote Sensing Program), NSF (Snow and Ice Data Center), Canadian GLOBEC, US GLOBEC, UAF (GAK line), MMS.

3. Chemical oceanography

To measure: NO_3, PO_4 and iron concentrations and selected tracers (e.g., isotope tracers) at key locations and times in GOA, on the shelf and in CI and PWS. Possible cooperating agencies/programs: UAF.

To measure concentrations of PCBs, DDT, and other persistent organic chemicals in mussels and tissues of APEX predators. Possible cooperating agencies/programs: NOAA (National Status and Trends Program--Mussel Watch), NMFS Seattle Laboratory; Prince William Sound and Cook Inlet RCACs.

4. Biological oceanography

To characterize: chlorophyll *a* (continuous) and primary productivity at key sites in the Gulf, on shelf, in PWS and CI; to obtain synoptic views of sea surface chlorophyll *a*. Possible cooperating agencies: NOAA/NMFS (FOCI, Coast Watch), DFO Canada, NASA, UAF, PWS Aquaculture Corporation.

To measure: zooplankton settled volume at inshore sites within PWS, CI and Kodiak, and zooplankton hydroacoustic biomass and net plankton on the shelf and adjacent waters at key times. Collections are expected to include icthyoplankton and larvae of important macroinvertebrates. Sample subsets to be analyzed for species composition. Periodic modeling of bloom dynamics. Possible cooperating agencies: PWS Aquaculture Corporation, US GLOBEC, GLOBEC Canada.

5. Nekton

To make estimates of biomass and species composition by hydroacoustic and net sampling on the shelf and within PWS and CI at key sites and times. Possible cooperating agencies/programs: US GLOBEC, UAF, FOCI, NOAA/NMFS.

6. Forage fish

To monitor: halibut and Pacific cod stomach contents in CI and other possible regions; seabird diets in PWS and CI (summer); juvenile herring surveys in PWS. To do hydroacoustic and net sampling at key shelf sites. Goal: An index of species composition and relative species composition and relative abundance of forage fishes. To measure carbon and nitrogen stable isotopes and fatty acids of herring and other forage fish on shelf and in PWS and CI. To do biophysical modeling to help predict herring and pollock stock composition and size. Possible cooperating agencies/programs: ADF&G, NOAA/NMFS, MMS.

7. Other fish and crustaceans

To obtain: commercial catch statistics and stock assessment data for salmon, herring, pollock, sablefish, Pacific cod, rockfish, and other species, including crabs and shrimp, in PWS, Kodiak, and CI. When available, supplement with additional data from sport and subsistence harvests. Possible cooperating agencies/programs ADF&G, NOAA/NMFS.

8. Inshore benthic and intertidal communities

To monitor: Annual abundance and productivity of selected subtidal and intertidal organisms, such as clams, polychaetes, and crustaceans, at locations in PWS, Kodiak and

LCI. Relate retention and transport phenomena to larval supply and recruitment. Possible cooperating agencies/programs: MMS, PWS and CI RCACs.

9. Apex predators

To monitor: seabird colony attendance every 4 years and chick productivity every year at established USFWS GOA index colony sites (e.g., Barren Islands) within the spill area for at least common murres and black-legged kittiwakes. Also total seabird guild composition and abundance at major index sites. Occasional at-sea counts of seabirds. Possible cooperating agencies/programs: USGS/BRD, USFWS/Alaska Maritime National Wildlife Refuge Seabird Monitoring Program, US GLOBEC (?), MMS.

To conduct regular periodic surveys of harbor seal molting at select sites across the northern GOA coast (e.g., PWS, outer Kenai coast, CI, Kodiak) accompanied by biological studies to assess body condition and other factors likely to be indicative of population status. Possible cooperating agencies/programs: NMFS, ADFG, NPS, UAF.

It will be important to continue periodic monitoring and further understanding of how and possibly why some species of predators fluctuate in abundance. Sea otters and killer whales are possible candidates and currently ecosystem trophic modeling may point towards one of these species as an important ecosystem component. Possible cooperating agencies/programs: USGS BRD, NMFS, USFWS, ADFG.

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Appendix A. Description of the GEM Database

In June 1999, the Restoration Office began to develop a database of monitoring, survey 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 October 1999, the database has information on 240 projects. Most of these projects were funded or conducted by government agencies. Major projects in this database are summarized in Appendix Table 1. The summary of projects is not exhaustive. There are two additional sources that may be consulted for a more extensive listing of projects, PICES web site, (http://pices.ios.bc.ca/data/weblist/weblist.htm), the Report of the Bering Sea Ecosystem Workshop (DOI-NOAA-ADF&G 1997), and Bering Sea and North Pacific Ocean Theme Page (www.pmel.noaa.gov/bering).

Each project in the database falls into one or more of the following categories: oceanography, fish and shellfish, marine mammals, seabirds, and contaminants. Each record includes a description of the project, the name and contact information for the principal investigator, the type of data gathered and analysis conducted, the locations of sampling stations, beginning and end dates, rough estimates of funding, and instructions for accessing the data generated by the project.

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 the Gulf Ecosystem Monitoring program. Still other projects compile data into catalogues or databases. Examples of such compilations are the [Pacific salmon and steelhead] Coded Wire Tag Database; the Pacific Seabird Monitoring Database, and the Beringian Seabird Catalogue.

