19.09.02 (4 of 12)

3-D Ocean State Simulations for Ecosystem Applications from 1995-1998 in Prince William Sound (PWS), AK

Project Number:	01389
Restoration Category:	Research
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	ADFG
Cooperating Agencies:	
Alaska Sea Life Center:	No
Duration:	2nd year, 2-year project
Cost FY 01:	$142.5 (includes: $69,184 plus 12K for computer and $52,080 subcontract plus ADFG GA)
Geographic Area:	Prince William Sound, Gulf of Alaska
Injured Resource/Service:	3-D Modeling of PWS Ecosystem

APR 13 2000

ABSTRACT

Using data collected from 1995–98 in PWS and the forcing of tide, coastal current inflow/outflow, freshwater discharge, and wind stress, a 3-D PWS model will be developed to produce continuous 4-year, 3-D fields of velocity, temperature, salinity, and mixing coefficients for resource managers, fishing industry, and biological applications. The interannual variability of PWS ocean circulation, and temperature and salinity due to interannually variable atmospheric forcing will also be studied. Thus, we can identify the key environmental parameters to be included in a long-term monitoring program to assist resource managers.

The supplement work (see the new task) for FY01 is to rescue the Sound Ecosystem Assessment (SEA) database and install it on a new server at IMS-IARC/UAF. The new server will serve future modeling studies for the Gulf Ecosystem Monitoring (GEM) program.

INTRODUCTION

In the SEA program, extensive observations of phytoplankton and zooplankton, and oceanography, were made during 1995–98 (Cooney, 1996, 1997; McRoy et al. 1997; Thomas et al. 1997; Vaughan et al. 2000). Fish larvae and schools of selected species were also studied (Stokesbury et al. 1997). The 3-D ocean circulation model explains some, but not all of the mechanisms and applications to biology (Mooers and Wang 1998). For example, oceanic advection and diffusion can only explain the existing phytoplankton and zooplankton movement, while spring blooms and occasional later summer blooms (i.e., second bloom in the year) due to the ecosystem dynamics, cannot be explained by a physical-only model.

In 1998-99, substantial progress was made for the PWS ocean circulation modeling in the following areas:

1. We implemented a freshwater discharge of a line source into PWS (Wang et al. 1999) with support from SEA funding for Dr. M. Jin and continued conducting seasonal (12-month) simulations under climatological forcing and under seasonal forcing (1996) collaborating with Dr. S. Vaughan. The tidal forcing was also implemented to the forcing function (Fig. 1).

2. We conducted a (1996) seasonal 3-D simulation for Dr. T. Cooney of PWS zooplankton over wintering, releasing the particles from the depths below 400m on February 1 through July 30, 1996 (see Fig. 2), with an assumed mortality rate of 6% day^{-1}. The simulated results are consistent with what was been observed in 1996, according to Dr. T. Cooney.

3. We conducted a (1996) seasonal simulation for Dr. B. Norcross of spawning larvae migration along the a few selected locations (Fig. 3). The duration larvae retention in PWS has been found shorter by the change of the spawning location due to the 1989 T/V *Exxon Valdez* oil spill event. The mortality rate of 5% day^{-1} was assumed.

4. We also provided 3-D velocity fields to E. Brown for her research (Brown et al. 1999). Brown found that physical forcing from the 3-D model fits well with her biological data. Thus, she strongly urges us to provide four consecutive years (1995–98) of the 3-D current velocity, temperature and salinity for her continuous proposal to EVOS.

5. Most recently, we collected the wind data from 1995–98 at a mid-Sound station (see Fig. 4) and other stations (not shown) with the efforts of Dr. Vince Patrick, Jenny Allen, and Stephen Bodnar (the first-year subcontract). These data have a 30min interval. We will average them to hourly or 3-hourly interval to drive the model and use that to examine the year-to-year variability of the circulation due to wind forcing.

NEED FOR THE PROJECT

A. Statement of Problem

1. Use 1995–98 CTD observations combined with the historical CTD observation from 1975–94 to produce updated climatology of T and S for each levels (such as surface, 5m, 10m, etc.). This will be collaborated with Alaska Digital Graphics.

2. Use 1995–98 wind speeds and directions at nine weather stations around PWS to produce four-year spatial varying wind fields. This will be collaborated with Alaska Digital Graphics.

3. Calculate 1995–98 freshwater discharge using a hydrological model under forcing of air temperature, river runoff, and precipitation.

4. Using 1-3 the above as forcing, we will simulate the 3-D PWS ocean circulation, T, S, etc. using the 3-D-PWS model (Wang et al. 1999 a,b) to provide biologists and resource managers with applications of the physical forcing model.

5. Analyse continuous 48-month interannual variability of PWS circulation, T, S, and other variables under atmospheric forcing.

6. Rescue the SEA database by moving it to a new server to be located at IMS-IARC/UAF.

B. Rationale/Link to Restoration

Prince William Sound (PWS or the Sound) is located along Alaska's south central coast, north of the Gulf of Alaska (GOA). PWS is a combination of fjords and estuaries along the coast of Alaska, which was formed by a combination of preglacial erosion, glacial excavation, and tectonics. Because of its rich natural resources, i.e., sea birds, mammals, salmon, forage fish, etc., a systematic numerical simulation (study) of the physical oceanography and ecosystem in the region is essential and timely. It is necessary to understand the physical-biological system in order to provide sound scientific knowledge and information to the state government, local communities and others whose decisions or use affect the health and vitality of the Sound.

There were few historical observational studies of PWS before 1989. When North America's largest oil spill by T/V *Exxon Valdez* (March 24, 1989) seriously damaged the PWS ecosystem and the adjacent downstream waters, such as Cook Inlet and Kachemak Bay, extensive observational programs were begun in region. The SEA (Sound Ecosystem Assessment) project is one of the major programs. This interdisciplinary project started in 1994 with major focus on pink salmon, Pacific herring habitat, ecology, and physical oceanography. As the physical component of this project, effort was placed on field programming and numerical modeling.

After the implementation of 3-D-PWS model and a passive tracer simulation were accomplished (Mooers and Wang 1998; Deleersnijder et al 1998), a seasonal simulation (12 consecutive months) was followed up by Wang et al. (2000) using the SEA observations of 1996 only (Fig. 1). However, field observations in physical and biological oceanography from 1995–98 during the SEA program have not been fully validated. In addition, the interannual variability as observed (Vaughan et al. 2000) cannot be explained in terms of numerical modeling alone. Thus, after SEA it is necessary to synthesize both observations and multi-year modeling simulations for 1995–98.

Therefore, it is highly appropriate to use the data that has already been collected during the SEA project synthesized with data from other sources for this multi-year oceanographic model simulation. The simulated results will be valuable to assist resource managers to forecast pink salmon and Pacific herring abundance and to anticipate or understand changes in the ecosystem. In addition, key elements

will be identified that will be pertinent to include in a long-term monitoring program, leading to an establishment of a nowcast/forecast system in PWS using this 3D-PWS model.

C. Location

The research conducted for the ecosystem of Prince William Sound, Alaska will help us understand the basic physical forcing of the Sound and greatly benefit the biological research community and resource managers. The observed data used in the model are from the observations conducted in PWS between 1995–98. The modelling will be done using the resources of the University of Alaska Fairbanks and IARC-Frontier.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Research institutions such as IMS and IARC of UAF and local community organizations such as the Regional Citizens' Advisory Council (RCAC) in Cordova and around Cook Inlet will be involved in this project. Both groups are concerned with possible long-term oil spill impact on the ecosystem and on the local communities as well.

PROJECT DESIGN

A. Objectives

1. Using the 3D-PWS model to simulate 1995–98 ocean circulation, T, S, vertically mixing coefficients using 2.5 turbulence closure model. The model validation will be conducted using actual observations during the four years.

2. Provide biologists and resource managers the 3-D fields (longitude, latitude, and depth) of velocity, T, S, etc. of 1995–98.

3. Conduct 48-month simulation of zooplankton over wintering for each year to compare the early spring distribution, the late spring-summer distribution, and the year-to-year difference (interannual variability).

4. Rescue the SEA database from PWSSC and install it with new data and information on a new server located at IMS-IARC/UAF.

B. Methods

The above objective will be implemented with the method of physical and biological data analysis and 3-D PWS numerical model.

1. Forcing data

    i. Winds. The hourly wind speeds and directions will be analysed at the nine stations around PWS used in Wang et al. (1999). Using nine wind-fetch empirical models, the winds will

be interpolated into the model grids from 1995–98. This work will be subcontracted to Alaska Digital Graphics.

ii. The SEA CTD data from 1995–98. All the CTD data from SEA, both physical oceanography observations and biological observations will be collected to produce seasonal T and S distribution from 1995–98. This work will be also collaborated with Dr. Vaughan at PWSSC to provide us the data.

iii. The hydrological model for freshwater discharge into PWS will be run to produce the 4-year daily runoff. The work will be done at UAF.

iv. Monthly heat flux for the same period will be extracted from the COADS.

v. The monthly inflow/outflow will be fixed to the observations of Niebauer et al. (1994).

2. Model simulations

The ocean circulation (physical) model should refer to the studies of Wang and Ikeda (1996), Wang et al. (1997), Mooers and Wang (1998), and Wang et al. (1999).

A continuous 48-month simulation will be conducted under the forcing described above and tidal forcing, beginning from January 1995 to December 1998. The outputs will be validated based on actual observations. Then, the model outputs (velocity, T, S, mixing coefficients, etc.) will be provided in 3D grids to biologists to verify their phytoplankton and zooplankton data. The four years interannual variability will be analysed to confirm what (i.e., which forcing factor) causes interannual variability, and their relative importance for interannual variability.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Data preparation will be subcontracted to Alaska Digital Graphics. The observations of SEA Project in 1995–98 were collected by them and we had very fruitful collaboration during the course of this project.

The PI was also recently funding by the Oil Spill Recovery Institute (OSRI) for one-year ($50K) of the two-year proposal titled "A 3-D coupled biological-physical model for the ecosystem in PWS, Alaska." This project will benefit the present proposed research by paying half of the time for Dr. Jin, who will be doing the intensive modeling work.

SCHEDULE

A. Measurable Project Tasks for FY 01 (October 1, 2000 – September 30, 2001)

December 31:	Complete tide simulation and validation with the four years of observations
January 18–28 (3 of these days):	Attend Annual Restoration Workshop
March 31:	Complete preparing the forcing data of the four years

August 31:	Complete the modelling of 1995–1998
September 15:	Submit manuscript to peer viewed journal

B. Project Milestones and Endpoints

March 15, 2001:	Complete the analysis of interannual variability of the ocean circulation and the ecosystem in PWS
April 15, 2001:	Submit annual report (FY 00)
August 15, 2001:	Complete the modelling of zooplankton over wintering
September, 30, 2001:	Submit final report and second manuscript

(New Task for 2001)

Please note that in the first year proposal, the PI (Wang) only proposed a one year subcontract to Dr. Vince Patrick, Jenny Allen and Stephen Bodnar formerly of the Prince William Sound Science Center, now Alaska Digital Graphics. Now, with the realization that PWSSC SEA server has been down since Patrick, Allen and Bodnar left the Center, much of the data has not been retrieved and may be lost if we do not immediately rescue the database collected during the SEA program.

Therefore, I propose to apply for 2001 budget from EVOSTC that includes funding for a subcontract to Alaska Digital Graphics to transfer the database from PWSSC to a new server located at IMS-IARC/UAF. The new task includes:

1) Budgeting for a UNIX workstation ($12K) to sit at IMS-IARC/UAF as a server for SEA database and be available for future GEM modeling projects.
2) Allen: 2.5 month for making the 1995-98 model outputs into the database and adding new data to the new computer server;
   Bodnar: 1.5 months for retrieving the SEA database and installing in on the new server;
   Patrick: 1.5 months for retrieving the SEA Information System and installing it on the new server.

The retrieved database in the IMS-IARC/UAF server will be serve incoming GEM projects with a focus on numerical simulations and provide a level of continuity that would not be available without this data. The breakdown of the SEA Information System and the server at PWSSC after a five-year investment by EVOSTC is a lesson we all should learn. Thus, it is very important to keep alive the data that scientists have collected during the last five-year SEA project.

C. Completion Date

September 30, 2001

PUBLICATIONS AND REPORTS

Manuscript titled "Tidal current and tidal residual current in PWS" (to be submitted to the *Journal of Geophysical Research-Oceans*) will be prepared and submitted to a refereed journal for formal publication. I may present the results and publish another paper in the book titled *Computer Modeling of Seas and Coastal Regions, V, 2001* in which I serve as a member of the International Advisory Committee for three years now. In the second year, we plan to submit a paper titled "Simulating

interannual variability of ocean circulation of PWS, Alaska" to the *Journal of Geophysical Research*, another manuscript titled *Impact of Ocean Circulation on Ecosystem in PWS, 1995-1998*.

PROFESSIONAL CONFERENCES

The PI and Dr. Jin plan to attend the annual EVOS meeting, 2000 Fall AGU Meeting in San Francisco, presenting the updated research results. This is an excellent way to communicate with our colleagues and to get recognised in the ocean science community. During the first year, we will travel to Anchorage discussing with Allen (or Allen will visit Fairbanks) regarding data processing and analysis.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This proposed research will be co-ordinated with 1) E. Brown's project (if her proposal gets funded) by providing her with the model outputs; 2) S. Vaughan's proposal for continuous monitoring project; 3) J. Allen's proposal for animation of 3-D model outputs, and other potential proposals for the restoration effort. We are willing to provide our 4-year simulation outputs to all EVOS-funded proposals by putting our simulation results on our web in both digital and graphic formats.

PROPOSED PRINCIPAL INVESTIGATOR

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907-474-2643
jwang@iarc.uaf.edu

PRINCIPAL INVESTIGATOR

Dr. Jia Wang, the PI, will be involved in the entire course of the project, providing scientific guidance to the project, without claiming salary. (The PI's salary will be funded by IARC-Frontier funds.) The PI needs one graduate student to conduct hydrological modeling to produce 48-months of freshwater runoff along the PWS coasts. Also, the PI will oversee the rescue of the SEA database and addition of new information into the new server.

OTHER KEY PERSONNEL

Dr. Meibing Jin, who is currently working on this EVOS-funded project awarded to the PI (Wang), will continue conducting the simulation and will be partially supported by the OSRI fund for six months.

The data preparation and server construction for rescuing the SEA database will be subcontracted to Dr. Patrick, Allen and Bodnar of Alaska Digital Graphics. Their collaboration will be essential for success of this proposed research.

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2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001						
Personnel		$0.0						
Travel		$0.0						
Contractual		$133.2						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$133.2			Estimated	Estimated		
General Administration		$9.3						
Project Total		$142.5						
Full-time Equivalents (FTE)		1.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY01

Prepared:

Project Number: 01389
Project Title: 3-D Ocean State Simulations for Ecosystem Applications from 1995-1998 in Prince William Sound (PWS), AK.
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$43.7						
Travel		$2.2						
Contractual		$52.1						
Commodities		$0.9						
Equipment		$12.0						
Subtotal		$110.9			Estimated	Estimated		
Indirect		$22.3						
Project Total		$133.2						
Full-time Equivalents (FTE)		1.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

The indirect rate is 25% TDC (5% for subcontract amounts over $25,000), as negotiated by the Exxon Valdez Oil Spill Trustee Council with the University of Alaska.

Student personnel costs include non-resident tuition of $5,868 per year.

FY01

Prepared:

Project Number: 01389
Project Title: 3-D Ocean State Simulations for Ecosystem Applications from 1995-1998 in Prince William Sound (PWS), AK.
Name: Jia Wang

FORM 4A
Non-Trustee
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
	M. Jin	Research Assistant Professor	6.0	4.8		28.8
	TBA	Graduate Student	9.3	1.6		14.9
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	15.3	6.4	0.0	
					Personnel Total	$43.7

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
	R/T Fairbanks to San Francisco (AGU Meetings)	0.6	1	4	0.2	1.4
	R/T Fairbanks to Anchorage	0.5	1	3	0.1	0.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$2.2

FY01

Prepared:

Project Number: 01389
Project Title: 3-D Ocean State Simulations for Ecosystem Applications from 1995-1998 in Prince William Sound (PWS), AK.
Name: Jia Wang

FORM 4B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed
Description	FY 2000
Subcontract: Alaska Digital Graphics	52.1
Contractual Total	$52.1

Commodities Costs:	Proposed
Description	FY 2000
Project Supplies (Telephone, Copying, Postage, Etc.)	0.9
Commodities Total	$0.9

FY01

Prepared:

Project Number: 01389
Project Title: 3-D Ocean State Simulations for Ecosystem Applications from 1995-1998 in Prince William Sound (PWS), AK.
Name: Jia Wang

FORM 4B
Contractual & Commodities DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

New Equipment Purchases:		Number	Unit	Proposed
Description		of Units	Price	FY 2000
	Workstation/Server	1	12.0	12.0
				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**	$12.0

Existing Equipment Usage:	Number
Description	of Units

FY01

Project Number: 01389
Project Title: 3-D Ocean State Simulations for Ecosystem Applications from 1995-1998 in Prince William Sound (PWS), AK.
Name: Jia Wang

FORM 4B
Equipment
DETAIL

Prepared:

Cook Inlet Information Management/Monitoring System

Project Number:	01391
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 (3rd year of 3-year project) December 1999 – September 30, 2001
Cost FY 01:	$239.0
Geographic Area	Cook Inlet
Injured Resource/Service:	All

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EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

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 projects and 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. The CIIMMS website is at *http://www.dec.state.ak.us/ciimms*.

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 – completion date, September 30, 1999.
4. Preliminary System Specifications - completion date, January 15, 2000.

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.
- Future activities
- Information/data description
- Information processing.
- 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 address the following design 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 formed the basis for a pilot phase implementation plan, completed May 18, 1999. The implementation of the pilot phase focuses on short term priorities identified in the User Needs Analysis process in a limited geographic area, the Kenai River watershed (Appendix A: "The CIIMMS Prototype: Sample Web Pages"). Results of the user survey and workshop (Post Workshop Report) as well as the detailed *Pilot Phase Implementation Plan* (CIIMMS Implementation Plan) can be found on the CIIMMS web site at http://www.dec.state.ak.us/ciimms (see the *About CIIMMS* link).

Short-term (Year 1 and prototype) priorities included in the prototype:

- Categorical indexes for Cook Inlet information inventory
- Keyword and boolean searching capabilities
- 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)
- Data documentation (metadata) records linked to actual data and summary information (e.g., fact sheets)
- Hotlist of related offsite links
- Form for suggesting information and links to add to CIIMMS
- Data documentation (metadata) entry tool to populate CIIMMS

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 (and refined with feedback gained from prototype), will be integrated into the CIIMMS system during FY 2000 (CIIMMS year 2).

Medium-term (FY2000) priorities include the following:

- Expansion of access to knowledge, information, and data, including traditional ecological knowledge, building on the datasets available via the prototype, to include data for various watersheds throughout the Cook Inlet basin (see Step 4 , page 11-12, for details);

- Expansion of search capabilities to include a tool to find different types of information for one geographic area (map based search tool); this may be a gazetteer, built according to the emerging standards for geospatial libraries (National Research Council, 1999).

- Expansion of the browse capabilities to include more refined categories, and a locational and originator browse tree;

- Refinement of User Interface to enhance navigation and ease of use in response to peer review comments and user input.