In addition to refining entries on these projects, the Restoration Office is contacting private foundations and other nongovernmental organizations for information about projects they have sponsored or conducted.

Appendix Table 1. Selected Information Gathering Programs in the Gulf of Alaska. For more complete listing see the PICES web site, http://pices.ios.bc.ca/data/weblist/weblist.htm

Agency / Program	Data	Coverage in Gulf of Alaska
Oceanography		
GLOBEC / Gulf of Alaska Monitoring Program	Vertical CTD-chlorophyll-PAR profiles, ADCP, fluorescence, sea surface temperature and salinity, nutrients, chlorophyll pigments, oxygen isotope ratios and zooplankton. 1997-2000.	Seward Line Transect Cape Fairfield Line Transect
GLOBEC / Northeast Pacific Retrospective Studies	Analysis of retrospective data sets to document the link between climate and ocean variability and population variability.1998-2005.	Full coverage
NASA / Earth Observing System (EOS)	Sea surface temperature, phytoplankton, dissolved organic matter, wind fields, ocean surface. Since 1996.	Full satellite coverage.
NOAA, NASA / Advanced Very High Resolution Radiometer (AVHRR)	Sea surface temperature. 1985 - 1999.	Full satellite coverage.
NOAA / Moored Buoy Program	Wave height, dominant wave period, atmospheric pressure, pressure tendency, air temperature, and water temperature.	Gulf of Alaska 56N148W North PWS 60N146W South PWS 60N146W
NOAA / Coastal-Marine Automated Network (C-MAN)	Wind direction, speed, and gust; atmospheric pressure; air temperature. Since early 1980s.	Bligh Reef Light, Five Finger, Middle Rock and Potato Point

NOAA / Fisheries Oceanography Coordinated Investigations (FOCI)	Salinity, temperature, currents and fluorescence; nutrients, chlorophyll, microzooplankton; atmospheric variables; sediments. Since 1984.	Shelikof Strait
Fish and Shellfish		
IPHC / Assessment of Pacific Halibut Stock	Age, length, catch, effort, sex, sexual maturity of Pacific halibut. Research surveys since 1925.	Pacific halibut range
NOAA / Ocean Carrying Capacity / North Pacific Ocean Salmon Ecology	Ocean migrations, abundance and movement patterns, stock identification, genetics, growth, condition, diet. Research cruises since 1995.	Full coverage.
NOAA / Sablefish Longline Surveys	Annual surveys of sablefish. Also data on rockfish. Since 1979.	Full coverage.
ADFG / Salmon Escapement Counts	Enumeration of returning adult salmon. Data since early 1900's.	Salmon streams throughout the Gulf of Alaska region,
ADFG / Surveys	Age, weight, length, AWL, sex, abundance and distribution for herring, shellfish, and other species. Since 1980.	Full coverage.
ADFG / Fish Pathology Disease History Database	Disease histories of salmon, trout, herring, clams, and other fish and shellfish. Since 1973.	Full coverage.
ADFG / Coded Wire Tagging	Identification of a particular stock from a particular year. Since the early 1970's.	Primarily salmon hatcheries; a few wild fish programs
Marine Mammals and Seabirds		
NOAA / Marine Mammal Stock Assessments	Stock assessments for sea lions, harbor seals, various whales, and porpoises. Since 1995.	Full coverage.
DOI / Beringian Seabird Colony Catalog	Breeding population size, species composition and location. Data since the late 1800s.	Seabird colonies throughout Alaska

DOI / Alaska Seabird Inventory and Monitoring Plan	Population, nesting productivity and timing, prey use, growth rates, survival. Since 1970s.	10 different sites annually on the Alaska Maritime NWR
Contaminants		
NOAA / National Status and Trends Program / Mussel Watch Project	Contaminants in sediments and bivalve mollusks including PAHs and PCBs. Since 1986.	Cook Inlet, Kodiak Island, PWS
NOAA / National Status and Trends Program / National Benthic Surveillance	Chemical concentrations in the livers of bottom-dwelling fish. 1984-1993.	Prince William Sound
DOI / Alaska Marine Mammals Tissue Archiving Project	Heavy metals, PAH's, organic pollutants and other contaminants. Since 1987.	Full coverage.

Appendix B. Text of the Resolution of the Trustee Council

RESOLUTION

of the

Exxon Valdez Oil Spill Trustee Council

concerning the

Restoration Reserve and Long-term Restoration Needs

WHEREAS, in November 1994, following an extensive public process, the *Exxon Valdez* Oil Spill Trustee Council ("Trustee Council") adopted the *Restoration Plan* to guide a comprehensive and balanced program to restore resources and services injured by the oil spill;

WHEREAS, since that time the Trustee Council has used the *Restoration Plan* to guide development of the annual work plans as well as the acquisition and protection of large and small habitat parcels important to the long-term recovery of injured resources and services;

WHEREAS, the *Restoration Plan* identified a series of large parcel purchases and the Trustee Council has been successful in obtaining habitat protection agreements with willing-seller landowners to provide protection for approximately 635,000 acres;

WHEREAS, the *Restoration Plan* recognized that complete recovery from the oil spill would not occur for decades and that through long-term observation and, as needed, restoration actions, injured resources and services could be fully restored;

WHEREAS, the *Restoration Plan* specifically recognized establishment of the Restoration Reserve to provide a secure source of funding for restoration into the future beyond the last annual payment from the Exxon Corporation;

WHEREAS, the Trustee Council has sponsored an extensive public involvement process to provide opportunity for comment on possible future uses of the Restoration Reserve including public meetings in communities throughout the spill impact region and also in Anchorage, Fairbanks and Juneau;

WHEREAS, a large volume of public comment regarding the Restoration Reserve has been solicited and received urging a wide range of uses for remaining settlement funds including a strong showing of support for additional habitat protection efforts as well as research and other restoration efforts;

WHEREAS, numerous Native tribal members and other community residents from the spill area have indicated a strong interest in continued support for community-based efforts consistent with those that have been previously funded by the Trustee Council such as subsistence restoration, Traditional Ecological Knowledge, youth area watch, cooperative management, and local stewardship efforts;

WHEREAS, the Public Advisory Group (PAG) has reviewed and discussed long-term restoration needs and use of the Restoration Reserve at considerable length and the views of the PAG members have been communicated to the Trustee Council;

WHEREAS, upon consideration of the restoration mission as provided by the settlement and the *Restoration Plan*, past restoration program efforts and accomplishments, public comments received by the Trustee Council, the views of the Public Advisory Group members, and the most current information regarding the status of recovery of the resources and services injured by the oil spill, the Trustee Council has identified substantial and continuing long-term restoration needs;

WHEREAS, full recovery of many injured resources and services is not yet complete and long-term restoration, conservation and improved management of these resources and services will require a substantial on-going investment to improve our understanding of the biology and marine and coastal ecosystems that support the resources as well as the people of the spill region;

WHEREAS, prudent use of the natural resources of the spill area without unduly impacting their recovery requires increased knowledge of critical ecological information about the northern Gulf of Alaska that can only be provided through a long-term research and monitoring program;

WHEREAS, together with scientific research and monitoring, a continuing commitment to habitat protection and general restoration actions, where appropriate, will help ensure the full recovery of injured resources and services;

WHEREAS, consistent with the *Restoration Plan*, restoration needs identified by the Trustee Council require a long-term comprehensive and balanced approach that includes a complementary commitment to scientific research and monitoring; applied science to inform and improve the management of injured resources and services; continued general restoration activities where appropriate; support for community-based efforts to restore and enhance injured resources and services; and protection for additional key habitats;

WHEREAS, by October 2002, as a result of the past and anticipated future deposits into the Restoration Reserve, it is estimated that the principal and interest in the reserve, together with remaining unobligated settlement funds, will be approximately $170 million unless, prior to that time, on-going negotiations concerning the Karluk and Sturgeon rivers and adjacent lands or other potential habitat transactions result in habitat acquisition agreements that obligates some of these funds;

WHEREAS, absent such additional acquisition agreements, $170 million is the total of the funds estimated to be available to support long-term restoration based on projected investment returns allowable through the Court Registry under its existing authority and thus reasonably anticipated as available for restoration purposes by the

Trustee Council starting with FY 2003 ("estimated funds remaining on October 1, 2002"); and

WHEREAS, the limits of the existing investment authority of the Trustee Council have resulted in the loss of millions of dollars in potential earnings that would have been available to effectively address restoration needs in the future and support a comprehensive program that maintains its value over time, and it is necessary that the limits on the investment authority for the joint settlement funds be amended by Congress if we are to optimize our potential restoration program;

THEREFORE BE IT RESOLVED, that the Trustee Council has determined that recovery from the *Exxon Valdez* oil spill remains incomplete and there is need for establishing at this time a continuing long-term, comprehensive and balanced restoration program consistent with the *Restoration Plan*;

BE IT FURTHER RESOLVED, that funds in the Restoration Reserve and other remaining unobligated settlement funds available on October 1, 2002 (for expenditure starting in FY 2003) be allocated in the following manner consistent with the "Outline of Action Under Existing Authority" dated 3/1/99 attached to this resolution:

$55 million of the estimated funds remaining on October 1, 2002 and the associated earnings thereafter will be managed as a long-term funding source with a significant proportion of these funds to be used for small parcel habitat protection and it is recognized that any funding that may be authorized for purchase of lands along or adjacent to the Karluk or Sturgeon rivers or other potential habitat acquisitions would be made from within this allocation; and

the remaining balance of funds on October 1, 2002 will be managed so that the annual earnings, estimated at approximately 5% per year, will be used to fund annual work plans that include a combination of research, monitoring, and general restoration including those kinds of community-based restoration efforts consistent with efforts that have been previously funded by the Trustee Council, such as subsistence restoration, Traditional Ecological Knowledge, Youth Area Watch, cooperative management, and

local stewardship efforts, as well as local community participation in ongoing research efforts;

BE IT FURTHER RESOLVED, that the Restoration Office and the Chief Scientist, under the direction of the Executive Director, shall begin to develop a long-term research and monitoring program for the spill region that will inform and promote the full recovery and restoration, conservation and improved management of spill-area resources; and

BE IT FURTHER RESOLVED, that it is the intent of the Trustee Council that this long-term reserve for research, monitoring and general restoration be designed to ensure the conservation and protection of marine and coastal resources, ecosystems, and habitats in order to aid in the overall recovery of those resources injured by the *Exxon Valdez* oil spill and the long-term health and viability of the spill area marine environment;