- Support the population of the FGDC-compliant metadata databases (state and federal) and CIIMMS database (non-FGDC-compliant metadata) for priority datasets for the watersheds throughout the Cook Inlet basin;
    - coordination with Alaska DNR and the ASGDC to get metadata training for the appropriate data providers (metadata training costs provided by separate Federal grant, awarded to ADNR in FY2000);
    - coordination with the EVOS Principle Investigators who have been involved with TEK projects as well as data collection within the Cook Inlet basin; to identify those data/databases which might be made available;

- Coordinate with the Alaska Geographic Data Committee (AGDC) on their work towards implementation of an on-line mapping tool;

- Refinement of data provider and contributor guidelines, in cooperation with the AGDC;

- Replace the search of the WorldCat database with a search of the Anchorage Municipal Libraries' server, which includes the ARLIS holdings, and all the EVOS project reports;

- Add the capability to search the UAF Library server when in becomes available early in 2000;

- Add the capability to search EPA's Envirofacts data warehouse (on-line access to environmental information from EPA databases on Air, Chemicals, Facility Information, Hazardous Waste, Superfund, Toxic Releases, Water Permits, Drinking Water, and Drinking Water Contaminant Occurrence, just to name a few)

- Add the capability to search the Capital City Library server, which includes the Alaska State Library, when it becomes available;

- Coordinate efforts by ADEC to develop an on-line water quality data management system, and make it accessible via CIIMMS;

- Outreach activities will include educating the stakeholders on the use of CIIMMS, as well as educating data providers on the steps necessary to make their data available, via the CIIMMS site, or preferably from their own server.

CIIMMS Long-Term Vision (FY2001 and beyond)

CIIMMS will mature into a geographically distributed decision support system with tools for data visualization and analysis and information synthesis. CIIMMS will provide a framework for collaboration, access to and sharing of data. As an information resource, providing access to both current and historical data and information, CIIMMS can contribute to the success of many

future projects within the spill area including the Gulf Ecosystem Monitoring project being funded with the Restoration Reserve.

CIIMMS cannot be realized overnight. As people benefit from CIIMMS, the incentive to contribute to CIIMMS will increase. Agencies will realize cost savings associated with the dissemination of information and distribution of data as more information and data is made available through CIIMMS. CIIMMS will provide a valuable tool for past and future EVOS funded efforts by providing access to data and information related to EVOS funded projects as well as providing a nexus for future research and restoration collaborations.

NEED FOR THE PROJECT

Statement of Problem

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. Each year, industry, government, the scientific community and citizen watchdog groups generate and aim to use large quantities of information about the Cook Inlet watershed and its resources. This information may be used to focus on a single resource, issue, or problem, requiring data management techniques specific to that need. Watershed management, meanwhile, has a scope that requires evaluation of a much broader spectrum of factors within a defined geographic area. Watershed managers and other information users can't necessarily access data generated for more narrowly defined purposes.

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, in order to *begin* the difficult task of integration and analysis. Currently, this is a difficult and time-consuming task. 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 made accessible, through the CIIMMS search, and related, via the CIIMMS categorized browse capabilities. Managers are more likely to make decisions which benefit injured resources and services and their associated habitats if they can access data and information (primary or summarized) 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 data sharing, resource management and planning within the Cook Inlet watershed. CIIMMS can make Trustee Council-funded research readily available to resource managers by improving access to information relative to injured resources/services and their habitats in the Inlet.

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

1. access to more complete resource information for decision-makers and the public.
2. access to maps, publications, data, and *knowledge* pertinent to injured species' habitats, movement corridors and environmentally sensitive areas.
3. EVOS researchers and agency resource managers the ability to easily access and view a variety of information, data documentation (metadata) and datasets specific to the Cook Inlet watershed--where data covers the entire spill area, it will not be subsetted;
4. broad access to information used by regulators to help them review permit applications with recovery of injured resources/services in mind.
5. a framework for analysis capabilities by providing access to much of the relevant data within the watershed;
6. 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 has been established to provide direction and feedback. This group will provide practical advice on design and implementation issues, and will help ensure that the system will remain usable in the future.

Membership of the advisory group was initially 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.

By the end of CIIMMS' year two, the advisory group membership will be comprised 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.

The CIIMMS Advisory Group most recently met on November 18, 1999. During the later part of the Initial Production Phase, this group will need to develop stronger direction and more defined operating procedures, in order to ensure that the long-term vision of stakeholders is achieved. This group is currently chaired by a member of the CIIMMS Project Team.

Traditional Ecological Knowledge

A year two priority of the stakeholders which surfaced at the CIIMMS user needs analysis workshop was the need to provide a tool for collecting and accessing traditional ecological knowledge (TEK). The University of Alaska Institute of Social and Economic Research (ISER) has just created an on-line database of Alaska Traditional Knowledge and Native Foods. The databases cover the entire EVOS area and other locations statewide. It contains information on existing measures of contaminants in species of fish and animals harvested by Alaska Natives,

harvest and consumption data, nutrition data, descriptions of the role of harvest and Native food consumption in communities, and examples of community projects taken in response to concerns about environmental change. CIIMMS is currently negotiating with the ISER project team to coordinate the long-term access to and growth of these databases. CIIMMS is also ideally suited to provide tools to involve the Cook Inlet community in contributing their own traditional ecological knowledge to the ISER databases.

A. Objectives

The CIIMMS' objective is 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, and contribute (on-line) valuable knowledge, information, and data about the Cook Inlet watershed from a distributed network of data resources and information providers.

B. Methods

The method and tasks outlined below encompass the design and further 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, including project documentation, and geospatial data with no existing FGDC-compliant metadata, will reside primarily on the CIIMMS site, in abbreviated form. FGDC-compliant geospatial metadata created as a result of the CIIMMS project will be stored and accessed on one of the two Alaska clearinghouses, currently in existence for that exact purpose.

The proposed approach for implementing the Initial Production Phase (FY2000) of the Cook Inlet Information Management/Monitoring System includes the following steps:

Step 1: Further iterative evaluation and revisions to CIIMMS prototype (deliverable 99391).

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

Step 3: Initial Production Phase implementation plan including long term operations and maintenance strategic plan (FY 00).

Step 4: Apply prioritization model for access and documentation of datasets (FY 00-01).

Step 5. Finalize data documentation and data access processes (FY 00).

Step 6: Provide guidance and documentation assistance to CIIMMS' data providers (FY 00-01).

Step 7: Expand number of distributed sites for access, including the Cook Inlet watershed (FY01).

Step 8: Design, develop and deploy geographically-based query tools (FY 00-01)

Step 9: Develop a long range implementation and maintenance plan (FY 00-01).

Step 1. Further iterative evaluation and revisions to CIIMMS prototype – complete.

Evaluation of the prototype developed as part of FY 99, 99391 continued through the first quarter of FY 00 in order to ensure that a large cross-section of the user community was given the opportunity to provide feedback. Training of potential users and subsequent evaluation of prototype functionality was carried out by staff of DNR, DEC, and Cook Inlet Regional Citizen's Advisory Council.

The following workshops or meetings were held by CIIMMS project team members, or attended by team members, for the purpose of educating users and obtaining feedback from stakeholders:

DATE	FUNCTION
September 17, 1999	Cook Inlet RCAC Quarterly Meeting, CIIMMS Overview, Kenai
September 24, 1999	CIIMMS Prototype Open House, Kenai Peninsula College, Kenai
September 25, 1999	CIIMMS Prototype Open House, Kachemak Bay University, Homer
October 13, 1999	Preliminary demo at Restoration Office, Anchorage
October 14, 1999	EPA Indian Grants Assistance Training, Anchorage
October 15, 1999	CIIMMS Prototype Open House, Anchorage
October 21, 1999	Interagency Hydrology Committee Meeting, CIIMMS demo, Anchorage
October 22, 1999	CIIMMS Prototype Open House, Juneau
October 26, 1999	EVOS Public Advisory Group, CIIMMS demo, Anchorage
November 3, 1999	Alaska Oil & Gas Association meeting, CIIMMS demo, Anchorage
November 9, 1999	Cook Inlet Oceanography Workshop, CIIMMS demo, Kenai
November 18, 1999	CIIMMS Advisory Group/Cook Inlet Coalition demo, Anchorage

The development and evaluation of the prototype has involved numerous reviews by project participants. Throughout this iterative process, deficiencies were identified and enhancements incorporated into the final system specifications. In addition, the site itself provides interactive tools for users to provide feedback to the CIIMMS project team. The CIIMMS project team is continually evaluating user feedback and responding to their constituents. Appendix B provides a summary of the results of these evaluation sessions.

Step 2. Review preliminary system specifications.

The preliminary system specification (entitled "Pilot Phase Implementation Plan,") developed as part of project 99391, was posted on the CIIMMS web site for review and comment by the user community. Preliminary system specifications matured into "DRAFT - Initial Production Phase Implementation Plan," February 28, 2000 available on the CIIMMS web site for review. http://www.dec.state.ak.us/ciimms/project/impplan2000.pdf. Following feedback and review, it is expected that the final Initial Production Phase Implementation Plan will be completed by June 1, 2000.

Step 3. Initial Production Phase Implementation Plan.

After short-term functions are accepted in the pilot phase (see Appendix A: "The CIIMMS Prototype: Sample Web Pages"), the Initial Production Phase will be implemented. This phase will occur between December 16, 1999, and April 15, 2001. 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-, medium and long-term priorities).

The CIIMMS design will employ a hybrid centralized/distributed system, more centralized in the prototype stage, and then migrating towards a more distributed design in year two and beyond. In the Pilot Phase (FY99), a few distributed sites were made accessible via CIIMMS. Examples of these are the Alaska DNR's WELTS database, which was made accessible via an SAIC server (in Virginia), both the Alaska geospatial data clearinghouses (one is at USGS in Anchorage, the other is at ADNR in Anchorage), as well as a server at Alaska Department of Fish & Game, where the 1998 Anadromous Streams and Anadromous Species datasets have been made accessible, and downloadable. As soon as the ARLIS server is operational, the ARLIS holdings will be searchable via CIIMMS. As more and more agencies and organizations become successful at providing access to their own data and information using new web technologies, CIIMMS will provide the 'front door' search and browse tools, as well as guidelines and technical support, to enable access to these data providers' sites. The pioneer sites, made accessible via the CIIMMS Prototype, will provide guidance to organizations interested in making data and information available via CIIMMS.

As part of the Production Phase Implementation Plan, a strategic plan for the long term operation and maintenance (O&M) of CIIMMS will be developed. This plan will address maintenance of the system, and transferring, relating, integrating and updating data or metadata over the long run. The plan will include staffing, training, hardware and software, application and networking recommendations. Finalization of the plan will take place at the end of the production phase (April 2001).

Data and information provided via CIIMMS is provided on an 'as is' basis. After the data within the Cook Inlet basin has been identified, and made accessible, the work on data visualization, and ultimately, data analysis, can begin. The work on data visualization and analysis is beyond the scope of CIIMMS in the first two years, since the first steps are to identify and make accessible all relevant data.

Step 4. Apply prioritization model for access and documentation of datasets (FY 00-01).

Workshop discussions confirmed that there are 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 or summarized data, and primary data.

The CIIMMS year two data access strategy will determine data priorities using the data priorities document generated with findings from the User Needs Questionnaire, and later prioritized by the User Needs Workshop participants (see Appendix C: "CIIMMS Information Priorities"). Using this list, the project team will further rank these datasets for inclusion, using the following 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
- Geographic extent

These ranking criteria will be applied to the data sequentially, and used to create a prioritized list of data and data types for inclusion in CIIMMS. Using the prioritization scheme as guidance, access to the data and information will be incorporated into CIIMMS.

Throughout this process, the CIIMMS website will be used to poll users on current data needs, to be sure we are still in step with stakeholders' requirements. Following is a list of some of CIIMMS data priorities, organized by source:

FY 00

- EVOS-funded project data, or data documentation, first priority is Cook Inlet, but where PWS and Kodiak/Alaska Peninsula EVOS project data can be added with little incremental cost, we will do so;
- Offer long-term access and update solutions, via CIIMMS, to the new Traditional Knowledge/Native Foods database, initiated by the University of Alaska Anchorage Institute of Social and Economic Research
- Expansion of the CIIMMS project database to include entry of more on-going projects across the entire Cook Inlet;
- Provide on-line discovery and/or access to the Matanuska-Susitna Borough's data, via CIIMMS on-line data documentation tools;
- Provide on-line discovery and/or access to Minerals Management Service extensive marine resources data for the Cook Inlet, via the CIIMMS on-line data documentation tools;

FY 01

- Continue support to ADF&G for access to high priority datasets (habitat, EVOS data, etc), via their server, through CIIMMS;
- ADEC's Underground Storage Tank database*;
- ADEC's Solid Waste Sites database*;
- ADEC's Contaminated Sites database*;

**CIIMMS will provide on-line access to these ADEC databases, but actual development and maintenance of these systems is the responsibility of the ADEC.*

Step 5. Finalize Data Documentation and Data Access Processes (FY00-01).

Metadata, or data documentation, standards for geospatial data have already been established by the FGDC (Federal Geographic Data Committee). These standards are time consuming, and require a considerable effort by the data provider to complete, for each dataset. The CIIMMS project proposes to help data providers as much as possible with this daunting task, and to work in cooperation with the Alaska State Geospatial Data Clearinghouse and DNR to target the appropriate data providers with training and funding (from FGDC metadata grants) to complete metadata for key datasets. Beyond this, the CIIMMS site now provides an on-line metadata entry tool for entering a brief set of information on a particular dataset, strictly for the purpose of making that dataset discoverable. This could be the first step in determining what data people want access to, to help us prioritize where metadata creation efforts would best be focused. Automated counting mechanisms will be put in place on the CIIMMS site to keep track of what metadata (and therefore datasets) are the most sought after.

Data documentation and data access procedures will be presented in the form of guidelines for data providers and stakeholders. The guidelines will include, but not be limited to, the following:

1) different types of metadata entry tools available on-line, via CIIMMS;
2) ways to make your data or information (including websites) accessible via CIIMMS (this will include a set of metatag standards, developed by the Dublin Core, specific to websites);
3) explanation of different ways to make your data or information downloadable, or accessible on-line (including spatial data downloads, or making spreadsheets or databases query-able or accessible on-line);
4) hardware and software requirements for above options;

The above guidelines would include cost estimates to the data provider, including set-up time, hardware and software costs, etc. Based upon user needs and input, project staff will adopt standards for process and content as required to meet user needs. The CIIMMS Advisory Group will provide ongoing review and feedback as guidelines are developed. These guidelines will set a target for data providers to meet.

Step 6. Provide guidance and data documentation assistance to CIIMMS' data providers (FY00-01).

Using the CIIMMS web-accessible data documentation tools, the project team and strategic members of the CIIMMS Advisory Group will provide training, and data documentation entry services where needed in order to populate the CIIMMS database. Where FGDC-compliant 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 non-digital data, so that it may be made discoverable via CIIMMS. Guidelines will be provided (see Step 5, page 12),

as well as technical assistance where necessary, to help make summarized information, as well as priority data sets, accessible via CIIMMS.

Step 7. Expand number of distributed sites for access (FY00-01).

Primary and high priority datasets that are in compliance with documentation, either FGDC-compliant, or using the CIIMMS brief on-line documentation tool, will be made accessible to the system. Other compatible datasets, accompanied by documentation files, will be linked to the system as time and budget constraints allow. Updates to existing datasets and new datasets will be evaluated 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. The CIIMMS project team will focus on the identification, data access and data documentation part of the entire data management process, keeping in mind that these processes will help facilitate the creation of standards, and eventually integration. It is reasonable to expect that a substantial effort may well be invested in these activities. Responsibilities for data cleanup, QA/QC, and conversion activities rest with the data provider. The estimated budget provides conservative controls on identification, access, and data documentation efforts.

Step 8. Design, develop and deploy geographically-based query tools (FY00-01).

Cook Inlet stakeholders have expressed the need for a map-based "area of interest" tool to aid in the search for CIIMMS' data and information. Gazetteer or map-based tools make it easier for all types of users to find data, data documentation (metadata), and information in the web environment. These queries will allow the user to define an area of interest based on several different spatial techniques, such as:

- Map interface with user ability to draw a rectangle to depict area of interest;
- Place name search (using USGS geographic place names database);
- Clickable maps with various known boundaries (start with watershed boundaries or HUCs, and then expand to township/range, USGS quadrangles, etc.).

The CIIMMS approach to the geographically-based (or map-based) query is similar to the gazetteer approach implemented by the Alexandria Digital Library. The gazetteer is a list of geographic names, together with their geographic locations and other descriptive information. We define the minimum components of a gazetteer entry as (1) a geographic name, (2) a footprint or geographic location represented by coordinates and (3) a type designation (i.e., city, hydrologic feature, etc.). With these attributes, the gazetteer can function as a tool for indirect spatial location identification through names and types. An example of a gazetteer is the USGS Geographic Names Information System (GNIS).

The gazetteer will support several functions of a map-based query for data and information:

- It will answer the question, for example, "What data and information are available for the Kenai River Watershed?"

- It will translate between geographic names and locations so that a user can locate metadata and information by matching the footprint of a geographic name to the footprints of the metadata, or data documentation.

- During metadata creation, it will allow a user to locate particular types of geographic features in a designated area, and pass these as keywords to the metadata.

The map-based query tool will provide a front-end to the CIIMMS middleware component (Blue Angel Technology Metastar Enterprise) that provides multiple clients with a uniform view of multiple heterogeneous metadata servers. The CIIMMS principal mechanism by which this uniform view is achieved is as follows:

- Clients formulate queries in terms of keywords.
- The middleware server translates and forwards queries to the metadata servers.
- Metadata servers are responsible for evaluating the queries in ways that are meaningful for their respective collections.

The overall implementation characteristics of the proposed CIIMMS map-based query tool are:

1. A conceptual set of contents (e.g., "any geographic locations or regions associated with collection items");
2. A set of allowable representations for the contents (using a phased approach, begin with clickable watershed boundaries, and time and funding permitting, proceed with user-defined rectangles, township/range boundaries, etc.);
3. A set of query operators (e.g., overlaps and contains); and
4. A name (e.g., geographic location) that uniquely identifies the geographic feature and its conceptual contents, allowable representations, and query operators.

Step 9. Finalize Long Term Operation and Maintenance (O&M) plan (FY00-01)..

Finalization of the long term operations and maintenance plan, as outlined in the Production Phase Implementation Plan (see Step 3, page 10-11). Deliverables associated with Step 9 include CIIMMS Long Range Implementation and Maintenance, System Documentation, and On-line Help tools.

ADEC has committed to the long-term maintenance of the information management/monitoring system subsequent to completion of this project. To this end ADEC has committed the following hardware and software resources to this project at a cost of $25,000. The CIIMMS Database Server is 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 are backed up nightly. The system is housed at the Alaska Department of Environmental Conservation in Anchorage, Alaska. The operating system for the CIIMMS Database Server is Windows NT. The CIIMMS metadata database will be developed in Microsoft SQL Server 7.0. The Internet Server runs Microsoft's Internet Information Server (IIS) on Windows NT. In addition to CIIMMS these servers run additional ADEC processes. Both servers will be monitored to ensure that there is adequate capacity to handle the growth of CIIMMS, and incremental upgrades will be made as needed.

The ADNR Commissioner has committed the agency to maintaining the associated geospatial 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 and within the budgetary scope of each agency.

Regarding database maintenance, "metadata" housed on the CIIMMS server will be maintained by the ADEC as part of ADEC's long term maintenance of the system. Any data being housed by CIIMMS will eventually be migrated to its owner's server, and as CIIMMS evolves to a more distributed system, distributed databases accessed by CIIMMS will be maintained by the agencies serving the data.

In addition, the project team will pursue through the CIIMMS Advisory Group the creation of a cooperative relationship with participating state and federal agencies, municipal entities and other organizations designed to foster the ongoing development and maintenance of CIIMMS. Through this cooperative relationship, the project team will pursue financial contributions in relationship to services provided for long term development efforts.

The project team is currently pursuing grant funding for future development efforts. Potential funding sources include EPA 319 grant program, the USGS, FGDC grant cycle, MMS grant cycle, the Global Disaster Information Network (GDIN), as well as other funds established through federal court settlements.