BE IT FURTHER RESOLVED, that in developing a long-term restoration research, monitoring and general restoration program for the spill region, the Executive Director shall solicit the views of the Public Advisory Group, community facilitators, resource management agencies, researchers and other public interests as well as coordinate restoration program efforts with other marine research initiatives including the North Pacific Research Board;

BE IT FURTHER RESOLVED, that the Executive Director shall work with the Alaska Congressional delegation and appropriate State and federal agencies to obtain the necessary investment authority to increase the earnings on remaining settlement funds, so that the Trustee Council will be able to conduct an effective restoration program that maintains its value over time; and

BE IT FURTHER RESOLVED, that in developing long-term implementation options for consideration by the Trustee Council, the Executive Director shall:

investigate possible establishment of new or modified governance structures to implement long-term restoration efforts,

explore alternative methods to ensure meaningful public participation in restoration decisions, and

report back to the Trustee Council by September 1, 1999 regarding these efforts.

Adopted this 1st day of March, 1999, in Anchorage, Alaska.

DAVE GIBBONS	BRUCE M. BOTELHO
Trustee Representative	Attorney General
Alaska Region	State of Alaska
USDA Forest Service	

MARILYN HEIMAN	STEVEN PENNOYER
Special Assistant to the	Director, Alaska Region

Secretary for Alaska
U.S. Department of the Interior

National Marine Fisheries Service

FRANK RUE
Commissioner
Alaska Department of
Fish and Game

MICHELE BROWN
Commissioner
Alaska Department of
Environmental Conservation

3/9/99 final

Appendix C. Bibliography of scientific publications

Exxon Valdez Oil Spill Trustee Council

645 G Street, Suite 401, Anchorage, AK 99501-3451 907/278-8012 fax:907/276-7178

MEMORANDUM

TO: *Exxon Valdez* Oil Spill Trustee Council

FROM: Molly McCammon
Executive Director

RE: Future of Small Parcel Program

DATE: October 15, 1999

On March 1, 1999 the Trustee Council adopted a resolution regarding the Restoration Reserve. It provided, in part, that:

> $55 million of the estimated funds remaining on October 1, 2002 and the associated earnings thereafter will be managed as a long-term funding source [for habitat protection] with a significant proportion of these funds to be used for small parcel habitat protection and it is recognized that any funding that may be authorized for purchase of lands along or adjacent to the Karluk or Sturgeon rivers or other potential habitat acquisitions [beyond current commitments] would be made from within this allocation.

Materials accompanying the resolution identified three issues that require further consideration...

(1) priority, criteria, and decision-making process for specific parcel selection,
(2) extent of public involvement in future program, and
(3) possible role of non-governmental organization to implement program after October 2002

... and stated that administrative costs will be allocated between the research/monitoring/general restoration program and habitat protection program in proportion to program area costs.

A draft discussion paper that begins to address the issues noted above is attached. It also describes some potential small parcel acquisition opportunities.

PROCESS FOR PARCEL SELECTION, INCLUDING PUBLIC INVOLVEMENT AND POSSIBLE ROLE OF NON-GOVERNMENTAL ORGANIZATION

Summary of Current Process

Program Administration

Parcel nominations are submitted to the Council and forwarded to a multi-agency review team for evaluation and ranking. Current team members are Catherine Berg/DOI-USFWS, Ken Holbrook/USFS, Mark Kuwada/ADFG, and Art Weiner/ADNR. Appraisals and negotiations are authorized by the Council on a parcel-by-parcel basis. Appraisals are conducted by the relevant resource agency and reviewed by both state and federal review appraisers. Purchase negotiations are conducted by agency land management staff and state and federal attorneys. Purchase offers can be made only with the approval of the Council. The costs of these administrative activities are funded by the Council through Project /126. This project also includes funds for the administration of the large parcel program, and does not segregate costs between the two programs. The 00126 (FY 2000) budget is $373,500.

Parcel Nomination

Broad public notices (ads in nine newspapers and an article in the Trustee Council newsletter), issued in May 1994 (Phase 1) and again in March 1995 (Phase 2), resulted in nomination of 262 parcels. There has been no outreach effort since 1995 and a "soft moratorium" has been in place (the focus is on nominations submitted under phases 1 and 2, but further nominations continue to be accepted). Approximately 120 additional parcels have been nominated since the completion of Phase 2 in 1995.

Parcel Evaluation and Ranking

Threshold criteria

Designed to eliminate parcels that would not contribute to restoration objectives or would otherwise be inappropriate:

- Willing seller
- Seller acknowledges purchase price must be at or below fair market value
- Within spill area
- Parcel linked to restoration of injured resource or service
- Parcel can be incorporated into public land management systems in a manner that will facilitate restoration objectives (in practice, this has come to mean that a Trustee agency must be willing to sponsor the parcel)

IN ADDITION, although not a threshold criteria, small parcels have been limited to under 1,000 acres with the following exceptions: Salamatof 1,377 acres, Moose River 1,243 acres, and Termination Point 1,028 acres.