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. 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 statewide 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 (ADFG) will participate with the CIIMMS project in order to incorporate critical habitat areas data, including EVOS related data: oil samples, stream surveys, fish surveys, etc. 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, 'gatekeeper' scripts (for monitoring access) and web accessibility. A significant effort will be made to incorporate the Alaska Habitat Management Guides for Cook Inlet. The Regional Guides are one of the most comprehensive sources of historic fish and wildlife information available. The Regional Guides provide detailed information in mapped and narrative form describing select fish and wildlife species' life functions and habitat requirements, geographical distribution, and human uses of fish and wildlife. ADFG data that was published on the EVOS Research and Restoration CD-ROM, along with other EVOS data (seabirds, bald eagles, sea otters 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 being made available, via the web, in the early part of 2000, and will be made accessible by CIIMMS as well.

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 statewide 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 (Permits and Compliance System) 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 refine the CIIMMS site, based on the medium term priorities discussed previously. We are working with EPA and will continue to utilize Science Applications International Corporation (SAIC), a National 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, Arizona, and Jordan.

SAIC will build final system specifications, develop and implement a map-based search tool (see Step 8, Page 13), implement access to certain distributed data systems, and will build enhancements to the user interface and access tools. 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 is 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 and 3)
Measurable Project Tasks for FY 2000 (December 15, 1999 – September 30, 2000)

December 1999	Initial Evaluation of CIIMMS prototype complete. (Step 1, page 8)
December 1999	Review of Preliminary System Specifications. (Step 2, page 10)
January 2000	Finalize System Specifications and Implementation Plan (Step 3, page 10)
January 2000	Begin Implementation of Final System Specifications. Initiate integration of prioritized databases, related information and associated metadata (documentation); continue agency staff training as an ongoing evaluation tool. (Steps 4-8, pages 11-14)
July 2000	Refinement of User Interface
January 2001	Access to specified databases completed. Data documentation (metadata) completed.
February 2001	Develop On-line User Help, Technical Specifications/System Documentation, including Long-Term Maintenance. (Step 9, page 14)
March 2001	Public outreach.
April 2001	Completion of Initial Production Phase of CIIMMS
September, 2001	Completion of Final Report

Project Milestones and Endpoints

Initial Production Phase (Years 2 and 3)
(FY 99 October 1, 1999 to September 30, 2001)

December 1999	Preliminary System Specifications Due.

January 2000	Final System Specifications and Implementation Plan Due (including Long Term Operation and Maintenance (O&M) Strategic Plan.
July 2000	Refinement of User Interface
January 2001	Integration/Access to databases, information and metadata, etc.
February 2001	On-line User's Manual and Technical Specifications/System Documentation (including Long Term Operation & Maintenance (O&M) plan).
March 2001	Public Outreach.
April 2001	Completion of Initial Production Phase of CIIMMS
April 30, 2001.	Project Complete
September 2001	Final Report Due.

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 funded in FY00 entitled "An Evaluation of the Data System for the Long Term Monitoring Program," will benefit from the framework built by CIIMMS. As year two progresses, CIIMMS can provide access to the resources available in the Cook Inlet and other parts of the spill area. Access to this data will be necessary for a complete and thorough evaluation to take place. The collaboration of the CIIMMS project team with the principle investigators on the above mentioned project is ongoing.

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.

One of the goals of CIIMMS in FY2000 is to evolve to a more distributed system. With respect to visualization tools and geographic data, the technology to achieve this capability, in a distributed environment, is beginning to emerge as the standards developed by the Open GIS Consortium (OGC) are realized by the major software vendors. The implementation of these OGC standards will enable web-based mapping systems to integrate local geospatial data with data served on the Internet. The AGDC is currently conducting an effort to implement this web-based map server technology. The CIIMMS project team and the AGDC exchange information on a routine basis, thus, as this effort moves forward and agencies begin to serve GIS data according to OGC standards, CIIMMS will aim to provide access to this data through commercial-off-the-shelf (COTS) visualization tools.

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 with both the Alaska Department of Fish & Game ('75-79) and the Department of Environmental Conservation ('79-Current). He currently manages the development and implementation of the Air & Water Quality Data & Monitoring statewide database program. Mr. Hock's past responsibilities include developing and implementing ADEC's watershed approach by working with local stakeholders, and participating on various statewide water quality planning committees. He was involved in the design and implementation of a variety of monitoring projects and has extensive ADEC experience in quality assurance, project plan development and review, and sampling methodology. He was instrumental in exploring and implementing new technologies within ADEC including modeling software, rapid bioassessment protocols, satellite telemetry, global positioning technology, geographic information systems, and automated water quality data acquisition and telemetry systems.

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, and is the CIIMMS database administrator. In addition, he coordinates all work of technical nature on the CIIMMS website. 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.

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. She is currently responsible for coordinating the work of the CIIMMS project team, and most aspects of outreach on the CIIMMS project.

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 an 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.

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APPENDIX A

THE CIIMMS PROTOTYPE:
Sample Web Pages

CIIMMS: Kenai River - Microsoft Internet Explorer

File Edit View Go Favorites Help

CIIMMS

COOK INLET INFORMATION MANAGEMENT/MONITORING SYSTEM

HOME | BROWSE | SEARCH | CONTRIBUTE | FEEDBACK

About CIIMMS

Information Profiles:
Kenai River

Information Sources

Cook Inlet Links

Cook Inlet Contacts

CIIMMS in the News

CIIMMS Contributors & Guidelines

Glossary

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kellyz@dnr.state.ak.us

Kenai Watershed "Information Profiles"

The following information profiles have been chosen for the prototype to give the users examples of how different "types" of the information related to the same theme can be discovered, accessed and/or displayed via CIIMMS:

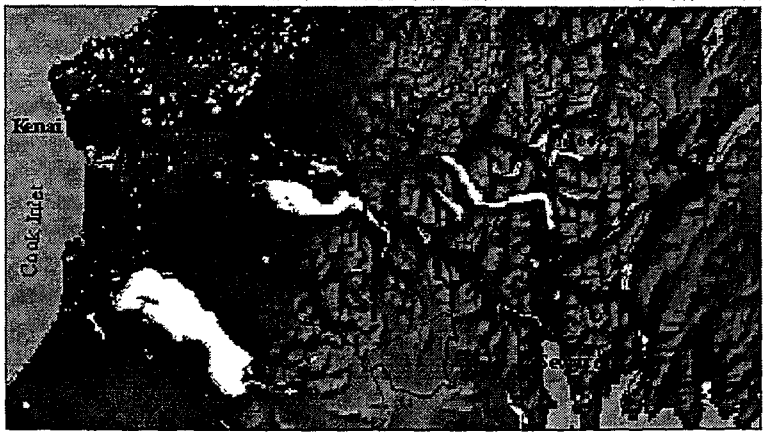
Spruce Bark Beetle (forestry scenario)

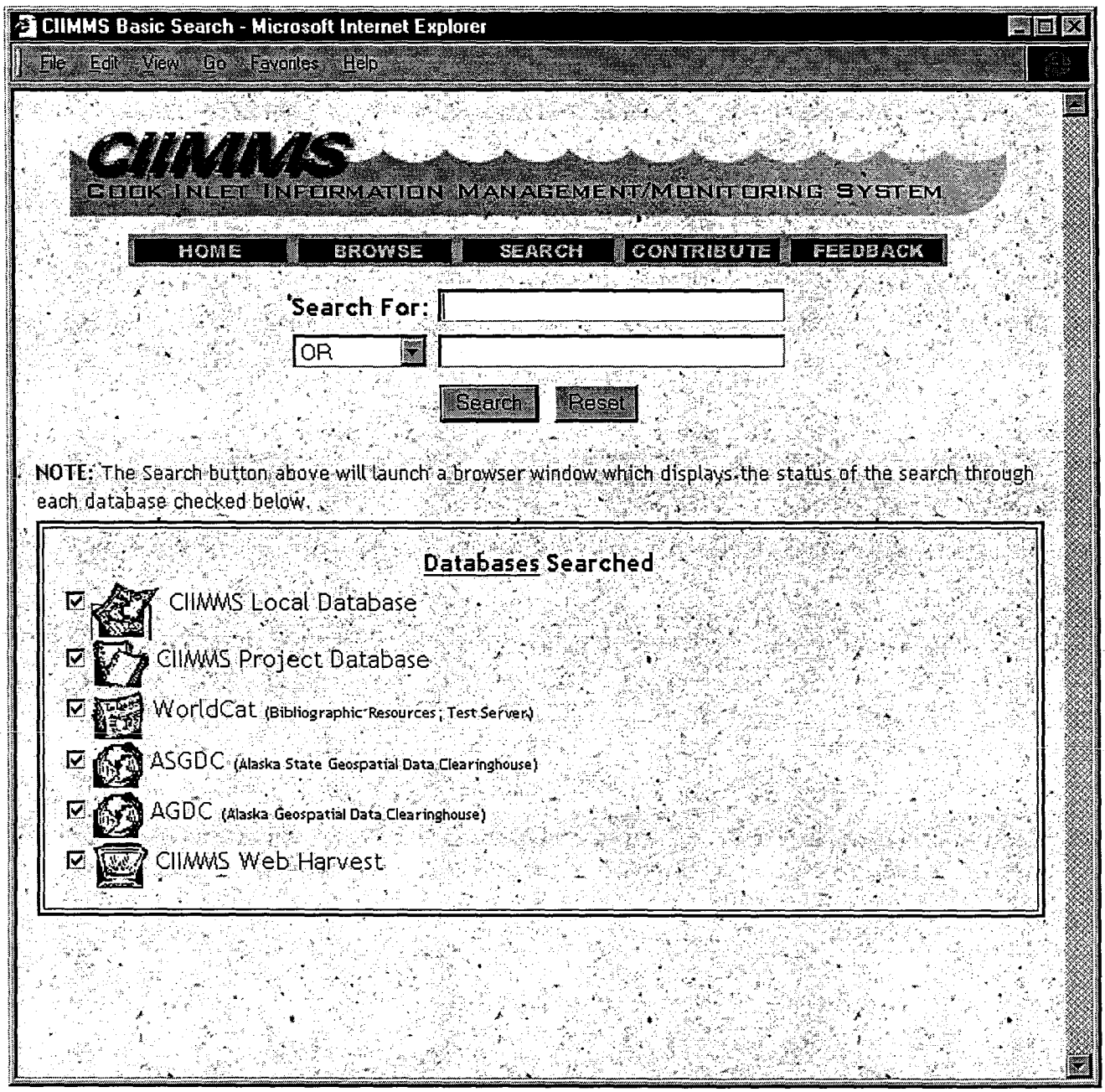
Well Log Tracking System (WELTS) (profile, database)

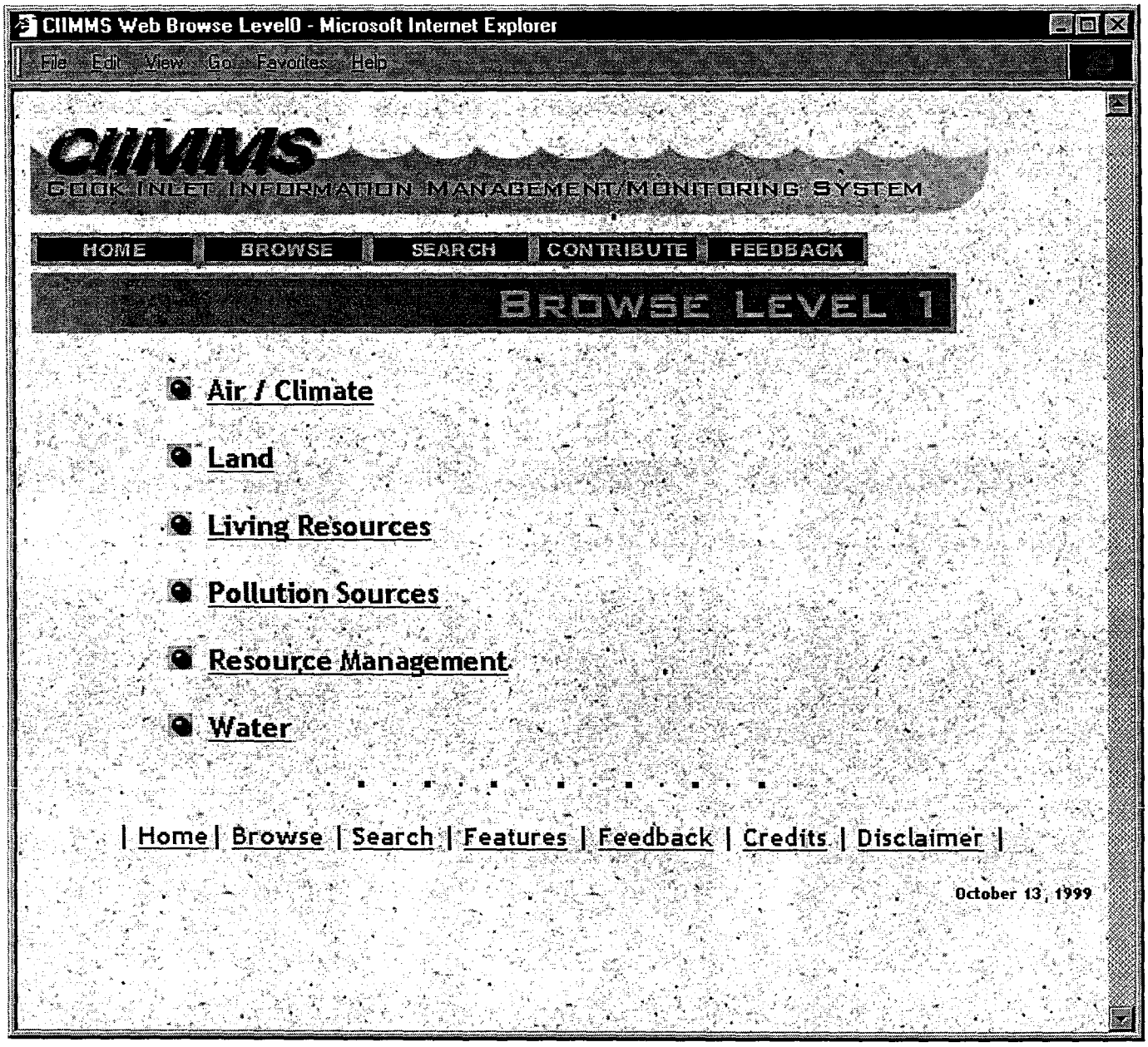
Exxon Valdez Oil Spill Projects

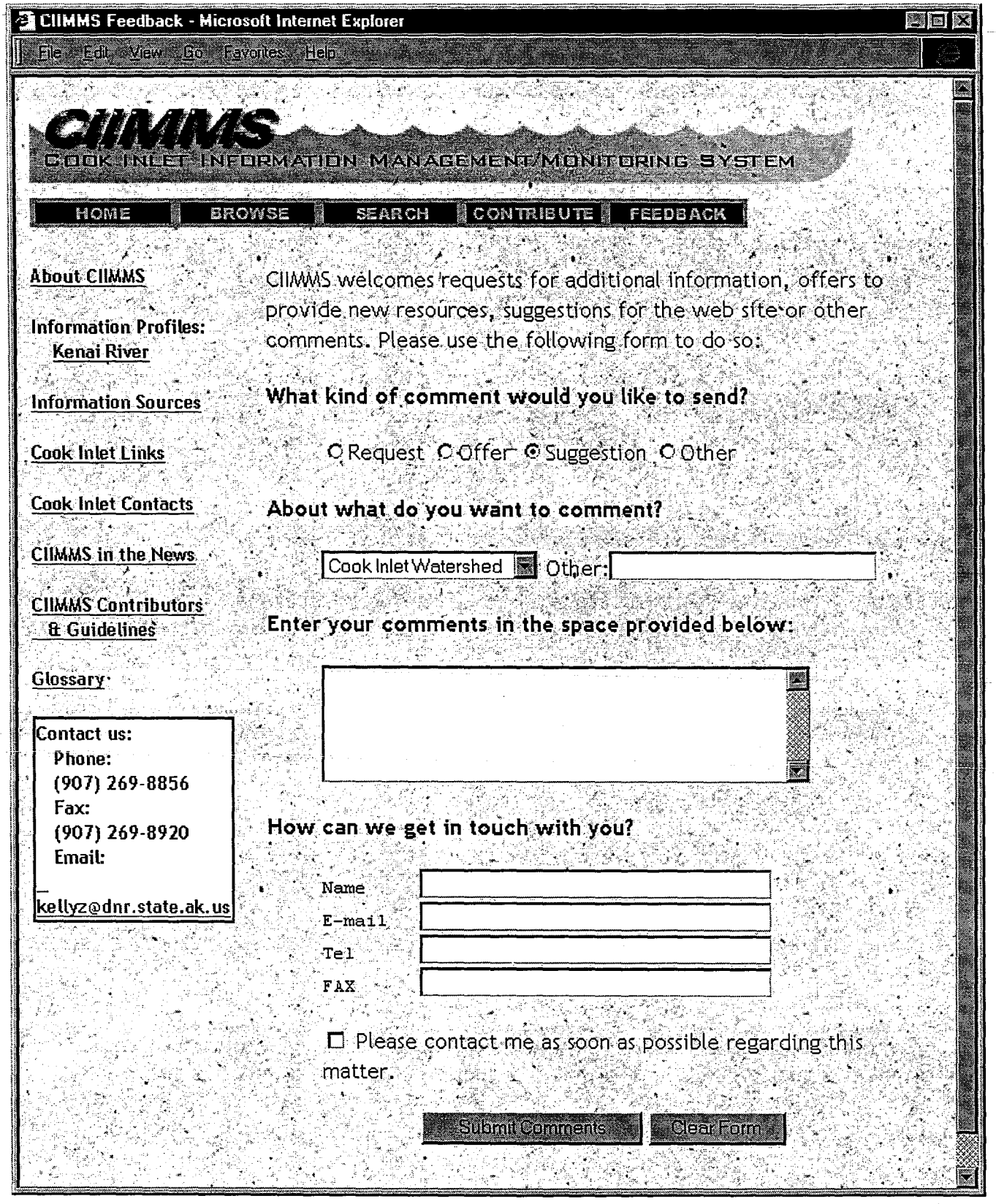
Wetlands

Anadromous Fish Streams




CIIMMS Basic Search - Microsoft Internet Explorer
File Edit View Go Favorites Help
CIIMMS
COOK INLET INFORMATION MANAGEMENT/MONITORING SYSTEM
HOME
BROWSE
SEARCH
CONTRIBUTE
FEEDBACK
Search For:
OR
Search
Reset
NOTE: The Search button above will launch a browser window which displays the status of the search through each database checked below.
Databases Searched
CIIMMS Local Database
CIIMMS Project Database
WorldCat (Bibliographic Resources ; Test Server)
ASGDC (Alaska State Geospatial Data Clearinghouse)
AGDC (Alaska Geospatial Data Clearinghouse)
CIIMMS Web Harvest


CIIMMS Web Browse Level0 - Microsoft Internet Explorer
File Edit View Go Favorites Help
CIIMMS
COOK INLET INFORMATION MANAGEMENT/MONITORING SYSTEM
HOME
BROWSE
SEARCH
CONTRIBUTE
FEEDBACK
BROWSE LEVEL 1
Air / Climate
Land
Living Resources
Pollution Sources
Resource Management
Water
| Home | Browse | Search | Features | Feedback | Credits | Disclaimer |
October 13, 1999


CIIMMS Feedback - Microsoft Internet Explorer
File Edit View Go Favorites Help
CIIMMS
COOK INLET INFORMATION MANAGEMENT/MONITORING SYSTEM
HOME
BROWSE
SEARCH
CONTRIBUTE
FEEDBACK
About CIIMMS
Information Profiles:
Kenai River
Information Sources
Cook Inlet Links
Cook Inlet Contacts
CIIMMS in the News
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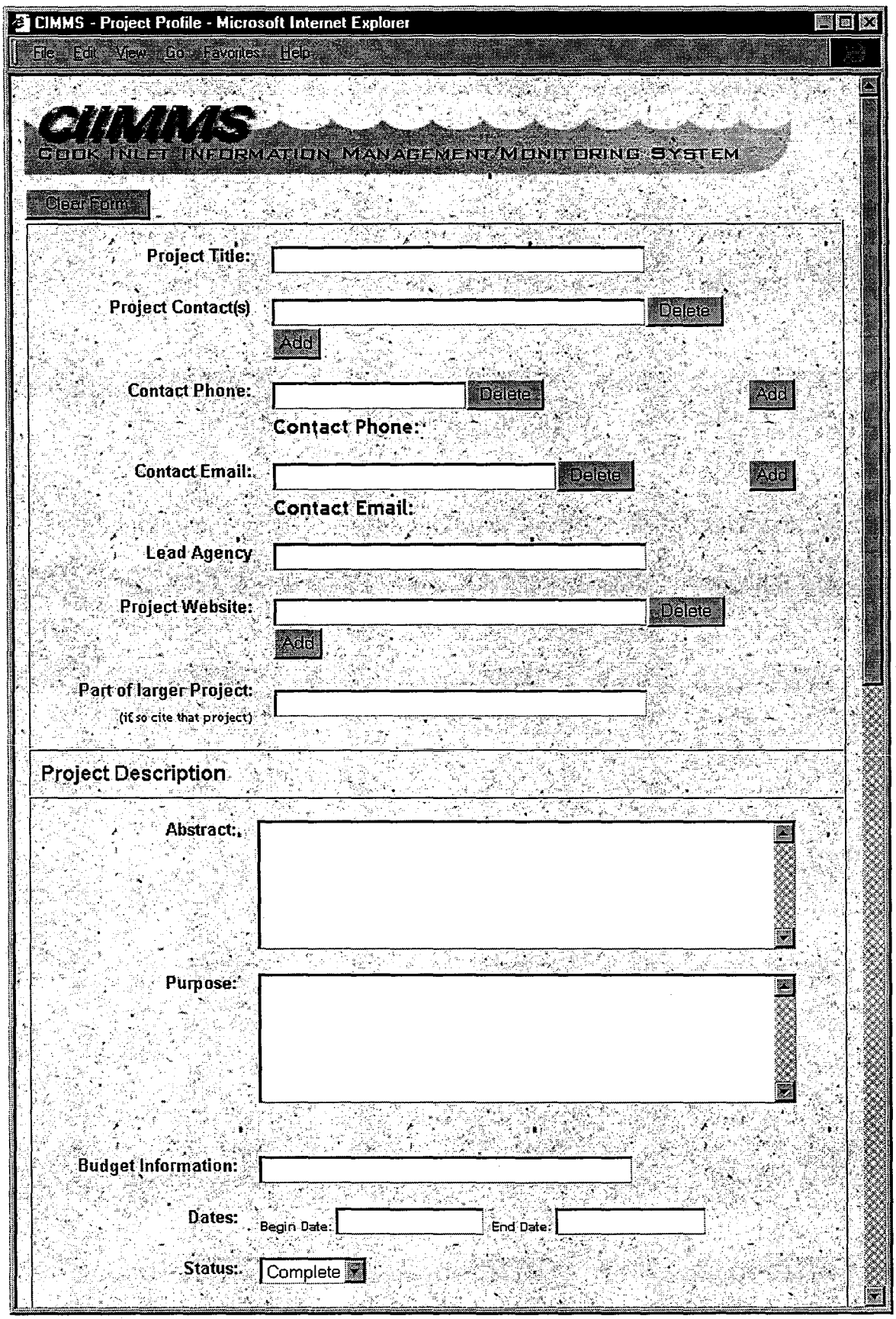
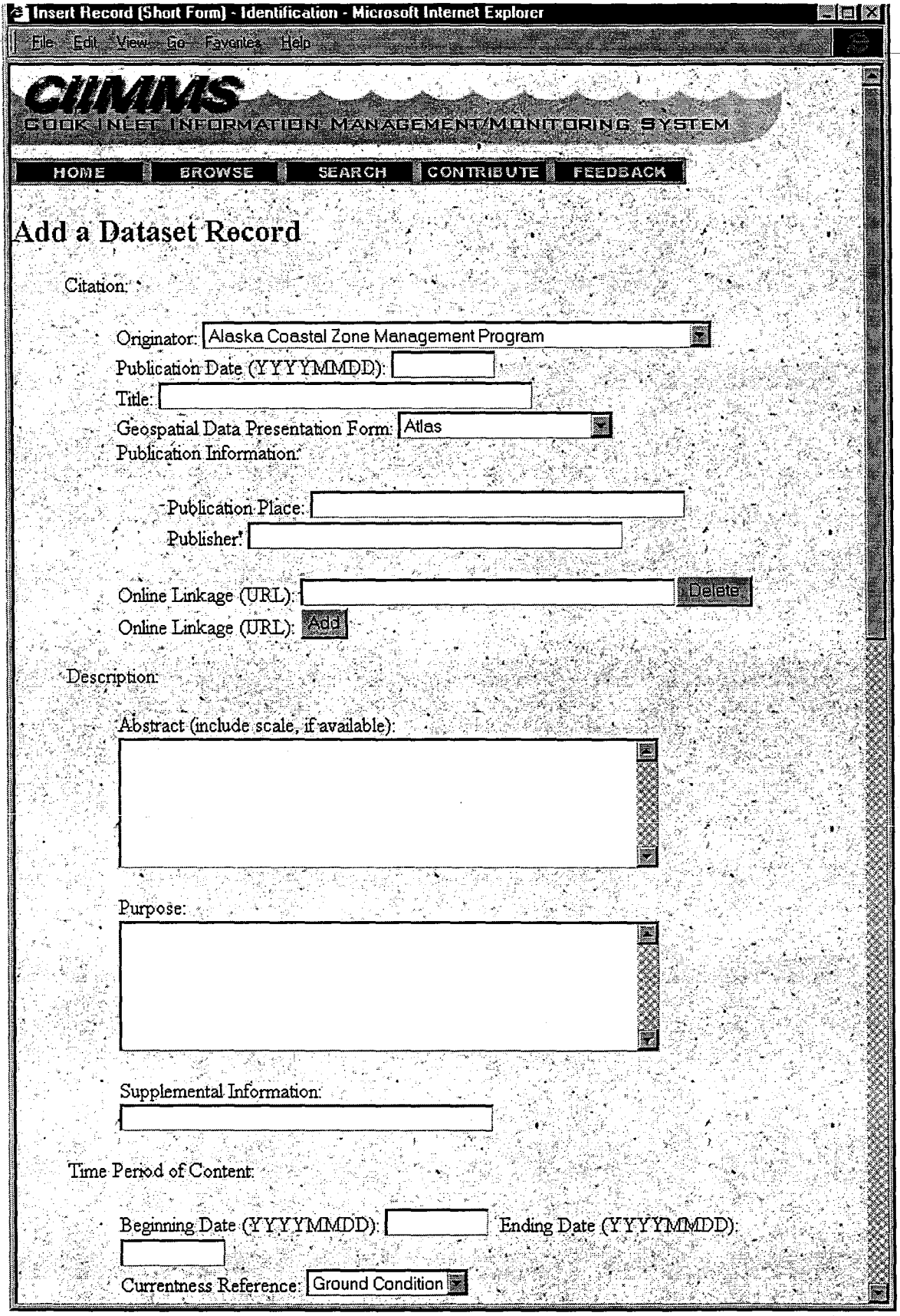
(907) 269-8856
Fax:
(907) 269-8920
Email:
kellyz@dnr.state.ak.us
CIIMMS welcomes requests for additional information, offers to provide new resources, suggestions for the web site or other comments. Please use the following form to do so:
What kind of comment would you like to send?
Request Offer Suggestion Other
About what do you want to comment?
Cook Inlet Watershed
Other:
Enter your comments in the space provided below:
How can we get in touch with you?
Name
E-mail
Tel
FAX
Please contact me as soon as possible regarding this matter.
Submit Comments
Clear Form


CIMMS - Project Profile - Microsoft Internet Explorer
File Edit View Go Favorites Help
CIMMS
COOK INLET INFORMATION MANAGEMENT/MONITORING SYSTEM
Clear Form
Project Title:
Project Contact(s)
Delete
Add
Contact Phone:
Delete
Add
Contact Phone:
Contact Email:
Delete
Add
Contact Email:
Lead Agency
Project Website:
Delete
Add
Part of larger Project:
(if so cite that project)
Project Description
Abstract:
Purpose:
Budget Information:
Dates:
Begin Date:
End Date:
Status:
Complete


Insert Record (Short Form) - Identification - Microsoft Internet Explorer
File Edit View Go Favorites Help
CIMMS
COOK INLET INFORMATION MANAGEMENT/MONITORING SYSTEM
HOME
BROWSE
SEARCH
CONTRIBUTE
FEEDBACK
Add a Dataset Record
Citation:
Originator: Alaska Coastal Zone Management Program
Publication Date (YYYYMMDD):
Title:
Geospatial Data Presentation Form: Atlas
Publication Information:
Publication Place:
Publisher:
Online Linkage (URL):
Delete
Online Linkage (URL):
Add
Description:
Abstract (include scale, if available):
Purpose:
Supplemental Information:
Time Period of Content:
Beginning Date (YYYYMMDD):
Ending Date (YYYYMMDD):
Currentness Reference: Ground Condition

APPENDIX B

BRIEF SUMMARY OF EVALUATOR'S COMMENTS

Types/number of users who responded during CIIMMS "Open House" sessions:

resource manager (9) citizen (6) scientist (8) technical (16) non-technical (4)

Actual Evaluation Questions, followed by summary of responses:

Did the site respond quickly enough to your requests?

- OK-uncertain on some browses when all data had been completed
- No- Timeouts prevented access
- Very quickly-but the college must have a T-1 line
- Unable to evaluate effectively due to timeout problems
- Slow searching
- No
- Yes, very fast on initial browses the database searches timed out a lot
- Yes
- Yes
- Yes
- Yes
- Yes
- Yes-very intuitive
- Yes
- Yes
- Sometimes
- Responded quickly but didn t necessarily provide the information I was looking for
- Yes
- Fairly slow
- Somewhat slow, but used to a fast network and cable modems
- Yes (one J-run error)
- Yes

How could we improve the content or layout of web pages in the following sections: (i.e. word choice, sentence brevity/clarity, help aids, more visual clues, larger text etc.)

SEARCH:

- Glossary of terms would be helpful
- Briefly describe the difference between search and browse
- The result count showed 3 results but could only see the first one, need a stop button on search
- View search page needs previous back next buttons at top and bottom of page
- Couldn t really see any final results-didn t work
- Ability to refine search by data source
- Need to be able to search on multiple works
- Allow ability to perform an advanced search
- Would be nice to have either back or home options from all screens

- Make sure it is not case-sensitive
- Seem to all work very well-timeouts happen fairly fast for ease of use
- Temporal-only want new additions to query by date submitted
- More defined icons for databases
- Slow
- World Cat.-Subsistence search got me Paraguay-not limited to Cook Inlet

BROWSE:

- Couldn t get to several data sources was interested in
- Timeout function adjustable to retries-look forward to next generation
- Nicely set-up
- Didn t work
- Expand amount of sites being searched-keep local sources first-good priority of sites in subjects searched
- No query defined error from Air Quality Monitoring browse ->search
- having the ability to view more than 10 results from a search
- kept receiving search undefined error
- Slow

CONTRIBUTE:

- Good window for Your insights are needed!
- Like the link to You may also use CIIMMS feedback form for more detailed comments
- Provide-suggestions on how to do searches
- Need ability to enter metadata for data (rather than just info related to overall projects)-looking forward to seeing this feature
- Did not evaluate
- Really liked the ability to contribute web links but maybe move entry box to higher page

How could we improve the structure/organization of the section as a whole, in terms of where and how pages link to one another (e.g., too many links? missing links? page A should link to page B. etc.)?

- Seems like the links are numerous-It may not be worth the time to get too organized
- Kenai wetlands connects to the ADEC website-what about other sources like the National Wetlands Inventory program
- Some basic instructions for viewing spatial data-can all images be viewed on screen w/o downloading etc.
- Be good to add a description and link to the Cook Inlet Subarea Contingency Plan and the same for the CI Geographic Response Strategies, the first batch to be completed and reviewed this winter
- Index or categorize links to other sites
- Scope of data/purpose is a little unclear initially

- Keep focus on Cook Inlet

What is your overall impression of the site?

- Wow!
- Thinks it is very good-a few bugs, but that is expected
- Might be time consuming to learn
- Looks like it will be very helpful once the bugs are worked out
- Great
- When finished, should provide a valuable resource
- Difficult to assess site-if all the links worked, it would provide a wealth of info
- Liked the site and will find it useful
- Most interested in the database searches not timing out if the request is too big
- Good start
- Strong preference for geographically based information because that is how decisions are made
- Great idea with potential-still a way to go
- So far, so good
- Think it will be very useful when it is completed
- Has potential
- Looks like it is coming along well-am looking forward to future capabilities
- Like it
- Pretty cool
- Looks good-very promising
- Good
- Looks useful-requires more review on my part
- Good
- Coming along well-good connections to local and state site
- Great
- Excellent

Is there anything we still should include which you did not see in your review of the section?

- Additional websites-link to EPA and COE s databases
- Have readily available link searches
- Statement on the front page that guides a prospective data holder to offer a link to his/her site and/or data
- Water quality, mussels(NOAA s status and trends mussel water study), on-line well logs
- USGS Well inventory
- Sort by area (geographic)
- Identify format examples for websites where a person using your system can view metadata and download real spatial data
- WELIS-Link available to put in ADL/LAS # and get case info
- Q&A-part of Metadata-puts out metadata in an English format
- Breakdown Jeff s map-small view/click to large view
- EPA data on subsistence species and containments

Do you have information or data that you would like to contribute to CIIMMS, and if so, what is it?

- How about an oil & gas facility inventory?
- Minimize use of acronyms-general public might not know what they mean
- Trying to determine what type of data we will be able to contribute
- Kenai Borough has quite a bit of info which could be incorporated
- CIAA conducts annual fishery and water quality monitoring of several drainages throughout the Cook Inlet drainage. Type of information collected include basic water chemistry (D.O., temp., nutrients, metals), salmon smolt and adult migration with age, weight and length measurements, macroinvertebrate populations. We also collect and maintain a limited amount of habitat data.
- EPA and DEC drinking water, well inventories
- DEC UST LUST Data
- Rare Species data
- Lists of tracked species by AK Heritage Program
- More Forestry public documents and maps

APPENDIX C

CIIMMS INFORMATION PRIORITIES

Desired Information Type	Priority		
	Short Term (Weighted Score) (≤1 year)	Medium Term (Weighted Score) (2-5 years)	Long Term (Weighted Score) (≥6 years)
Biological			
Air Quality			
Ambient air quality	55	18	3
Emissions sources	75	15	3
Habitat			
ADFG habitat and species maps	115	3	0
Beetle kill areas / Forest Damage Area	65	24	0
Important habitats for wildlife species	90	12	2
Species range and migration routes	60	30	2
Biological stream types (clear water, tanin, glacier)	50	30	4
Anadromous streams (ADFG)	90	15	1
Critical habitat areas	100	9	1
Nearshore migration corridors	70	27	2
Wetland delineation criteria, types, locations	95	18	0
Population			
Species lists/population/inventories/distributions/trends/harvests	65	27	1
Human pop/density	65	24	1
Aquatic			
Fish distribution and abundance	75	18	0
Salmon escapement./harvest layer	60	24	0
Fish catalog information	70	27	0
Forage fish population and distributions	40	27	3
Fish catch reports	40	27	2
Timing of fishery events (spawning, out-migration)	65	12	3
Marine mammals distribution	65	21	1
Stream invertebrates and habitat	40	30	1
Marine invertebrates	35	21	4
Terrestrial			
Wildlife changes by watershed	45	27	2
Species demographics layer	50	27	2
Human demographics (population density) layer	60	27	2
Brown bear data (coming soon)	20	36	4
Seabirds, bald eagle, sea otter usage areas	75	18	2
Caribou distribution	50	27	3
Seabird – feeding habits, foraging locations	70	18	2
Toxicity			
Water Quality			
Turbidity, Nitrate, Silicon, Dissolved Oxygen, Phosphorus, natural turbidity	50	18	3
Groundwater	50	21	2
Precipitation	60	12	2

Desired Information Type	Priority		
	Short Term (Weighted Score) (≤1 year)	Medium Term (Weighted Score) (2-5 years)	Long Term (Weighted Score) (≥6 years)
Impaired water bodies layer (EPA/DEC)	70	15	1
CIK hydrocarbon analyses	50	24	1
Wells	50	30	0
USGS NAWQA	50	27	0
Storm sediment loads	35	30	2
Fecal coliform	50	24	3
EVOS hydrocarbon data	50	24	1
Vegetation			
Distribution	65	24	0
Forest types	55	30	0
National wetlands inventory	80	15	0
Forest conditions layer	35	30	3
Human Effects			
Infrastructure (& plans)			
Roads and trails	95	3	1
Mining and timber development activities / locations	85	12	1
Human development areas	85	6	1
Oil / gas / drilling development activities / locations	95	6	1
Tanker / shipping routes	75	12	3
Current and planned timber sales	80	12	2
Waterbody designated use	75	12	2
Land Status			
Land use	115	3	0
Land ownership	100	9	0
Permitted users	85	15	0
Existing / planned activities	80	18	0
Land management zones	85	15	1
Timber sales / leases	65	15	2
Real estate development	75	18	2
Harvests	65	18	0
Land	60	12	0
Planning and Cultural			
Tax rolls	25	24	5
Current permits / stipulations	75	12	3
Recreation ops / public access and navigability	35	21	6
Commercial leasing	40	23	3
Developments opportunities	20	33	4
Areas considered for mariculture	40	24	3
Political Boundaries			
Jurisdictions	75	15	3
Federal and state management units	90	15	1
Pollution Sources			
Oil and gas	75	18	0

Desired Information Type	Priority		
	Short Term (Weighted Score) (≤1 year)	Medium Term (Weighted Score) (2-5 years)	Long Term (Weighted Score) (≥6 years)
NPDES discharge sites / data / impacts	75	21	0
Superfund sites	75	15	1
ADEC's contaminated sites	75	15	1
ADEC's facilities	30	24	3
Geophysical and other permits	40	27	2
Storm water permits	45	27	2
Discharge monitoring reports (DMR's)	30	33	2
Land clearing	35	27	2
Integrated Information Systems			
Monitoring stations by agency	50	21	0
Metadata	85	0	0
Historical data	45	18	2
Community information	40	15	5
Bibliography of CI articles, studies, and resource inventory	55	9	3
Coastal management plans	50	27	0
Appropriate agency contacts	90	3	0
Ongoing studies	65	12	0
General watershed information	60	9	2
BLM's Aquatic Resources Information System	45	9	2
Linked video	0	21	6
STORET	30	6	6
Analyses: land-use / wq correl.; biosystems integrity; critical habitats; species-specific timing periods; environmental assessments; habitat value of a site	20	12	1
Physical / Geological Base			
Boundaries			
Coastline layer (incl. "h and 1 shoreline"), coastal morphology	65	12	1
NOAA ESI maps data (shoreline geomorph)	55	15	1
HUCs			
Climatology			
Rainfall	70	12	1
Temperature	60	15	1
"Climate"	50	18	1
Snowpack	50	21	1
Weather	60	12	1
Fog	45	21	1
Winds	60	15	1
Snow	60	15	1
Grids			
Hazards			
Hydrography / Water Quantity			
Stream flow	70	15	0

Desired Information Type	Priority		
	Short Term (Weighted Score) (≤1 year)	Medium Term (Weighted Score) (2-5 years)	Long Term (Weighted Score) (≥6 years)
Baseflow	60	15	0
Hydrology	65	15	0
DNR and USGS QW datasets	40	18	0
Ground water / surface water flow	60	18	1
Geology			
Land Cover			
Land forms	45	15	1
Aerial photographs	45	15	3
Satellite images	35	15	3
CIK 1:63,360 wide imagery	35	6	2
High altitude photography	20	21	3
Terrain (topography, slope, aspect, etc.)	60	9	1
DEMs	25	12	1
DOQs	15	15	3
Oceanography			
Tidal / current data	60	12	0
Bathymetry	50	18	0
Currents and circulation	60	12	0
Plankton	35	21	0
Temperature	40	18	0
Salinity	40	18	0
Updated marine charts	55	15	1
Bottom substrate	40	18	1
Sea ice	40	15	3
Rip tides	45	18	1
Soils			
Soils data layer	55	12	0