Evaluation criteria and formula for those parcels that meet threshold criteria

LINKAGE

4 questions related to link to key habitats of an injured resource (i.e., areas used for spawning, overwintering, concentrated nesting, haulouts, seabird colonies, dense seagrass beds, mussel beds, etc. but not areas used for feeding, migration corridors, or dispersed or infrequent human use) or service (i.e., areas with high use levels or strategic value to services; for example, the only public access or the only or best camping, subsistence harvest, or sport fishing site but not scenic viewsheds). Uniqueness (in relation to off-parcel habitat), connectedness (to other habitats in the greater ecosystem), and quality (high levels of production, diversity, etc.) are considered.

PROTECTION

4 questions related to potential threats to injured resources/services (i.e., the adverse effects of development on the parcel to habitat on the parcel as well as to habitat on adjacent lands) beyond the protection that can be provided by the owner and existing laws and regulations.

MANAGEMENT

2 questions related to improving ability to manage public resources to promote recovery (i.e., opportunities to enhance injured resources/services and to provide access).

Example

1st	Within each of the three categories (linkage, protection, management), answer each question yes or no	
2nd	Sum the yes's in each category	
3rd	Add 1 to each category's sum to get a new sum for each category	
4th	Multiply the three new sums by each other to get a parcel score	
Steps 1-3:	*Linkage*	*(2 yes & 2 no = 2) + 1 = 3*
	Protection	*(1 yes & 3 no = 1) + 1 = 2*
	Management	*(0 yes & 2 no = 0) + 1 = 1*
Step 4:	*3 x 2 x 1 = 6 (parcel score)*	

Parcels are ranked HIGH (40 or more points), MODERATE (20-39 points), or LOW (19 or less points). Parcels ranked HIGH or MODERATE are considered suitable for purchase. In addition, parcels ranked LOW, but which are identified as otherwise having unique or outstanding restoration value for injured resources or services, can be designated by the Council as "parcels meriting special consideration" and suitable for purchase. The

Council adopted this modification to the evaluation process in 1995, realizing that the process does not always recognize all of the restoration values associated with certain parcels.

Appraisal and Negotiation

A standardized 12-step process for appraisal, appraisal review, and appraisal approval was established in June 1994. Prior to the soft moratorium being in place, all parcels ranked HIGH or MODERATE (scores of 20 and above) were automatically appraised without further Council action. Since the soft moratorium has been in effect, each appraisal must be specifically authorized by the Council. Appraisals are conducted by the relevant resource agency and reviewed by both state and federal review appraisers. This step also includes purchase negotiations, title searches, and surveys.

Offer to Purchase / Reciprocal Conservation Easement

The Council must approve each offer to purchase. Considerations in approving an offer include the parcel's restoration benefits, terms and conditions of the landowner, public comment, the management strategy proposed for the parcel, and the availability of funds. Parcels are purchased by one of the Trustee agencies, using funds allocated by the Council. Following the Council's approval of an offer, the managing agency develops a purchase agreement with the seller, then proceeds to acquire title to the parcel and incorporate it into public management. Each purchase agreement includes a "reciprocal conservation easement," under which the government not purchasing the land (i.e., either state or federal) is provided the right to enforce certain restrictions on the use of the land. These easements are designed to ensure that the lands purchased are not used for purposes inconsistent with restoration.

Public Comment

The Council takes all action on small parcels at public meetings, which are publicly noticed with an announced agenda. Public comment is invited at every Council meeting and the PAG is briefed on the status of small parcels at each of its meetings. However, a formal notice of public review and a formal review period is not a step in the small parcel process. Some small parcels have generated a lot of public comment; many have generated none.

Program Funding

Each year since 1994, some of the settlement funds have been spent on small parcel acquisition. To date, the Council has spent $18.5 million to purchase 7,100 acres and has approved roughly $3 million in offers on an additional 1,400 acres. The Council's March 1 resolution identified several other parcels on which a total of approximately $2.4 million in purchase offers is expected to be made through FY 02. As discussed above, administrative costs of the small parcel program are funded through Project /126.

Outcome of Current Process

Of the approximately 382 small parcels nominated to date, of which all but four have now been evaluated, 6 ranked HIGH and 13 ranked MODERATE. The balance ranked LOW or failed to meet threshold criteria. (The HIGH, MODERATE, and LOW classifications are based on the observed breaks in the distribution of scores for the 262 parcels nominated in response to the 1994 and 1995 public solicitations.) Of those in the LOW category, the Council has designated 52 individual parcels as parcels meriting special consideration. Several of these had scores of 18, which is just below the cutoff for the MODERATE classification. In addition, in conjunction with the purchase of large parcels of land on Shuyak Island from the Kodiak Island Borough and in Prince William Sound from the Tatitlek Corporation, the Council designated as parcels meriting special consideration all of the parcels to be purchased as part of the following packages: Kodiak Island Borough Tax Parcels, Larsen Bay Shareholder Parcels, and Tatitlek Homesite Parcels (total number of parcels not yet known).

RANK	NUMBER OF PARCELS
High	6
Moderate	13
Low (includes PMSC)	about 230
Didn't meet threshold criteria	about 129

Of the 44 small parcels purchased by the Council to date, three parcels were ranked HIGH, seven parcels were ranked MODERATE, and 34 were ranked LOW but designated parcels meriting special consideration. The Council has made offers to purchase 19 additional parcels -- of these, one parcel is ranked MODERATE, six are ranked LOW but designated parcels meriting special consideration, and 12 were designated parcels meriting special consideration from the outset (as part of the packages noted above). Negotiations that may lead to offers are underway on several additional parcels. Of these, one is ranked HIGH, one is ranked MODERATE, two are ranked LOW but designated parcels meriting special consideration, and the rest were designated parcels meriting special consideration from the outset (as part of the packages noted above).

Discussion of Current Process in Regard to Future Program (FY 2002 & Beyond)

Program Administration: *Should the Council or a non-profit administer?*

The Conservation Fund submitted a letter to the Council in December 1997 describing how it might administer a small parcel program. The Conservation Fund, which is a national land trust responsible for protecting 1.4 million acres throughout the country, has participated in some of the Council's small parcel acquisitions. The Nature Conservancy or a local land trust may also be

interested in administering a small parcel program. A non-profit may have more flexibility and more ability to be innovative in administering a small parcel program than the Council and government agencies do. A non-profit would also have the advantage of being able to leverage funds with funds from private donors and other contributors. On the other hand, the current Council/agency administrative process is in place and functioning; transferring authority for the program to a non-profit may require new state or federal legislative authorization to proceed.

Parcel Nomination: *Should there be another broad public solicitation?*

The broad public solicitations conducted at the initiation of the small parcel program (1994 and 1995) resulted in a large number of nominations that did not meet threshold criteria (almost 50 percent), as well as a large number that ranked LOW. Evaluating and ranking the large volume of nominations received required a significant commitment of resources. The fact that over 120 nominations have been received since the two solicitation periods closed suggests that the groundwork laid by the program to date has created a general public awareness of the program. In addition, the resource agencies seem to be generally knowledgeable about remaining restoration/protection opportunities. However, new opportunities to protect habitat are likely to continue to arise, and without a broad public solicitation important restoration opportunities may be missed. In addition, if the administration of the program were transferred to a non-profit, or if the criteria governing evaluation of small parcels were to change, a public announcement would be warranted.

Parcel Evaluation and Ranking

Threshold criteria: *Are the criteria still appropriate?*

The criterion that each parcel be linked to restoring an injured resource/service may exclude parcels that would provide opportunities to enhance, rather than directly restore, an injured resource/service or that might contribute a more general ecosystem benefit. The Council's habitat protection program was designed to provide injured species added protection over the period they need to recover naturally. While this is clearly still applicable today for many species, it may not be applicable over the longer term. The Council's proposed Gulf Ecosystem Monitoring (GEM) program emphasizes not only recovery but the long-term health of the ecosystem as well. Another example of a broader purpose comes from the Nature Conservancy's habitat protection handbook: "The purpose of land conservation is to insulate ecologically significant natural resources from urgent threats to their existence so that the resources have a reasonable chance of survival."

Parcels may also be excluded by the criterion that the purchase be at or below fair market value. Some of the Council's large parcel acquisitions have been for more than fair market value, and similar flexibility in the small parcel program might result in additional opportunities to protect key

habitat. On the other hand, this criterion has greatly simplified negotiations with landowners in regard to price and probably has allowed the Council to maximize its small parcel acquisition funds.

The agency sponsorship criterion might also be reviewed. In at least two instances, lands purchased by the Council have been transferred to a city or borough government. Some non-governmental organizations, such as the Nature Conservancy and various other trusts and organizations, also hold and manage lands. Waiving this criterion might allow for protection of parcels that contain key habitat but that do not fit into an agency's management scheme or for which agency funding for management is not available.

Evaluation criteria and formula: *Are the criteria and formula still appropriate?*
The large majority of parcels purchased or under consideration for purchase were not ranked HIGH or MODERATE but rather were designated parcels meriting special consideration. This suggests that the current evaluation criteria and formula are not adequately identifying all of the parcels that are of high priority for restoration and that some changes to the evaluation process may be warranted.

EMPHASIZE MANAGEMENT BENEFITS

An analysis has not been done of exactly why the parcels meriting special consideration ranked LOW. In most instances, though, this special designation was made at the request of a resource management agency, suggesting that the current formula may not place adequate value on management benefits. In the current evaluation system, "linkage" and "protection" are each awarded up to five points; "management" is awarded up to three points. In scoring a parcel, this serves to place lesser value on management benefits than on linkage or protection. For example, placing more emphasis on a parcel's relationship to surrounding land that contains linked habitat and on the pattern of adjacent land ownership and management might result in higher rankings for inholdings in existing conservation units. The Nature Conservancy handbook states that "ranking considerations [should] include the proximity to other protected areas."

REVISE OTHER ASPECTS OF THE EVALUATION CRITERIA

Other aspects of the current evaluation formula may also help explain the LOW scores. Criteria that might be worth reviewing:

- Definition of key habitat. For example, the current definition excludes feeding habitat and migration corridors. By contrast, the large parcel definition includes feeding and migration.
- Definition of public use in regard to link to an injured service. For example, the current definition of public use is "the only public access or... the only or best subsistence, sport fishing, [etc.] site in the area." By

contrast, the large parcel criteria simply refers to high public use.
• Scoring system. For example, the current yes/no formula does not allow parcels to be scored based on their relative value within a particular category, i.e., a parcel either contains key habitats or it doesn't. This differs from the large parcel evaluation formula, which emphasizes "degree of linkage" to an injured resource/service. Under the large parcel formula, each of 15 resources/services is ranked high, medium, or low; 7 additional questions are answered yes or no.