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 1999	Proposed FY 2001	PROPOSED FY 2000 TRUSTEE AGENCIES TOTALS ADEC	ADF&G	ADNR	USFS	DOI	NOAA
			$56.4	$27.1	$142.0	$0.0	$13.5	
Personnel	$166.7	$112.7						
Travel	$4.0	$16.6						
Contractual	$130.0	$80.5						
Commodities	$0.2	$0.4						
Equipment	$0.0	$6.3	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$300.9	$216.5				Estimated		
General Administration	$34.1	$22.5				FY 2002		
Project Total	$335.0	$239.0			$0.0	$0.0		
Full-time Equivalents (FTE)	0.0	1.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0			$0.0	$0.0		

Comments:

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Lead Agency: ADEC/ADNR

FORM 2A
MULTI-TRUSTEE
AGENCY
SUMMARY

Prepared:
4/12/00

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 1999	Proposed FY 2001
Personnel	$74.4	$34.8
Travel	$2.9	$9.8
Contractual	$0.0	$6.0
Commodities	$0.2	$0.2
Equipment	$0.0	$0.0
Subtotal	$77.5	$50.8
General Administration	$11.2	$5.6
Project Total	$88.7	$56.4
Full-time Equivalents (FTE)		0.4
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

Comments:

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Environmental Conservation

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
4/12/00

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2001
Jeff Hock	Environmental Specialist IV	20	1.0	7.2		7.2
Russell Kunibe	Analyst Programmer IV	20	4.0	6.9		27.6
TBD						0.0
Nadeem Siddiqui						0.0
TBD						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		5.0	14.1	0.0	
					Personnel Total	$34.8

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2001
					0.0
Travel to Anchorage to work with cooperators and conduct training	0.5	4	19	0.2	5.8
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	1	6	0.2	1.4
Travel to Mat-Su to work with cooperators and conduct training	0.0	1	6	0.2	1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$9.8

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Environmental Conservation

FORM 3B
Personnel
& Travel
DETAIL

Prepared:
4/12/00

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed
Description	FY 2001
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 2001
Office Supplies (paper, toner cartridges, etc. for report preparation)	0.2
	0.0
	0.0
	0.0
Commodities Total	$0.2

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Environmental Conservation

FORM 3B
Contractual & Commodities DETAIL

Prepared:
4/12/00

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2001
			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
			0.0
			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
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		

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Environmental Conservation

FORM 3B
Equipment
DETAIL

Prepared:
4/12/00

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 1999	Proposed FY 2001						
Personnel	$86.0	$43.3						
Travel	$0.7	$6.2						
Contractual	$130.0	$74.5						
Commodities	$0.0	$0.0						
Equipment	$0.0	$6.3	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$216.7	$130.3			Estimated FY 2001	Estimated FY 2002		
General Administration	$22.0	$11.7						
Project Total	$238.7	$142.0						
Full-time Equivalents (FTE)		0.7						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Natural Resources

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
4/12/00

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2001
	Analyst Programmer III	18	5.0	6.0		30.0
	Analyst Programmer IV	20	1.5	5.8		8.7
	Student Intern	12	2.0	2.3		4.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		8.5	14.1	0.0	
					Personnel Total	$43.3

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2001
					0.0
Travel to Homer, Kenai, Soldotna	0.2	8	12	0.2	4.0
Travel to Juneau	0.5	2	6	0.2	2.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$6.2

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Natural Resources

FORM 3B
Personnel
& Travel
DETAIL

Prepared:
4/12/00

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

Contractual Costs:		Proposed
Description		FY 2001
Implement access to distributed data systems		36.0
Consulting Services for development and implementation of Final System Specifications	$36.0	36.0
Develop detailed plan for long term maintenance.	$12.0 (in Oct-Dec 01)	
Develop System documentation	$12.0 (in Oct-Dec 01)	
Develop On line help	$12.0 (in Oct-Dec 01)	
Final Report Production		2.5
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$74.5

Commodities Costs:		Proposed
Description		FY 2001
	Commodities Total	$0.0

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Natural Resources

FORM 3B
Contractual & Commodities DETAIL

Prepared:
4/12/00

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2001
			0.0
			0.0
Additional storage capacity for existing UNIX server	1	1.3	1.3
MetaManager Software	1	5.0	5.0
			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**	$6.3

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		

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Natural Resources

FORM 3B
Equipment
DETAIL

Prepared:
4/12/00

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 1999	Proposed FY 2001
Personnel		$23.4
Travel		$0.0
Contractual		$0.0
Commodities		$0.2
Equipment		$0.0
Subtotal	$0.0	$23.6
General Administration		$3.5
Project Total	$0.0	$27.1
Full-time Equivalents (FTE)		0.4
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

Comments:

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Fish & Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
4/12/00

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2001
	Cartographer	16	3.0	5.0		15.0
	Analyst Programmer	20		6.7		0.0
	Habitat Biologist	18	1.0	6.2		6.2
	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		4.5	22.2	0.0	
					Personnel Total	$23.4

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2001
					0.0
					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

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Fish & Game

FORM 3B
Personnel
& Travel
DETAIL

Prepared:
4/12/00

Contractual Costs:	Proposed FY 2001
Description	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 2001
Description	
Office supplies, digital storage and transfer media, phone, fax, software upgrades	0.2
Commodities Total	$0.2

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Fish & Game

FORM 3B
Contractual & Commodities DETAIL

Prepared:
4/12/00

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2001
			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

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: Alaska Department of Fish & Game

FORM 3B
Equipment
DETAIL

Prepared:
4/12/00

2001 EXXON VALDEZ TRUST COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 1999	Proposed FY 2001
Personnel	$6.3	$0.0
Travel	$0.4	$0.0
Contractual		$0.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$6.7	$0.0
General Administration	$0.9	$0.0
Project Total	$7.6	$0.0
Full-time Equivalents (FTE)		0.0

LONG RANGE FUNDING REQUIREMENTS

		Estimated FY 2001	Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

Other Resources

Comments:

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
4/12/00

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2001
						0.0
Lowell Surring	Wildlife Biologist	12		6.3		0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.0	6.3	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2001
					0.0
					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

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3B
Personnel
& Travel
DETAIL

Prepared:
4/12/00

Contractual Costs:	Proposed FY 2001
Description	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 2001
Description	
Commodities Total	$0.0

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3B
Contractual & Commodities DETAIL

Prepared:
4/12/00

2001 EXXON VALDEZ TRUST COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2001
			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

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US Forest Service

FORM 3B
Equipment
DETAIL

Prepared:
4/12/00

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 1999	Proposed FY 2001
Personnel		$11.2
Travel		$0.6
Contractual		$0.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$11.8
General Administration		$1.7
Project Total	$0.0	$13.5
Full-time Equivalents (FTE)		0.1
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

Comments:

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US DOI, USGS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
4/12/00

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2001
						0.0
Leslie Patrick	Assistant District Chief, Water Resources Division					0.0
	Supervisory Hydrologist	13-6	1.0	11.2		11.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.0	11.2	0.0	
					Personnel Total	$11.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2001
					0.0
Travel to Homer, Kenai, Soldotna	0.2	1	2	0.2	0.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.6

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US DOI, USGS

FORM 3B
Personnel
& Travel
DETAIL

Prepared:
4/12/00

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed FY 2001
Description	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 2001
Description	
Commodities Total	$0.0

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US DOI, USGS

FORM 3B
Contractual & Commodities DETAIL

Prepared:
4/12/00

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2001
			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

FY01

Project Number: 01391
Project Title: Cook Inlet Information Management/Monitoring
Agency: US DOI, USGS

FORM 3B
Equipment
DETAIL

Prepared:
4/12/00

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 1999	Proposed FY 2001						
Personnel		$0.0						
Travel		$0.0						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$0.0			Estimated FY 2001	Estimated FY 2002		
General Administration		$0.0						
Project Total	$0.0	$0.0						
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY00

Project Number:
Project Title:
Agency:

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:
4/12/00

Prince William Sound Food Webs: Structure and Change, Submitted Under the BAA

Project Number:	01393
Restoration Category:	Research
Proposer:	Prince William Sound Science Center Cordova, Alaska
Lead Trustee Agency:	NOAA
Cooperating Agencies:	
Alaska SeaLife Center:	
Duration:	Year 3, 3-year project
Cost FY 01:	$ 122.6 K (exclusive of agency overhead)
Cost FY 01:	$ 131.2K (inclusive of agency overhead)
Geographic Area:	Prince William Sound
Injured Resource/Service:	Fishes and their Injured Consumers, Fisheries: Commercial, Recreational, and Subsistence

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EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT

Recent research has shown that the advective regime connecting the northern Gulf of Alaska (GOA) with Prince William Sound (PWS) may affect recruitment and nutritional processes in Fishes (Kline 1999b). Accordingly, food webs are subject to changes in carbon flow occurring between GOA and PWS. This project seeks to: (1) conduct retrospective analysis of GOA production shifts since EVOS, and (2) address Ecopath model validation data gaps. These analyses will enable us to gain a better understanding of the ecological role of 'regime shift" processes conjectured to be impeding the natural restoration of populations in PWS affected by the EVOS.

INTRODUCTION

Stable isotope ratios of carbon and nitrogen have been shown to serve as effective tracers of energy supply in the Prince William Sound study area (Kline 1997a, 1997b, 1998, 1999b) This is due to (1) the conservative transfer of carbon isotope ratios between the lower tropic levels (phytoplankton to zooplankton to forage fishes, etc.) of Prince William Sound (PWS) and adjacent Gulf of Alaska (GOA) waters up to the top consumers and (2) the naturally occurring gradient in $^{13}C/^{12}C$ productivity generated in the Gulf compared with the Sound. Organisms acquire these isotope ratios in response to the importance of the food in bulk body tissues. Isotope ratio analysis of tissues thus provide insight into both habitat usage and assist in quantifying amounts derived from various areas. Nitrogen isotope ratios, in turn, provide excellent definition of relative trophic level. The heavy isotope of nitrogen is enriched by about 0.3 % with each trophic level and thus can accurately indicate the relative trophic status of species within an ecosystem (Minagawa and Wada 1984, Fry 1988) and is useful for food web model validation (Kline and Pauly 1998, Kline 1999b).

Results from prior work

Juvenile herring and pollock are the dominant pelagic fishes in PWS and both consume zooplankton. Juvenile herring and pollock from PWS shifted in $^{13}C/^{12}C$ content between 1994 and 1995 from which a change in carbon source dependency was inferred (Kline 1999b). Although both species shifted in concert to greater GOA dependency in 1995 than 1994, pollock were consistently less dependent on GOA carbon. Juvenile pollock and herring occupy different levels in the water column, have different schooling behavior, and recruit from the larval stage at different times, effecting access to a different forage-base as confirmed by the data. This difference may not be reflected in the species composition of diet but instead the where and when of the production cycle as integrated into the isotopic signature (Kline 1998), which reflects the assimilated carbon pool of the fish. The greater reliance on GOA-derived carbon in herring may reflect their dependence on carbon generated later in the season during the time when advection of GOA production was nearly the sole carbon source in 1995 as suggested by the data. The concordant shift to greater GOA dependency by both species in 1995, Sound-wide, implied that system-wide bottom-up effects permeated the whole ecosystem due oceanographic processes.

The isotopic gradient between PWS and GOA had a consistent relationship in the 1994-1996 period except for May 1996 when the gradient reversed owing to a large magnitude change in the GOA signature (Kline 1999b). Whereas PWS mean $^{13}C/^{12}C$ values ranged within 1 delta unit, and the difference between PWS and GOA averaged 3 delta units, the GOA mean value shifted in Spring 1996 by 5 delta units. This large shift reflected a change in phytoplankon fractionation during uptake

of CO_2 which varies as a function of growth rate (Laws et al. 1995, Bidigare et al. 1997). Thus the productivity pattern during the spring bloom of 1996 was markedly different from other times. Large fluctuations in productivity in the GOA suggests large inconsistencies in food availability for consumers from year to year if these fluctuations are typical. Thus the question arises : Are fluctuations in GOA spring bloom productivity, as evidenced by changes in $^{13}C/^{12}C$, typical?

The Ecopath modeling group (Pauly and Pimm et al.) Trustee Council sponsored synthesis of known ecological relationships of many of the organisms inhabiting PWS will be used to conduct perturbation experiments to examine EVOS and restoration effects. The utility of this effort will in part be dependent on how realistic their models are. One way to determine if the model is realistic is to compare model predictions with those made using an independent method. Ecopath generates as part of the output, the fractional trophic level for each functional group defined in the model input that can be validated with $^{15}N/^{14}N$ data (Kline and Pauly 1998). Kline and Pauly (1998) validated a preliminary PWS Ecopath model using this novel approach. They used a limited number of functional groups which contrasts with the full Ecopath model which will have ~ 50. In comparison to the preliminary model, the artifact of functional group over-aggregation will be significantly reduced in the full model, enabling a more robust Ecopath validation if $^{15}N/^{14}N$ data for a large proportion of the functional groups were available. See Kline (2000) for the preliminary results of this project.

NEED FOR THE PROJECT

A. Statement of Problem

The Problem: Recovery of EVOS damaged species is uncertain in light of regime shifts

Decadal-scale changes in the production cycles of the subarctic Pacific Ocean have been conjectured to effect population changes in fishes and their zooplankton forage base (Brodeur and Ware 1992, Francis and Hare 1994). A "ring of zooplankton" occurring near the Gulf of Alaska (GOA) continental shelf break appears to undergo dramatic oscillations in abundance over decadal time scales (Brodeur and Ware 1992). This "ring of zooplankton" is driven onto the shelf providing the ecosystem with an important forage base (Cooney 1988, 1993). Natural stable isotope (NSI) data suggested that the transport of zooplankton from the GOA into Prince William Sound (PWS) may provide significant quantities of forage for food webs and may be a good method for detecting changes in biophysical coupling in the PWS region (Kline 1999b).

A recent "regime shift" similar to that seen in the past (Brodeur and Ware 1992, Francis and Hare 1994) is conjectured to be presently occurring in

the North Pacific (Anderson et al. 1996). Post-EVOS recoveries are uncertain since the regime shift may impede population increases. Recently, using NSI, it has been possible to ascertain that GOA primary productivity patterns vary at inter-annual time scales and that GAO production is important to PWS (Kline 1999b). Using retrospective NSI analysis, it may be possible to assess whether fluctuations in primary production took place since EVOS. If so, this could explain the poor recovery of some injured species. Furthermore, fluctuations in the mass balance of carbon postulated to be taking place can be incorporated into applications of the Ecopath model being developed by Trustee Council funding which can also be validated using NSI data (Kline and Pauly 1998).

Need #1: Gulf of Alaska productivity fluctuations - retrospective analysis since EVOS

There is a discontinuity between the start of PWS ecosystem studies in 1994 and the timing of EVOS in 1979. Ecosystem shifts occurring in the GOA since 1989 were thus not incorporated in present studies. To overcome this perspective, retrospective NSI analyses may enable a reconstruction systematic ecological changes occurring since 1989.A retrospective approach is being used by GLOBEC in several projects in the N.E. Pacific as a means of overcoming temporal limitations in our database (U.S. GLOBEC 1996). Fixed tissues such as the protein layer on the exterior of mussels provide a recent record of changes in the isotopic composition of their phytoplankton diet. An opportunistic collection of *Mytilus californianus* from Middleton Island made in September 1997 provides an inexpensive approach to retrospective analysis. Middleton Island's location in the Alaska Current provides an "upstream perspective" on the EVOS area since samples from there will reflect changes in plankton upstream before interaction with PWS-origin carbon is possible.

Need #2: Mass-balance modeling validation data gaps

Kline and Pauly (1998) established the utility of using NSI data to validate the Ecopath mass-balance model (Project 330). This was done with a small number of highly aggregated functional groups. The final model has about 46 functional groups. Of the functional groups listed good isotopic representation was available for about 7 prior to this project. Thus confident model validation could only be performed for a limited selection of the functional groups. therefore this project will analyze additional samples to increase the number of functional groups validated. These and preliminary results are listed in Kline (2000).

B. Rationale/Link to Restoration

Shifts in carbon flow occurring as a result in variations in the physical environment represent fundamental changes in the way the PWS

ecosystem supports commercially important species. The availability of macrozooplankton forage for fishes varies in space and time because of changes in physical processes in PWS. The NSI approach is unique in its ability to integrate time and spatial scales at mesoscale levels. No other technique currently available can generate such results. The natural tracer aspects of the approach emulates artificial tracer experiments without the burden of needing to generate signals or experimental artifacts. Tracking the effect of Gulf carbon inflow on pelagic production that appears to vary between years will be used to resolve the question of how oceanographic process affect fisheries recruitment. Finally, the value of the Ecopath modeling effort funded as restoration tool would be greatly enhanced through a incorporation of a proven model validation concept.

C. Location

Prince William Sound

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The participation of the community and incorporation of local knowledge into regional science efforts was the raison d'être for the PWSSC. The Center has a web page and distributes brochures and newsletters to all PWS communities. Our 1999 building addition includes an area where public presentations are given. Our education program provides a unique community involvement. To further our invovement in the entire community and external governing board is being implemented in 2000. The following are some of the individuals and groups that have been invited to participate: President, Valdez Chamber of Commerce Valdez; Marine Safety Office Cmdr. US Coast Guard Valdez; Mayor, City of Whittier Whittier; President, Chugach Alaska Corporation Anchorage, SeaRiver; President, The Eyak Corporation Cordova; Alaska Dept. of Environmental Conservation, Valdez; U.S. Coast Guard Cmdr., Sweetbrier, Cordova; Herb and Barb Jensen, Cordova; Dave and Kim Erbey, Cordova Air Service, Cordova; Jim and Patty Kallander, Cordova; Sue Aspelund, Executive Director, Cordova District Fishermen United Cordova; Jack Babic, Jr., Cordova; Cal Baker, Cordova District Ranger, Cordova; Bob Baldwin. BP Exploration Shipping; Bob Berceli, Alaska Dept.& of Fish & Game, Cordova; Trish Berg, ARCO Alaska Shipping; Russ Bradley, President, Cordova Chamber of Commerce, Cordova; Pat Carney, BP Exploration Shipping; Dave Cobb, Mayor, City of Valdez, Valdez; Tom Colby, Alaska Tanker Company, Valdez; John Devens, Executive Director, PWS Regional Citizens' Advisory Council, Valdez, Gail Evanoff, President, Chenega Bay Village Council, Chenega Bay; Senator Georgianna Lincoln, State Senate, Alaska State Legislature, Juneau; Bob Henrichs, President, Native Village of Eyak, Cordova; David Janka, Auklet Charter Services, Cordova; Representative John Harris, House District 35, Alaska State Legislature, Juneau; Margy Johnson, Former

Mayor, City of Cordova, Cordova; Tim Joyce, Alaska Dept. of Fish & Game, Cordova; Gary Kompkoff, President, Tatitlek Village Corporation Tatitlek; Carroll Kompkoff, President, The Tatitlek Corporation Cordova; Dune Lankard, Eyak Preservation Council, Cordova; Gerald McCune, President, Cordova District Fishermen United, Cordova; Jody McDowell, President, Prince William Sound Community College, Valdez; Vince Mitchell, SERVS Valdez; Riki Ott, Ph.D.. Copper River Watershed Project, Cordova; Brad Phillips, Phillips Cruises, Anchorage; Steve Ranney, Fishing and Flying, Cordova; Gayle Ranney, Fishing and Flying, Cordova; Ken Roemhildt, Superintendent, North Pacific Processors, Cordova; Jerry Sanger, Charter operator, Whittier; Dan Sharp, Alaska Dept. of Fish & Game, Valdez; Dorothy Shepard, Cordova Coordinator, PWS Community College, Cordova; Stan Stephens, Stan Stephens Charters, Valdez; Paul Swartzbart, Cordova; Chuck Totemoff, President, Chenega Bay Corporation, Anchorage; Bill Webber, Jr., Cordova; Mark Willette, Alaska Dept. of Fish & Game, Cordova; Ed Zeine, Mayor, City of Cordova, Cordova.

Additionally, community involvement and traditional ecological knowledge were incorporated into the sampling. For example, local fishermen provided the T. Kline with the knowledge and opportunity to acquire the *Mytilus californianus* samples.

PROJECT DESIGN

Natural stable isotope abundances reflect (1) trophic level and (2) source of assimilated matter and are thus a proxy for the change in diet. Stable isotope ratios will thus be used as a indicator of production and shifts in predation as tests of hypotheses which are stated below in relation to the stated needs.

A. Hypothesis-based Objectives

The needs described above suggest several hypotheses, listed below, that form the basis for the project objectives.

<u>For Need #1 -- thus Objective #1</u>
$Ho_{1.1}$: The isotopic shift seen in 1995 was a singular anomaly, therefore the GOA $^{13}C/^{12}C$ values in earlier years will be consistent.
$Ha_{1.1}$: If they are different, what is the pattern (if there is one)?
$Ho_{1.2}$: The $^{13}C/^{12}C$ of *Mytilus californianus* = $^{13}C/^{12}C$ of *Neocalanus*. This is expected since both are herbivores.
$Ha_{1.2}$: If they are not equal is the there a systematic difference?

There are three goals to be fulfilled for Objective #2:

1. Reconstruct a $^{13}C/^{12}C$ time-series covering at least the 1989 - 1997 period.

2. Compare the time-series with observed $^{13}C/^{12}C$ changes in 1994-1997 (Fig. 2 plus the additional data-year (1997) currently being generated in project 311).

3. Publication of the results in the open literature.

For Need #2 -- thus Objective #2
$Ho_{2.1}$: Trophic level of each functional group predicted by Ecopath = the trophic level of each functional group predicted by their mean $^{15}N/^{14}N$.
$Ho_{2.2}$: Omnivory index of each functional group predicted by Ecopath = the standard deviation of trophic level of each functional group predicted by individual $^{15}N/^{14}N$ values.

There are three goals to be fulfilled for Objective #2:

1. Provide a better representation of the Ecopath functional groups so as to enhance model validation. Note that only a limited number of functional groups were used in the preliminary model validation (Fig. 3). The goal is to make a substantial improvement.

2. Provide validation data for the more model-sensitive higher trophic levels (D. Pauly, pers. comm.). Much of the predictive power of the Ecopath model is for trophic level 4 and 5 functional groups, therefore validation of these functional groups would provide a robust test of the model.

3. Publication of the PWS Ecopath model validation in the open literature, this would have to be a significant leap over Kline and Pauly (1998) to pass the reviewers, hence goals 1 and 2.

See Kline and Pauly 1998 for a description of the validation method.

Data Gaps

The proposed study will build upon the existing data base; adding new data will fill data gaps and further the construction and tests of conceptual food webs supporting productivity in the greater Prince William Sound area. The goal is to determine the trophic positions and to define the natural history parameters accessible from NSI data in light of the observed declines in their populations. These include changes in trophic level over the lives of pelagic organisms, habitat dependencies, seasonal energetics and trophic dynamics relative to other community organisms. As part of this goal, we will integrate our analytical work with the field and laboratory studies of other investigators looking at food web structure, productivity of lower trophic levels, and provide validation data for assessment of conceptual and quantitative models.

Sampling objectives are listed in relation to needs and their hypotheses. The emphasis will shift among the objectives by fiscal year (these are given proceeding each objective).

B. Objective-based Methods

For Objective 1, Retrospective Analysis Of GOA Production Shifts Since EVOS

FY99-00: Stable isotopic analysis of the outer protein layer (periostracum) on the shells and body tissues of Sea-mussels (*Mytilus californianus*) of varying ages collected at Middleton Island (N= 50 mussels) in September 1997. The periostracum will be analyzed by cutting sections (of 2.0 mg for each analysis) along annular growth rings. Mussels of different age will be used to extract data from various years (as annuli are wider and more distinct at earlier ages) to reconstruct an isotopic time series retracing conditions from 1997 backwards in time to EVOS and earlier. For example a 5 to 10 - year old mussel will resolve well recent years whereas a 10 to-20 year old will resolve years when the mussel was younger. Overlapping years (of periostracum samples) of good age resolution will be used to inter-calibrate mussels while younger mussels will be calibrated against our zooplankton database (Fig. 2). An estimated 250 isotopic analyses (~ n = 10/ mussel) will be required for this task in FY99 (*reduced from 500 in original DPD*). The expected results would consist of an isotopic characterization in GOA isotopic signature from 1989 (possibly earlier) to 1997. The following question will be asked: Did changes of the magnitude seen in 1996 occur in other years? If so, how often. If not, then the 1996 will be considered an anomaly rather than a common occurrence.

For Objective 2, Addressing Ecopath Model Validation Data Gaps

A) Analysis of available samples from the P.I.'s archives and samples from other P.I.'s.

The purpose of this objective is to acquire data most cost-effectively - without additional field sampling. Functional groups identified for additional analyses are noted by the underlined. Since the Ecopath model is centered on data collected from 1994-6 and for which years these samples are from, they are optimal for this purpose.

The methods for calculating trophic level and omnivory index are given in Kline and Pauly 1998 (duplicated in Kline 1999b). The data generated will used in a similar way.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

N/A

SCHEDULE

This schedule reflects project \393 commencement date of 1 April 1999.

A. Measurable Project Tasks for FY01 (October 1, 2000 - September 30, 2001)

Oct. 00 - Jun. 01:	Preparation of last samples (for Objectives 1 & 2) for mass spectrometry
Oct. 00 - Sep. 01:	Mass spectrometry at UAF (~ 6-9 month processing time)
Oct. 00 - Sep. 01:	Process new isotope data

B. Project Milestones and Endpoints

Jun. 2001:	Preparation of samples for mass spectrometry completed
Jan. 2001, 2002:	Attend Annual Restoration Workshop
Dec. 2001:	All data received from mass spec. lab.
Apr. 2002:	Isotope data processed
Apr. 2002:	Data integration and synthesis complete
Oct. 1999 - Sep. 2002:	Preparation for and dissemination of results at EVOS and other symposia
Jan. - Apr. 2001, 2002:	Preparation of reports
Apr. 15, 2002:	Draft final report
Sept. 30, 2002:	Final report

C. Completion Date

September 30, 2002 (Final Report)

PUBLICATIONS AND REPORTS

Kline and Pauly - a greatly augmented sequel to Kline and Pauly (1998) incorporating validation of the model developed in project 330) is planned for 2001-02.

Kline - A paper based on the retrospective analysis is planned for 2001-02.

PROFESSIONAL CONFERENCES

Travel is requested for the P.I. to present results at a national (or when appropriate, international) meeting such as ASLO or AGU and to attend workshops with collaborators. Travel to present project results at national meetings and to participate in collaborative workshops are essential to the project's success.

NORMAL AGENCY MANAGEMENT

N/A

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Collaboration with other EVOS investigators will continue and facilitate relating carbon-source dependency with e.g., somatic energy content (A.J. Paul) and trophic level (D. Pauly and S. Pimm). Other P.I.'s in possession of NSI data for certain functional groups, noted in Table 1 (their names proceeded by "see") will be asked to provide appropriate portions of pertinent data for incorporation into objective #2. Results of analyses will be exchanged at workshops and by telecommunications. Preliminary analysis from the integrated effort will be used to direct retrospective analysis of archived samples. Sampling will be coordinated with other P.I.'s and within the auspices of other biota sampling programs. Pertinent data of each sample (i.e. data on each individual fish will be shared among components). Coordination in relation to specific objectives listed in project design section.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Since approval of funding for this project was delayed until December 1998 and the contract was not completed until 1 April 1999, the project schedule has been reset in time accordingly. It is still planned as a three-year project. The contract for the proposed final year of the project, FY2001, will thus start on 1 April, 2001 and end on 30 March, 2002. A no-cost extension will enable funding to the final report submission on the Trustee Council's 15 April scheduled due date in 2002 and revision by 30 September, 2002.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

T. Kline has been actively involved in stable isotope research since 1985. His has innovated applications of stable isotope analysis in fish ecology with emphasis on salmonid fishes in northern, western, south central and southeast Alaska. His techniques have enabled the quantification of the effect of salmon carcass nutrient input to juvenile sockeye salmon production. This research has been the first to provide direct evidence for the importance of salmon carcasses for juvenile salmon production (Kline et al. 1990) . His stable isotope models also enable the quantification of different sources of production important in salmon ecosystems (Kline et al. 1993). Dr. Kline also led an investigation relating feeding strategies to growth forms in North Slope salmonids (Kline et al. 1998). His on-going efforts include collaborations with ADF&G, the North Slope Borough, and BPX. The results of these projects have been presented in numerous scientific papers as well as in public forums (speaking to local groups and classes). T. Kline initiated project \320I which has been the first comprehensive project using natural stable isotopes in Prince William Sound. Through this project he has developed new models and application of natural stable isotope abundance methods (Kline 1997, Kline and Pauly 1998). He was the first to provide direct evidence of the importance of carbon from the Gulf of Alaska in Prince William Sound (Kline 1997, 1998). The role of Gulf carbon was extended in a second EVOS project \311 which like \320I was completed in 1999.

Kline also has previous experience in aging bivalve mollusks using their annual growth checks (Kline 1983); this of particular relevance for Objective 1.

OTHER KEY PERSONNEL

Fish Biologist: J. Williams. PWSSC. J. Williams received his Masters degree in Fisheries from Texas A&M University in 1995. While earning his degree, he spent one year conducting field research in a remote are of Venezuela, successfully incorporating native fishermen in his survey of reservoir fish populations. His research has been presented in a variety of forums and is currently under review for journal publication. J. Williams is a certified Rescue Diver, Divemaster and has eleven years of diving experience. He has recently become certified as a Scientific Diver, fulfilling American Academy of Underwater Science standards, in the PWSSC Scientific Diving Program. J. Williams is tasked with sample and data processing and data management for this project and will actively contribute to data synthesis.

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2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized *'FY 2000	Proposed FY 2001	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$0.0						
Travel		$0.0						
Contractual	$145.5	$122,605.2						
Commodities		$0.0						
Equipment		$0.0						
Subtotal	$145.5	$122,605.2	Estimated					
General Administration	$2.9	$8,582.4	FY 2002					
Project Total	$148.4	$131,187.6						
Full-time Equivalents (FTE)	1.2	0.9						
			*'Dollar amounts are shown in thousands of dollars.					
Other Resources								
Agency cost exclusive								

FY01

Prepared:

Project Number: 01393
Project Title: Prince William Sound Food Webs: Structure and Change, Submiited Under the BAA
Name: Prince William Sound Science Center
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized *'FY 2000	Proposed FY 2001						
Personnel	$86.4	$76,527.4						
Travel	$3.7	$4,861.0						
Contractual	$25.1	$10,000.0						
Commodities	$2.5	$3,950.0						
Equipment	$3.5	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$121.2	$95,338.4	Estimated FY 2002					
Indirect	$24.2	$27,266.8						
Project Total	$145.5	$122,605.2	$127.7					
Full-time Equivalents (FTE)	1.2	0.9						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY01

Prepared:

Project Number: 01393
Project Title: Prince William Sound Food Webs: Structure and Change, Submiited Under the BAA
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
	T. Kline	Principal Investigator	7.0	8734.6		61,142.2
	J. Williams	Technician	4.0	3846.3		15,385.2
	TBN	Technician	0.0	5385.3		0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	11.0	17966.2	0.0	
					Personnel Total	$76,527.4

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
	National meeting	1000.0	1	6	121.0	1,726.0
	registration and car rental	300.0	1	5	55.0	575.0
	EVOS and collaborative workshops	300.0	2	8	145.0	1,760.0
	car rental	50.0	8	8	50.0	800.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$4,861.0

FY01

Prepared:

Project Number: 01393
Project Title: Prince William Sound Food Webs: Structure and Change, Submiited Under the BAA
Name: Prince William Sound Science Center

FORM 4B
Personnel & Travel DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

Contractual Costs:				Proposed
Description		cost per unit		FY 2000
PWSSC network charge by computer-months	computer months	11	100	1,100.0
Stable Isotope Analysis	number:	200	27	5,400.0
Freeze drier charge	number:	200	3	600.0
photocopying				600.0
shipping				500.0
communications (fax and phone)				800.0
page charges				1,000.0
			Contractual Total	$10,000.0

Commodities Costs:	Proposed
Description	FY 2000
Lab supplies miscl	1,000.0
Lab supplies: chemicals, vials, knives	750.0
Office supplies miscl	600.0
Computer supplies and upgrades	1,000.0
Dyesub, photog. (presentation materials)	600.0
Commodities Total	$3,950.0

FY01

Prepared:

Project Number: 01393
Project Title: Prince William Sound Food Webs: Structure and Change, Submiited Under the BAA
Name: Prince William Sound Science Center

FORM 4B
Contractual & Commodities DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

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	

FY01

Project Number: 01393
Project Title: Prince William Sound Food Webs: Structure and Change, Submiited Under the BAA
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Prepared:

Planning for Long-Term Monitoring in the Nearshore: Designing Studies to Detect Change and Assess Cause

Project Number:	01~~XXX~~ 395
Restoration Category:	Research
Proposer:	Coastal Resources Associates, Inc. NOAA Auke Bay Laboratory U.S. Geological Survey - Alaska Biological Science Center Western EcoSystems Technologies
Lead Trustee Agency:	DOI--USGS
Cooperating Agencies:	NOAA
Alaska SeaLife Center:	No
Duration:	1st year, 2-year project
Cost FY 01:	$210,500
Cost FY 02:	$145,000
Cost FY 03:	None
Cost FY 04:	None
Cost FY 05:	None
Geographic Area:	Gulf of Alaska
Injured Resource/Service:	Intertidal communities, sea otters, harlequin ducks

RECEIVED
APR 14 2000
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT

The goal of this proposal is to produce a draft nearshore monitoring plan that provides a framework for future monitoring that is practical, sensitive, and cost-effective. The process we will use to create this plan will be to formulate hypotheses with respect to potential changes to the nearshore environment, identify questions that must be answered before a design can be developed to address these hypotheses, answer design questions by analyzing existing data or conducting directed field studies, and conduct cost-benefit analyses to identify the most powerful design within funding constraints. The final product will be a draft plan for nearshore monitoring that can be incorporated into the Gulf Ecosystem Monitoring (GEM) plan. Workshops will be held during the course of plan development to seek input from the Trustee Council and stakeholders.

INTRODUCTION

The Gulf Ecosystem Monitoring (GEM) program has five major programmatic goals:

DETECT: Serve as a sentinel (early warning) system by detecting annual and long-term changes in the marine ecosystem, from coastal watersheds to the central gulf;

UNDERSTAND: Identify causes of change in the marine ecosystem, including natural variation, human influences, and their interaction;

PREDICT: Develop the capacity to predict the status and trends of natural resources for use by resource managers and consumers;

INFORM: Provide integrated and synthesized information to the public, resource managers, industry and policy-makers in order for them to respond to changes in natural resources; and

SOLVE: Develop tools, technologies, and information that can help resource managers and regulators improve management of marine resources and address problems that may arise from human activities.

The goal of our proposed study is to develop and refine a design for monitoring the nearshore habitat as part of a future GEM program. It is NOT our intent to initiate such a monitoring program, but rather to identify and answer remaining questions about nearshore systems necessary to develop a cost-effective and sensitive nearshore monitoring program. Planning a 100 -year long-term monitoring effort is no trivial task, and advanced planning will help insure that the program gets started on a path that will persist (and no doubt evolve) over the next century and will provide meaningful insights into the Gulf of Alaska (GOA) ecosystem.

We will design a nearshore monitoring program appropriate for detecting changes that may occur within the nearshore system, with emphasis on intertidal communities. The nearshore is explicitly considered as a part of the Draft GEM program presented by the Trustee Council and is a necessary and useful component of any marine monitoring program within the GOA because:

- It is a unique "triple interface" between air, land, and sea (Peterson 2000) and provides an important link between these systems.
- It is particularly vulnerable to a variety of anthropogenic disturbances on a scale ranging from global climate change (e.g., Barry *et al.* 1995; Sagarin *et al.* 1999) to localized effects of shoreline development (Short and Wyllie-Echeverria 1996).
- Communities in the nearshore are appropriate for cost-effective study because they are accessible, many of the organisms are sessile or of limited mobility, and there is a well-developed understanding of ecological processes that occur there, allowing development of testable hypotheses.

While much of the focus of the draft plan will likely be on the animals and plants that live in the intertidal zone, we will also consider incorporating components of the nearshore subtidal zone for monitoring, as well as larger mobile predators such as sea otters (*Enhydra lutris*) and harlequin ducks (*Histrionicus histrionicus*). These species are nearshore predators that rely upon

intertidal and subtidal resources, are widely distributed throughout the northern GOA, have proven to be important sentinels of the health of nearshore systems, and have a history of ecological research in the GOA that facilitates definition of hypotheses and interpretation of data (Esler *et al.* 2000, Monson *et al.* 2000).

The final product of this study will be a draft plan that can be used as a framework for a cost-effective nearshore component of the more broadly-scoped GEM program. The process we will use to develop this plan will be to identify hypotheses with respect to natural and anthropogenic sources of variation in the nearshore, identify metrics that may be sensitive and powerful tools for addressing these hypotheses, identify specific design questions, address these questions by analyzing existing data or conducting limited field studies, and conduct cost-benefit analyses.

Analyses of data from past Coastal Habitat Studies (Highsmith *et al.* 1996, Hooten and Highsmith 1996, Stekoll *et al.* 1996, Sundberg *et al.* 1996, van Tamlen and Stekoll 1996) and studies conducted by NOAA hazmat (Driskell *et al.* 1996, Ebert and Lees 1996, Houghton *et al.* 1996) that address design issues relating to the specific question of assessing oil spill impacts are currently underway (T.A. Dean and L.L. McDonald, in preparation). While these studies will assist in directing a future monitoring program, questions remain with respect to the design of a more broadly focused GEM monitoring effort that should detect change on a variety of temporal and spatial scales.

The process of refining a draft nearshore monitoring plan will be an interactive one in which the Trustee Council, peer reviewers, and stake holders will have input. We will hold a series of informal workshops conducted at critical stages during the process. As part of the process, we will also identify potential cooperative or interactive agreements with other agencies with existing nearshore monitoring programs (e.g., NOAA National Status and Trends, Prince William Sound and Cook Inlet RCAC) to leverage any work that may eventually be sponsored by the Trustees.

The design of any monitoring program depends in part on the specific objectives of the plan and the funding available. Determining the scope of future nearshore monitoring effort is clearly the responsibility of the Trustee Council. However, in order to provide some bounds for development of a draft design, we have assumed that approximately 10 to 20% of GEM funding will be directed toward monitoring in the nearshore zone.