Large parcel formula = [sum of high + (0.5 x sum of medium)] x sum of yes

Similarly, the Nature Conservancy handbook states that ranking considerations include "the uniqueness of the natural feature, the present condition of the feature, the severity of threats, the urgency to actively manage the habitat or site," all of which allow assessment of the relative or comparative value of the parcels being evaluated.

RELY ON AGENCY PRIORITIES

In lieu of the current evaluation and scoring scheme, a process relying on agency priorities could be put in place. Priorities could be defined based on agencies' internal evaluations and individual needs. This approach would be much like that being used currently for the Kodiak Island Borough Tax Parcels, the Larsen Bay Shareholder Parcels, and the Tatitlek Homesite Parcels. A lump sum has been approved by the Council for each of these packages, and the individual parcels to be purchased are selected by the authorized agency (DOI in the case of Kodiak and Larsen Bay; USFS in the case of Tatitlek). The Council approves purchase offers based on a presentation by the agency of each parcel's benefits. This approach is also much like that described in the Conservation Fund's letter, which would base purchase selections on (1) agency priority, (2) degree of threat, and (3) financial performance of the small parcel fund. Another consideration is that an evaluation formula, such as that currently in place, is time consuming to develop, test, and validate. An agency priority approach would be simpler to develop and implement, and perhaps be of a more appropriate scale for the smaller program envisioned for FY 02 and beyond.

EMPHASIZE REGIONAL DISTRIBUTION

A September 1994 memo from the Chief Scientist and the core reviewers recommends that the Council's habitat protection program be geographically balanced throughout the spill area in order to provide optimum protection. The majority of acreage purchased to date through the small parcel program is in the Kenai region -- over 5,000 acres compared to roughly 1,000 acres in the Kodiak region and 358 acres in Prince William Sound. The majority of acreage protected through the large parcel program is in the Kodiak region -- 331,000 acres compared to

roughly 248,000 acres in Prince William Sound and 56,000 acres in the Kenai region. No large or small parcels have been purchased in the Alaska Peninsula region.

Appraisal and Negotiation: *Is the current 12-step process still appropriate?*

Streamlining the appraisal process may provide cost savings important to the smaller program envisioned for FY 02 and beyond. For example, the current process involves a contract appraiser (hired by the relevant resource agency), a state review appraiser, and a federal review appraiser for each parcel. Another issue to consider is whether the Council should delegate its authority to authorize appraisals to the Executive Director, as it had prior to the soft moratorium being in place. If administration of the program were transferred to a non-profit, the question would arise of whether this authority should be delegated to the non-profit or remain with the Council/Executive Director.

Offer to Purchase / Reciprocal Conservation Easement: *Should a reciprocal conservation easement still be required on each parcel? Should each offer to purchase still require Council authorization?*

In planning the smaller program for FY 02 and beyond, it may be appropriate to reconsider the necessity of continuing the reciprocal conservation easement policy. It adds a step to the acquisition process and necessitates both the state and federal governments being actively involved in each acquisition. The latter question, regarding who authorizes offers to purchase, would arise if administration of the program were transferred to a non-profit.

Public Comment: *Should public review be a formal step in the process?*

In some instances there has been short notice of which small parcels are on the Council's meeting agenda, and people wishing to comment may have had little practical opportunity to do so. Requiring a 30-day public comment period, for example, would improve the opportunity to comment, but would add more time and cost to the acquisition process and may delay bringing acquisition deals to closure. If the administration of the program were transferred to a non-profit, including some public process stipulations may be necessary because non-profits are not bound by the open meeting requirements that the Council is bound by.

Program Funding: *How should the March 1 resolution's provision that the $55 million be managed as a long-term funding source be implemented?*

Issues to be addressed include whether the fund will be a declining-balance fund (i.e., drawn down over time and liquidated by a specified date) or whether it will be managed as an endowment with only the earnings available for expenditure. If the latter, a decision on whether or not to inflation-proof would need to be made. Inflation proofing would preserve the integrity of the fund principal, but would leave a smaller amount of earnings available for expenditure each year. An investment strategy would also need to be developed and an investment manager identified. [NOTE: Of the $55 million, as much as $25 million may be

used for an eventual Karluk/Sturgeon rivers protection package. Annual earnings on the $30 million balance, calculated at the conservative rate of five percent, would be roughly $1.5 million. Administrative costs, as well as parcel acquisition costs and any inflation proofing, would be paid from this sum.]

POSSIBLE FUTURE SMALL PARCEL ACQUISITION OPPORTUNITIES

Kodiak Region

Future possibilities

The Council's March 1 resolution designates an additional $241,000 for the Kodiak Island Borough Tax Parcels and an additional $585,000 for the Larsen Bay Shareholder Parcels ($174,000 from the original $1 million allocation for these two packages have already been committed through offers to purchase). Both packages are focused on purchasing inholdings in the Kodiak National Wildlife Refuge. DOI is to identify for the Council by January 15, 2000 the potential parcels to be purchased with these funds and whether additional funds might be needed in the future to complete acquisition of the available parcels. These parcels are typically located at strategic access points and frequently in riparian areas with high fish, wildlife, habitat, subsistence, recreation, and archaeological values.