As a starting point for this process, we developed an initial concept presented as a preliminary nearshore monitoring plan (Appendix A). In brief, the objective of the draft plan is to detect changes within the nearshore system in the GOA and to assign cause to these changes. The focus of the draft plan is on intertidal communities, representative subtidal species, and selected nearshore vertebrate predators. Hypotheses regarding nearshore community response to change will be developed and sampling plans will be designed to test these hypotheses. Our initial concept includes sampling at a series of approximately 10 to 20 sites along the GOA coast between Sitka and Kodiak. Sampling would be conducted within a restricted number of habitat types that are representative of the region or perhaps unique to the region, sensitive to change, and tractable to sample. At each site representative nearshore intertidal and subtidal species

would be enumerated. The focus would be on numerically dominant, keystone , sentinel, indicator or strongly interacting species. At these same sites, the concentrations of potential toxicants (e.g. persistent organic pollutants) in sediments and in the tissue of mussels would be measured. Also, the abundance, and possibly other metrics (e.g., Cytochrome P450 1A levels, age/sex ratios, etc.) of representative nearshore vertebrate predator species (e.g. fishes, sea otters, or harlequin ducks) would be measured at each site. At a subset of these sites that span the geographic range, more intensive monitoring would be done to detect larger-scale changes that may result from climate change or other large-scale events and to elucidate relationships among measured metrics. Included in our initial concept of nearshore monitoring is more intensive sampling at a subset of sites which may include more detailed demographic measures for selected species. The latter will be used to provide an early warning system for detecting change in latitudinal distributions of species and helping to describe processes by which those changes may occur. We present this preliminary draft plan as a logical starting point, based on our experience working in nearshore environments, and recognize that the final plan resulting from this proposed work may or may not resemble this initial concept.

NEED FOR THE PROJECT

A. Statement of Problem

A draft Gulf Ecosystem Monitoring (GEM) program has been developed that will likely serve as a blueprint for future GOA monitoring sponsored by the Trustee Council. The draft GEM program recognizes the value of the nearshore and specifically identifies the need for monitoring this portion of the GOA system. However, few specifics are given as to which parts of the nearshore are to be monitored or how the monitoring will be conducted. As with the development of any program of this scope, the devil is often in the detail, and the success of a nearshore monitoring program will depend on careful planning. This project will provide a framework from which a successful plan can be developed and implemented. It is NOT our intent to initiate such a monitoring program during the life of this project.

B. Rationale/Link to Restoration

The future GEM program will provide a long-term legacy of the EVOS restoration effort. This will assist managers in making reasoned decisions that will lead to long-term efforts to restore and preserve injured resources. Foremost among those injured resources are those in the nearshore zone that this proposal addresses.

C. Location

The final report will be a draft plan for nearshore monitoring to be conducted throughout the Gulf of Alaska. Limited field studies from accessible ports may be initiated to meet focused objectives and test new field procedures.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Community representatives and native villagers will be asked to review the nearshore monitoring program and to participate in workshops.

PROJECT DESIGN

A. Objectives

The objective of the proposed study is to produce a draft nearshore monitoring plan that provides a conceptual framework for cost-effective monitoring of nearshore habitats and the resources that they support.

B. Methods

Overview of the process

The draft plan for nearshore monitoring in GEM will be developed through a series of steps as follows:

1. Develop a preliminary draft plan that identifies hypotheses with respect to potential changes in the nearshore realm, identifies predictive models which are in need of nearshore data, identifies decisions that must be made in designing studies to test these hypotheses, and makes preliminary design decisions based on existing analyses.
2. Identify remaining design questions.
3. Conduct a workshop to present the preliminary draft and plans for addressing remaining questions to the Trustee Council for review. Revise the plan as appropriate.
4. Where possible, address design questions through additional analyses of existing data.
5. Conduct directed, limited field studies to answer design questions that cannot be addressed through analysis of existing data.
6. Based on answers to design questions, refine the draft nearshore monitoring plan and list alternatives that provide a viable means of detecting change and addressing hypotheses.
7. Conduct cost-benefit analyses to select among remaining viable alternatives.
8. Conduct a workshop and present the revised draft plan to the Trustee Council and stake holders for review.
9. Finalize the draft plan, including documentation of how design decisions were made and the final plan was derived.

We will seek input from the EVOS Trustee Council and others at critical stages of the design development (Table 1). First, we will develop a preliminary draft plan and make a tentative list of recommendations, a list of remaining questions, and recommendations for future analyses. These will be presented to the Trustee Council and peer reviewers at a workshop to be held in January 2001 in conjunction with the annual EVOS Trustee meetings. The plan and a list of tasks to be conducted to address remaining questions will be revised, additional analyses and

fieldwork will be conducted, and a revised plan will be presented to the Trustee Council and to stakeholders for public review.

As indicated above, an initial step in the process of developing a draft plan will be to identify remaining design-related questions, and we anticipate that additional analyses and some directed field efforts will be needed to address these questions. For example, power analyses will likely be conducted to determine the sampling effort required to detect a given level of change and additional sampling will likely be required to provide estimates of spatial variation to be used in these analyses. However, specifics as to what kind of analyses and additional field sampling will be required cannot be determined until after the initial design phase is completed. For budgetary purposes, we have estimated the level of effort that will likely be required to do the necessary analysis and sampling. However, specific tasks will only be determined after these questions regarding remaining design issues are identified, and the allocation of effort between analytical and field sampling effort may change as a result.

There has been a substantial sampling effort in the nearshore in Prince William Sound over the past several years, and some sampling in the nearshore habitat was done in the Kenai Peninsula and Kodiak regions as part of the Trustee-sponsored CHIA sampling program. Data from these studies will be used to guide future efforts. However, we have relatively little understanding of the normal range in variation within the nearshore from elsewhere in the Gulf of Alaska. Thus, we anticipate that sampling will be required to provide estimates of spatial variation within these areas. Furthermore, because determination of power is specific to a given sampling design, existing data from Prince William Sound or elsewhere may not be adequate to address all remaining design-related questions. Therefore, in spite of the large stockpile of historical data from Prince William Sound, some additional directed sampling within this region may be required.

Example of the process

The process of developing a monitoring plan will begin by identifying hypotheses regarding changes that may potentially occur in the nearshore zone (Table 2) and by making a list of design-related issues that need to be considered (Table 3). Based on these, a list of potential monitoring options will be made, criteria for evaluation of the options will be developed, and a preliminary evaluation made. For example, in our preliminary draft plan (Appendix A) we recognize that, in order to be cost-effective, a nearshore program will not be able to sample all existing habitats, but will need to focus on representative ones. We have listed the habitats (Table 4) and developed criteria for selection. The criteria include: the distribution of these habitats (whether they occur throughout the GOA and are relatively common), how important they are as resources, how vulnerable they may be to disturbance, and how tractable sampling would be within the habitat. Based on these criteria, high- energy beaches and exposed rocky shores were excluded from further consideration. A list of questions regarding unanswered issues with respect to habitats was then made and means of addressing these questions identified (Table 5).

This process will be repeated for each of the design issues identified and the draft plan will be

revised accordingly. The plan will then be presented to the Trustee Council and peer reviewers, and revised again.

The next step in the process will be to examine existing data or to conduct field studies to address unresolved design issues. We anticipate that most questions can be answered by examining existing data sources. However, it is likely that there will be issues, especially in relation to between-site variability, that will require limited field sampling. With respect to the example for habitat selection outlined above, remaining questions can be addressed by reviewing existing habitat sensitivity index maps for each region and determining the extent to which a given habitat might occur within each GOA region. Based on these new analyses, a modified list of habitats will be made.

It is anticipated that the selection of a final design will depend, in large part, on a cost-benefit analysis. It is likely that there will be insufficient funds to evaluate all of the remaining options, and there will need to be decisions made with respect to the final plan based on costs. The first step in the cost-benefit analysis will be to estimate the cost to sample each metric at a particular site at a given time. We expect that our analyses of existing data will allow us to determine the sampling effort required to obtain a reasonable estimate for each metric within a particular habitat at a site, and that the final cost decisions will rest primarily on which metrics are measured, which habitats are sampled, how many sites are sampled per habitat, and the frequency of sampling. A cost matrix will be developed that will allow us to do 'what if" analyses so that we can evaluate the effect of manipulations in the design to the overall program cost, and evaluate the impact of various trade offs in the design on cost and program effectiveness (e.g., power and sensitivity). For example, we might determine that comparable reductions in cost could be obtained by eliminating surveys of sea otter abundance or by reducing the frequency of sampling of hydrocarbons in mussel tissue from once every other year to once every third year. An evaluation would then need to be made as to the overall value of sea otter abundance *vs.* more frequent tissue hydrocarbon analysis with respect to tests of overall hypotheses regarding change in the nearshore system. It is likely that many of these decisions will be difficult ones and will require reliance on professional judgment as well as hard data. However, the process will allow an objective evaluation of alternatives, will provide documentation of how decisions were made, and will allow easy modifications of decisions as necessary.

The initial cost-benefit analyses will be conducted by the project team and the results presented to the Trustee Council members and stakeholders for review. A plan will be revised based on these reviews and a final plan will be written and presented to the Trustee Council.

The project will be conducted by a team of scientists who have been directly involved in the studies of the nearshore system in Prince William Sound since 1989. The work will be administered jointly by the NOAA Auke Bay Laboratory and by the Biological Resources Division of the U.S. Geological Survey. Thomas Dean, President of Coastal Resources Associates, Inc. will serve as project coordinator. Thomas Dean and Charles O'Clair of the Auke Bay Laboratory will be responsible for invertebrate, algal, and eelgrass portions of the plan. Jeff Short of the Auke Bay Laboratory will be responsible for contaminant and physical/chemical

aspects. Jim Bodkin and Dan Esler of the USGS will be responsible for consideration of nearshore vertebrate predators (nearshore marine mammals and sea birds). Lyman McDonald will provide statistical advice.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This proposal is being submitted by NOAA and USGS, who will fund contracts to Coastal Resources Associates, Inc. and Western EcoSystems Technologies, Inc.

SCHEDULE

A. Measurable Project Tasks for FY 01 (October 1, 2000 - September 30, 2001)

Measurable tasks for FY-01 include:

- Presentation of the preliminary plan to the Trustee Council and reviewers in a January 2001 workshop
- Completion of additional data analysis and field work

B. Project Milestones and Endpoints

Milestones for the project are as follows:

October 1, 2000	Obtain Funding
January 1, 2001	Complete preliminary plan
January 20, 2001	Present preliminary plan to Trustee Council for review
March 31, 2001	Complete revision of plan and define additional analysis and fieldwork required
August 31, 2001	Complete fieldwork and additional data analysis
October 31, 2001	Complete cost-benefit analysis
November 30, 2001	Conduct workshop to present revised plan to the Trustee Council and stakeholders
February 28, 2002	Present final plan to the Trustee Council
March 31, 2002	Submit a manuscript on plan development for review

C. Completion Date

It is anticipated that the project will be completed by April 2002.

PUBLICATIONS AND REPORTS

A final report will be presented to the Trustee Council that outlines the plan for monitoring of nearshore resources as part of GEM.

A manuscript will be prepared entitled "Developing a 100-year monitoring plan for nearshore habitats in coastal Alaska: Processes and decisions." T. A. Dean, J. Bodkin, D. Esler, M. Lindeberg, L. McDonald, C. O'Clair, J. Short, and S. Rice are anticipated authors. It is intended that this manuscript will be submitted for publication to the Journal of Environmental Management or to Ecological Applications.

PROFESSIONAL CONFERENCES

No funding is being requested for attendance at professional conferences in FY01.

NORMAL AGENCY MANAGEMENT

The work proposed here is not part of normal agency management and is related specifically to addressing EVOSTC restoration concerns. No similar work has been conducted, is currently being conducted, or is planned using agency funds.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Under the coordination and integration of restoration effort section, the proposed work relies on analysis of data collected across a number of EVOSTC-funded studies and will require integration and coordination as other potential aspects of the GEM plan are conceived. As described in the introduction, this research relies on incorporation of data from other Trustee sponsored research, including the CHIA, NOAA-HAZMAT and NVP studies. Proposed efforts include use of the results of those studies to aid decisions in designing a cost-effective, sustainable, nearshore monitoring plan. We do not anticipate purchasing equipment under this project and will likely use equipment purchased previously under those EVOSTC projects identified above. Proposed research and data collection and analysis, where necessary, will follow previously established protocols and standards.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

None

PROPOSED PRINCIPAL INVESTIGATORS

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BIOGRAPHICAL SKETCHES FOR PRINCIPAL INVESTIGATORS

Dr. Thomas A. Dean, Ph. D. University of Delaware, is President of the ecological consulting firm Coastal Resources Associates, Inc. (CRA) in Vista, CA. Dr. Dean has over 20 years of experience in the study of nearshore ecosystems, and has authored over 30 publications, including several dealing with impacts of the *Exxon Valdez* oil spill on nearshore plants and animals. He has extensive experience in long-term monitoring studies, and has played a major role in both intertidal and subtidal EVOS investigations since 1989.

Dr. Lyman McDonald, B.S., M.S. Oklahoma State University, Ph.D. Colorado State University, is a Biometrician with 30 years of comprehensive experience in the application of statistical methods to design, conduct, and analyze environmental and laboratory studies. He has designed and managed both large and small environmental impact assessment and monitoring programs.

Dr. Charles E. O'Clair, B.S. in Zoology from the University of Massachusetts, Ph.D. in Fisheries from the University of Washington. He is currently a Fishery Research Biologist with the National Marine Fisheries Service, Auke Bay Laboratory in Juneau, Alaska. He has over 17 peer-reviewed scientific publications. His research experience includes 11 years of damage assessment and restoration process research related to the *Exxon Valdez* Oil Spill. Other research experience includes 15 years of field and laboratory work on the effects of oil pollution and logging practices on marine benthic invertebrates and research on the ecology and behavior of Dungeness, king and Tanner crabs.

James L. Bodkin, Research Wildlife Biologist, and team leader for coastal ecosystem research in Alaska for the Alaska Biological Science Center of USGS, Biological Resources Division. He has over 30 peer-reviewed scientific publications and directs an active coastal marine research program. He has studied and published on sea otter foraging ecology and community structuring since 1988 and has been principal investigator for sea otter survey methods development. He is

currently a co-principal investigator for the Nearshore Predator Project (NVP), and is examining the recovery of sea otters.

Dan Esler, Wildlife Research Biologist with the Alaska Biological Science Center, USGS Biological Resources Division in Anchorage, Alaska. He has conducted waterfowl research in arctic and subarctic regions of Alaska and Russia for the past 11 years. Since 1995 he has served as project leader for harlequin duck and Barrow's goldeneye studies as part of the EVOSTC-sponsored projects. He earned a M.S. from Texas A & M University in 1988 and is currently a doctoral candidate at Oregon State University. He has authored over 20 peer-reviewed journal publications and numerous reports and presentations addressing research and issues in waterbird conservation.

Jeffrey W. Short, B.S. in Biochemistry & Philosophy, M.S. Physical Chemistry from the University of California, Santa Cruz. He has established and managed the hydrocarbon facility at Auke Bay Laboratory since 1989 and has been a principal investigator of EVOS research including the analysis of PAH in seawater, the EVTHD database, and the role of pristane in PWS.

Mandy R. Lindeberg, has been involved in *Exxon Valdez* oil spill research for the last 10 years. Her research includes intensive studies on intertidal invertebrates and seaweeds, mussel populations, and currently she is a co-principal investigator of spot shrimp populations in Prince William Sound. Her responsibilities include quality control of field and laboratory sample processing, data analysis, graphics, and proposal and report preparation.

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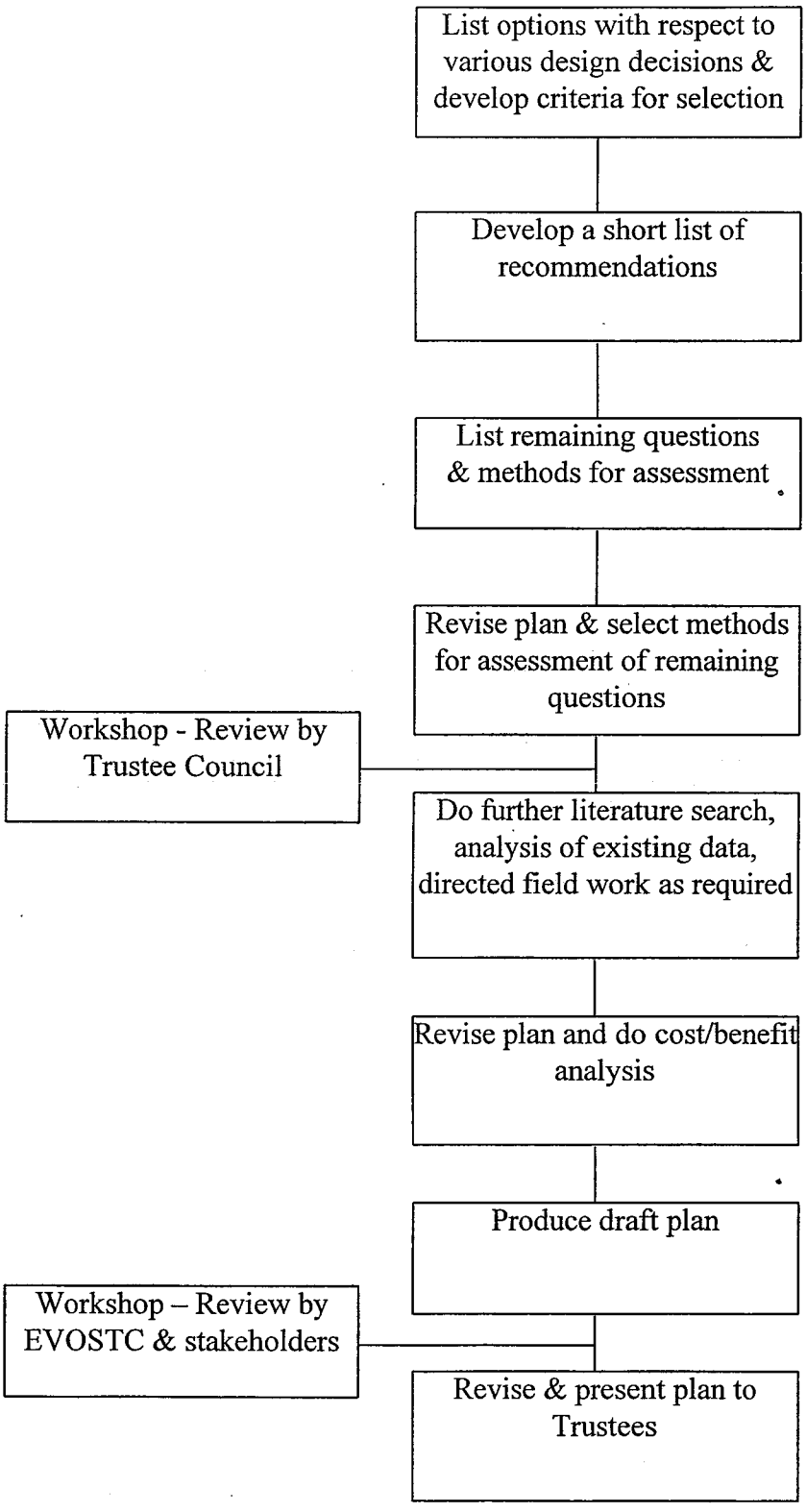
Table 2. Examples of hypotheses for change in nearshore ecosystems in the Gulf of Alaska.

Potential Perturbation	Hypothesized Effects
Anthropogenic	
Climate change (warming)	• Poleward shift in species distribution • Increase in abundance of more southerly distributed species • Increase in frequency of recruitment for more southerly species • Increase in eelgrass production • Decrease in macroalgal production due to UV increase
Introduction of persistent organic pollutants	• Increased toxicant loads in target species • Decreased growth, survival, reproduction in some (especially higher order vertebrate) species
Logging activities	• Reduction in abundance of species, especially those sensitive to increased sedimentation, bark deposition, and organic-enrichment • Distributional or demographic response by birds and mammals
Harbor construction	• Reduction in eelgrass and other species sensitive to increased sedimentation • Increased toxicant (TPAH) in sediments & animals • Reduced abundance of birds & mammals
Increased tourism and recreational use	• Reduction in abundance of intertidal species from increased foot traffic • Distributional response by birds & mammals; potential demographic response
Natural	
PDO cycle (18.6 year sol-lunar cycles)	• Temporary (decade long) poleward or equatorial shift in species distribution associated with maximum/minimums in the temperature cycle • Temporary (decade long) increase in frequency of recruitment during warming for more southerly species

Table 1. Flow diagram indicating the process of determining design elements through an interactive and iterative approach.



	associated with peaks in the temperature cycle • Associated variation in vertebrate abundance/demography
El Nino /La Nina	• Temporary (one to two year) poleward shift in species distribution in warm years, especially among mobile forms like fishes. • Temporary (one to two year) increase in frequency of recruitment for more southerly species in warm years. • Short-term changes in vertebrate demography
Earthquakes	• Local reduction in intertidal species in uplift areas • Reductions in invertebrate-eating birds and mammals

Table 3. Primary categories of design related questions for nearshore monitoring.