Two parcels totaling 280 acres on Kiliuda Bay (KAP 1256 and KAP 2027) were nominated in March 1999 and are currently with the review team for evaluation. If the state/Old Harbor Corporation land exchange, which is related to the Old Harbor large parcel acquisition, moves forward, the state might be interested in acquiring additional inholdings in the Kiliuda Bay area.

In addition, the Karluk Weir parcel (KAP 150), a 5-acre parcel owned by the Karluk IRA Council, is not currently available for purchase but may be a priority if it were to become available. Purchase of this parcel, which was nominated in 1994 and ranked MODERATE, would ensure a permanent weir site on the Karluk River, which is necessary to properly manage the river's fisheries resources. The Long Island parcel (KAP 1058), a 1,462-acre parcel owned by Lesnoi, Inc., also ranked MODERATE, but has been a lesser priority for protection than the Termination Point parcel (KAP 145), on which an offer is currently being considered. The Long Island parcel, which is boat-accessible from Kodiak, has strong recreation values. Lesnoi, Inc. has also worked with the Kodiak Island Borough to develop a package of over 2,000 acres of mostly road-accessible beachfront south of Chiniak. The Borough may seek funds from the Council to purchase this land.

In progress

Offers are under review on 1,261 acres, including Termination Point.

Purchases to date

To date, 1,055 acres have been purchased in the Kodiak region through the small parcel program.

Kenai Peninsula

Future possibilities

Potential habitat protection opportunities remain along the Kenai River. In early 1997, a multi-agency work group (USFWS, USFS, ADFG, ADNR) identified all of the privately-owned parcels (roughly 3,000 acres), as well as the parcels owned by the City of Kenai (roughly 2,000 acres), that had at least 1/8 mile (660 feet) of riverbank. Although it is likely that many of these parcels will never be for sale, it is also likely that some of them will be for sale in the future. There may also be important parcels near but not along the river (e.g., contiguous wetlands and migration corridors) and parcels with less than 1/8 mile of riverbank.

Protection of habitat along the Kenai River's tributaries and along other important rivers on the Kenai Peninsula -- such as the Anchor, Ninilchik, Kasilof, and Killey rivers --- may warrant consideration. Inholdings in Kenai Fjords National Park and Kenai National Wildlife Refuge may become available in the future.

In addition, the Baycrest parcel (KEN 12), on which the Council's earlier purchase offer was rejected, has been reconfigured and renominated by the landowner. This 42-acre parcel is currently with the review team for evaluation. The Deep Creek parcel (KEN 1001), a 91-acre parcel owned by the Ninilchik Native Association, is not currently available for purchase but may be a priority if it were to become available. This parcel, which was nominated in 1995 and ranked MODERATE, has high recreation values. The Hopkins parcel (KEN 146), which was nominated in 1994 and ranked LOW, has generated some public interest and is valued by managers for public access on the north side of Kachemak Bay.

In progress

Offers are under review on 47 acres. In addition, purchase negotiations are underway on the Stariski Creek parcel (KEN 12), for which $500,000 is designated in the Council's March 1 resolution.

Purchases to date

The Kenai River has been the focus of the Council's habitat protection efforts on the Kenai Peninsula. To date, 12 parcels comprising 5,100 acres along the river have been purchased at a cost of $11.8 million. (An additional 107 acres along the river have been purchased with roughly

$1.6 million in EVOS criminal funds.) In all, the Council has purchased 5,679 acres on the Kenai Peninsula through its small parcel program.

Prince William Sound

Future possibilities

The Council's December 1997 resolution authorizing protection of lands around Irish Cove (part of the Tatitlek large parcel protection package) also committed Tatitlek Corporation to pursuing Council acquisition of additional homesite lots in the Two Moon Bay and Snug Corner Cove subdivisions. The Council's March 1 resolution designates $205,600 for this purpose (an amount equal to the balance of "the amount previously authorized but no longer needed" for the Tatitlek large parcel acquisition). There are 164 homesite parcels and all but 20 are potentially for sale. Although the value of the parcels is not yet known (appraisals are underway by USFS and should be completed by October 15, 1999), it is likely that funds in addition to the $205,600 already approved by the Council will be needed if all of the available homesites are to be purchased.

In progress

Purchase negotiations are currently underway on the Duck Flats and Jack Bay parcels (PWS 05, PWS 06, PWS 1010), for which $880,000 is designated in the Council's March 1 resolution. At the direction of the Council, these parcels will be removed from consideration if a purchase agreement is not reached by January 15, 2000. Offers are under review on an additional 101 acres.

Purchases to date

To date, 358 acres have been purchased in Prince William Sound through the small parcel program. This is less acreage than has been purchased in either the Kodiak or Kenai regions and reflects the fact that there are not many privately owned small parcels in the sound.

Alaska Peninsula

Future possibilities

A 2.5-acre parcel in Chinitna Bay (KAP 1257) was nominated in May 1999 and is currently with the review team for evaluation. Inholdings in the Alaska Peninsula Wildlife Refuge and the Becharof National Wildlife Refuge may become available in the future.

In progress

None

Purchases to date

None

Parcels Over 1,000 Acres

The March 1 resolution specifies that a "significant proportion" of the $55 million in Restoration Reserve funds allocated to the habitat program are to be used for small parcels and that any other potential habitat acquisitions would also be made from this allocation. Although the focus of this memo has been on small parcels, it is worth noting that there may be opportunities in the future for additional large parcel acquisitions as well.

REFERENCES

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