Category	Examples of Design Related Questions
Habitat	Which habitat (e.g., sheltered shorelines with mixed cobble-gravel substratum, exposed rocky shores, tidal mud flats, eelgrass beds) are to be sampled?
Site	How many sites are to be sampled, how are they to be distributed, how are sites selected?
Frequency of Sampling	How frequently are different sites or metrics at each site to be sampled?
Metrics	What physical attributes (e.g., temperature, salinity), target species, biological attributes (e.g., diversity, number of species, population density of dominant taxa, P450 expression in individual species) are to be measured at each site?
Specific Collection Methods	What specific methods are to be used to sample a given metric at each site (e.g., for mussel density, how many quadrats and how large a quadrat are to be sampled at each site. How are they to be distributed and selected?)

Table 4. Example of preliminary selection of habitats to be sampled.

Habitat	Distribution	Importance	Vulnerability	Sensitivity	Tractability
Sheltered rocky shores	Widely distributed except from Cape Spencer to PWS & along outer Kenai	Important as habitat	Very - generally in areas of likely disturbance from development	Moderately - changes expected due to climate change	Very – many are easily accessed and relatively inexpensive to sample
Exposed rocky shores	Somewhat restricted to outer coasts of PWS, Kodiak, & SE Alaska	Important as habitat	Moderately - vulnerable to development activities	Moderately – change expected due to climate change	Not very – sites are inaccessible & difficult to sample
Sheltered mixed or soft substrate	Widely distributed in Kodiak, PWS, Cook Inlet, & parts of SE. Rare from PWS to Cape Spencer	Important	Very vulnerable – in areas of likely developments & in areas where toxicants are likely to persist	Very sensitive. Easily disturbed habitats	Very – many accessible by road. Sampling somewhat more costly than sheltered rocky
Exposed sand beaches	Restricted to outer coasts from SE Alaska to PWS	Of less importance	Relatively invulnerable	Not sensitive	Not very – Sites are largely inaccessible
Subtidal rocky (kelp beds)	Widely distributed, especially in SE Alaska, PWS, Lower Cook Inlet, & Kodiak	Important	Moderately vulnerable	Moderately sensitive	Accessible – but may require diving

Table 5. Questions regarding selection of habitats for sampling and methods for answering these.

Question	How to Address
• What habitats are prevalent in the GOA?	Review environmental sensitivity index maps for each region. Discuss with local experts.
• Are there cost-effective means of assessment, especially in subtidal habitats?	Review methods for remote sensing or other cost-effective means of obtaining data.
• Are there historical data of changes within the habitat in question?	Literature review of existing data.
• What is the extent of variation between sites in different portions of GOA?	Literature review and preliminary sampling of selected metrics within the habitat in question, especially at the geographic extremes (Kodiak and Sitka?).

Appendix A.

Long-Term Monitoring in Nearshore Communities: Detecting Change and Assessing Cause (Preliminary Draft)

14 April 2000

Long-Term Monitoring in Nearshore Communities: Detecting Change and Assessing Cause

Summary

The objectives of the nearshore portion of the GEM program are to detect changes that occur within the nearshore in the Gulf of Alaska (GOA), over various scales of time and space, and to estimate relationships between measured variables which help explain those changes. The nearshore-monitoring program will focus on sampling of selected intertidal invertebrates, nearshore subtidal species, and nearshore vertebrate predators at fixed sites within the coastal region between Kodiak and Sitka, Alaska. An explicit objective will be to examine potential interactive effects of the intertidal and nearshore subtidal resources with the larger mobile predators that utilize these resources, to test identified hypotheses concerning these relationships, and to provide data for use in predictive models. Sampling of selected metrics (e.g., the abundance of numerically dominant or keystone species in the intertidal zone, the concentrations of toxicants in the tissue of mussels, and the abundance of selected marine mammals and birds (e.g., sea otters and harlequin ducks) will be conducted at a series of 10 to 20 sites (or 20 to 100 sites if annual visits are not required) within selected habitats in the GOA region. Some of the sites will be located near areas of likely disturbance while others will serve as reference sites in undisturbed areas. This scale of sampling will be conducted primarily to assess moderate scale impacts that may result from human induced perturbations such as harbor development, local contamination, timber harvest, etc. More intensive sampling of the intertidal community will be conducted at a subset of the reference sites (3 to 15 in number depending on the frequency of required visits) in order to assess changes due to large scale perturbations such as global climate change and to elucidate relationships among measured metrics. Directed studies also will be conducted to assess impacts of future accidental disturbances such as an oil spill and to determine the mechanisms of change. Specific hypotheses regarding changes in the environment will be tested. The program will be integrated with existing or future nearshore sampling efforts conducted by other agencies in order to reduce costs, leverage the results, and expand the area covered by the Trustee sponsored work.

Introduction

The goals of the Gulf Ecosystem Monitoring (GEM) program are:

DETECT: Serve as a sentinel (early warning) system by detecting annual and long-term changes in the marine ecosystem, from coastal watersheds to the central gulf;

UNDERSTAND: Identify causes of change in the marine ecosystem, including natural variation, human influences, and their interaction;

PREDICT: Develop the capacity to predict the status and trends of natural resources for use by resource managers and consumers;

INFORM: Provide integrated and synthesized information to the public, resource managers, industry and policy makers in order for them to respond to changes in natural resources; and

SOLVE: Develop tools, technologies, and information that can help resource managers and

regulators improve management of marine resources and address problems that may arise from human activities.

This portion of the GEM plan will focus on the nearshore system. The nearshore community is explicitly identified and emphasized in GEM because:

1. It is a unique "triple interface" between air, land, and the sea (Peterson 2000) and provides an important link between these systems.
2. It is particularly vulnerable to a variety of anthropogenic disturbances on a scale ranging from global climate change (e.g., Barry *et al.* 1995, Sagarin *et al.* 1999) to localized effects of shoreline development (e.g., Short and Wyllie-Echeverria 1996).
3. Communities in the nearshore are relatively inexpensive to study because they are accessible and many of the organisms are sessile or of limited mobility (e.g., Lewis 1996).
4. There is a well-developed understanding of the processes that occur there allowing the development of testable hypotheses (e.g., Connell 1972, Paine 1977, 1994, Estes *et al.* 1998).
5. Unlike most pelagic systems, the components of the nearshore system have a restricted spatial scale. Therefore, nearshore systems are more useful in determining impacts from disturbances that may occur on a small to moderate spatial scale (e.g., Dayton 1971, Sousa 1979, Lewis 1996).
6. The nearshore provides habitat for a variety of economically, recreationally and culturally valuable resources, important to both Alaska coastal residents as well as residents throughout the country.

While much of the focus will be on the animals and plants that live in the intertidal zone, the plan will also examine selected aspects of the nearshore subtidal zone, and will examine potential interactive effects of the intertidal and nearshore subtidal resources with larger mobile predators that utilize these resources. The latter will include representative nearshore vertebrate predators, which have strong ties to intertidal resources. We will select vertebrate predator species such as sea otters and harlequin ducks that are widespread throughout the GOA (Bodkin *et al.* 1994, Robertson and Goudie 1999) and have proven to be important sentinels of the health of nearshore systems (Ballachey *et al.* 1999, Bodkin *et al.* 1999, Esler *et al.* 1999, Monson *et al.* 2000, Esler *et al.* 2000).

The following section lists hypotheses regarding potential change in the nearshore system that are likely to occur within the GOA over the next several decades, gives an overview of how these hypotheses are to be tested, provides a rationale for the selected design and sampling plan, gives a preliminary plan with respect to specifics of sampling, and provides an overview of how results from this plan may be analyzed and interpreted.

Hypotheses regarding changes in the nearshore

Changes in the nearshore community are likely to occur over the next several decades, and these will likely vary with respect to temporal and spatial scales. Both natural and anthropogenic perturbations are probable. For example, long-term (multi-decadal) and widespread changes in intertidal communities are likely to occur as a result of temperature fluctuations caused by naturally occurring cycles as well as anthropogenically induced climate change. More localized and shorter term perturbations may result from events like earthquakes, shoreline development,

point source pollution, or oil spills. The following reviews potential changes that may occur. These hypotheses help to focus the sampling program on strata and species, which will help predict effects of large-scale environmental changes, verify model assumptions, and provide data for predictive models.

Anthropogenically induced climate change There is now little doubt that there have been alterations in climate that result from anthropogenic activities. Those factors important to nearshore ecosystems are as follows:

1. Increase in Atmospheric CO_2 There has been an increase of about 25% in the levels of carbon dioxide in the atmosphere since the onset of the Industrial Revolution and CO_2 levels are expected to triple by the end of this century (Beardall *et al.* 1998). The increase in inorganic carbon will result in a relative increase in photosynthesis among seagrasses compared to benthic algae (Beardall *et al.* 1998, Short and Neckles 1999). Seagrass photosynthesis is limited by available inorganic carbon while macroalgal photosynthesis generally is not (Beardall *et al.* 1998).

2. Increase in Temperature The increase in CO_2 levels is expected to result in an increase in global average temperature by about 3°C by the end of this century (Beardall et. al. 1998). Effects on seawater temperature are expected from this warming. The extent of warming will likely vary depending on location and season. There has been little documented increase in sea surface temperature (Morel *et al.* 1990), but indirect evidence suggests this has occurred. There has been a reduction in ice cover at both poles (Johannessen *et al.* 1995, Overpeck 1996) and studies in nearshore benthic communities in both the Atlantic and Pacific Oceans have observed an influx of more southerly species and a reduction in northerly species associated with temperature increases (Barry *et al.* 1995, Holbrook *et al.* 1997, Southward 1967, Sagarin *et al.* 1999). There is also an expected increase in the frequency of recruitment for more southerly distributed species and a resulting shift in size-distributions toward smaller individuals (Lewis 1996). Distribution shifts in species abundance may be confounded by naturally occurring shifts in temperature (El Nino events and 18.5 year sol-lunar oscillation cycle) (Denny and Paine 1998) or by interactions among species (Davis *et al.* 1998) but are suggestive of changes that may occur due to longer-term increases in temperature.

3. Increase in UV Radiation There is strong evidence indicating a recent increase in the flux of UV-B radiation to the earth's surface due to decreasing ozone concentrations (Crutzen 1992). The effects are most notable in the Antarctic, but also occur in the Arctic. The increase in UV-B can have inhibitory effects on photosynthesis. These effects will probably be most noticeable among subtidal kelps, especially in their early life-stages that are especially susceptible to adverse effects of UV exposure (Beardall *et al.* 1998).

4. Decrease in Salinity The increase in temperature and increase in sea level will also result in a reduction in salinity in nearshore zones, and especially estuarine systems in arctic or subarctic regions that are closely linked with glaciers and larger watersheds. These reductions in salinity have not been widely discussed in the literature. However, these might be expected to have strong effects in coastal Gulf of Alaska. Generally depauperate benthic communities are noted in lower salinity portions of estuaries and communities are especially depauperate in locales where salinities fluctuate widely. Thus, salinity reduction and fluctuations may cause changes in species distributions and abundance in coastal Alaska that rival or exceeds those changes more directly related to increases in

temperature.

Based on the expected changes in the physical environment and the changes observed elsewhere, we hypothesize that the following changes will occur within the nearshore community in response to climate change.

1. A poleward shift in species ranges with an increase in the occurrence of more southerly species, and a reduction in more northerly species near their southern limit of distribution.
2. An increase in the abundance of species near the northern limit of their range and a reduction in abundance of more northerly ones.
3. An increase in the frequency of occurrence of recruitment for more southerly species, and a resulting shift in size distributions toward ones with proportionally more small individuals. This will be especially true for longer-lived species.
4. An increase in the photosynthesis rates for seagrasses (especially *Zostera marina*) and an increase in the relative contribution of seagrasses to nearshore primary production.
5. A reduction in nearshore kelps as a result of increased UV radiation levels.
6. A reduction in the number of species, especially within regions susceptible to increases in fresh water input. More stenohaline species are the most likely to be lost.

The intertidal species most likely to extend their ranges into the northern Gulf of Alaska are those with their northern limit in Sitka or Yakutat (Table 1). Other species with a northern distribution limit in Prince William Sound, Cook Inlet, or Kodiak would be expected to increase in abundance (Table 1) and perhaps experience a reduction in interannual variation in recruitment.

There is some evidence to suggest that these predicted changes may already be taking place. For example, Lindstrom *et al.* (1999) noted northerly range extensions for at least ten species of intertidal macroalgae in Prince William Sound based on collections made between 1990 and 1996. Furthermore, the largest number of species were observed in the warmest year (1993) when several more southerly distributed species flourished. Also, there is evidence for more frequent recruitment in populations of the intertidal limpet, *Tectura persona*. Limpet populations had proportionally more small individuals in 1991 through 1993 (Hooten and Highsmith, unpublished data) than in 1964 (Haven 1971) suggesting more frequent recruitment. It is possible that changes in algal species composition may be due to recently increased sampling effort, and that changes in limpet size distributions may be due to physical differences between sites sampled in 1964 and 1991 through 1993 or to interannual variation in recruitment. Furthermore, comparison of historical data (Haven 1971, Nybakken 1969) to more recent surveys (Highsmith *et al.* 1996, Houghton *et al.* 1996) do not indicate any large-scale changes in species distributions. However, these data are at least suggestive of changes that may, with further study, prove to be a biological consequence of climate change.

Effects of climate change on nearshore vertebrate predators are difficult to predict. Effects could manifest as indirect consequences resulting from changes in community structure (e.g., prey composition or abundance) or as direct effects on physiology, behavior, or habitat suitability. In turn, these may have population-level implications if they result in changes in vital demographic rates (survival and productivity). Population responses to climate change likely will vary by species based on life history and natural history characteristics (Moss 1998) and the degree of flexibility of each species for responding to change (Sutherland 1998). For example, Robertson

and Goudie (1999) speculated that global warming would affect spring run-off, which in turn might have implications for harlequin duck productivity and subsequent population dynamics. We hypothesize that climate change may affect nearshore vertebrate populations in the following ways:

1. Shifts in prey availability will result in corresponding changes in diets of bird and mammal nearshore predators, with potential effects on survival or reproduction.
2. Breeding phenology may change in response to warming trends; productivity may be either enhanced or constrained, depending on timing of reproduction in relation to optimal conditions.
3. For migratory birds, migration routes and phenology may change.
4. Breeding and wintering distributions of migratory birds may change in response to climate change; productivity and survival may be affected and changes in bird community structure may have indirect effects on some species.

El Nino, La Nina and multi-decadal oscillations in temperature Fluctuations in temperature due to El Nino or La Nina events or multi-decadal temperature shifts may also cause changes in the nearshore community. El Nino and La Nina events are short-term (generally one to two year) deviations in temperature (positive and negative respectively) that can result in short-term changes in such biological processes as algal growth and survival (Dayton *et al.* 1998, Dean and Jacobsen 1986) and fish recruitment (Cowen 1985). Multi-decadal changes in temperature (Francis *et al.* 1998, McGowan *et al.* 1998) may also cause changes to nearshore systems including increases in some nearshore fishes and reductions in shrimps (Anderson and Piatt 1999, Robards *et al.* 1999).

The predicted changes that may result from shorter term, naturally occurring increases in temperature are much the same as those predicted to result from temperature increases associated with anthropogenically induced climate change. These would include an increase in the abundance of more southerly species and an increase in the frequency of recruitment for more southerly species. The major differences in nearshore community response is that shifts in distributions or increases in recruitment caused by El Nino or multi-decadal oscillations would be more temporary (perhaps persisting for a decade or so). Furthermore, changes associated with increases in CO_2 concentrations or UV radiation that occur as the result of climate change would not be evident during El Nino events or upswings in multi-decadal temperature oscillations.

Increases in the concentration of toxic chemicals Large-scale changes in the nearshore may also result from increases in concentrations of certain toxic chemicals (Loganathan and Kannan 1991, Stromberg 1997). The GOA may be particularly susceptible to contamination originating in Asia and transported to the eastern Pacific. Changes that are likely to result because of an increase in toxic chemicals include an increase in the concentrations of toxicants in intertidal invertebrates, subsequent uptake by vertebrate predators that rely on these resources for food, and possible reductions in survival or recruitment of the predators.

Moderate scale changes due to development Anthropogenic induced changes that occur over spatial scales ranging from a bay to a region (e.g., Prince William Sound) are also likely. These include impacts associated with 1) increased human use, especially as related to development of infrastructure allowing access to remote locations, 2) harbor construction activities, 3) logging activities, and 4) increased introduction of toxic chemicals associated with shore-side

development. These kinds of perturbations have historically led to a reduction in sensitive species and a general alteration in the species abundance and distribution patterns. For example, trampling of intertidal communities from increased foot traffic is known to have a severe impact on the abundance of some intertidal algae and invertebrates (Keough and Quinn 1998, Brown and Taylor 1999, Schiel and Taylor 1999); harbor development, dredging activities, and an associated reduction in water clarity are thought to be the primary cause for a 90,000 hectare reduction in eelgrass beds worldwide between 1985 and 1995 (Short and Wyllie-Echevarria 1996); harbor construction is known to cause local increases in heavy metals and polycyclic aromatic hydrocarbons (AEC 1986, McMahon 1989); logging activities are known to affect water quality and cause a shift in benthic fauna with the elimination of many sensitive species and an increase in stress tolerant ones (Conlan and Ellis 1979, Pease 1974). Changes to community structure can result in shifts in the diet and distributions of nearshore vertebrates (e.g., Custer and Custer 1996, Wormington and Leach 1992).

Based on these changes that have been observed elsewhere we predict that development activities in the GOA will cause:

1. A reduction in sensitive species (especially some algae) in the intertidal zone as a result of physical disturbance associated with increased foot traffic or physical disturbance due to logging.
2. A reduction in eelgrass, other nearshore plants and sensitive animals, as a result of dredging activities and a general increase in sedimentation associated with shoreline development.
3. An increase in the level of toxicants in nearshore invertebrate species and an increase in exposure to toxicants among nearshore vertebrate predators.
4. An increase in plants and animals that are stress tolerant and respond positively to increased sedimentation and organic enrichment.
5. Changes in nearshore vertebrate distribution, behavior, and physiology, with subsequent effects on survival and productivity.

Introductions of exotic species Changes in the nearshore community are likely to result from the introduction of exotic species. For example, the green crab, *Carcinus maenus*, was introduced into the Pacific Northwest and has moved northward into British Columbia in recent years. Impacts of the crab on the nearshore system are likely (primarily through predation on juvenile Dungeness crabs, oysters and clams) but have not been documented to date (Cohen *et al.* 1995, Grosholz and Ruis 1995, Jamieson *et al.* 1998). The spread of this crab or other introduced species may be exacerbated by increases in temperature associated with climate change or natural cycles in temperature. Except in a few instances (e.g., the one given for the green crab above) the spread of exotic species and their potential impact on nearshore communities are difficult to predict.

Earthquakes Over the next several decades it is extremely likely that there will be changes to the nearshore in the GOA that result from uplift or subsidence due to earthquakes. This is an extremely active geologic area, and there is evidence that multiple seismic events have probably caused changes to the nearshore fauna and flora over the past several decades (Tarr 1912). The 1964 Alaska earthquake caused uplift of up to 7 m in portions of Prince William Sound, causing severe impacts on intertidal communities where uplifting occurred (Baxter 1971, Haven 1971). The earthquake caused mass mortality of almost the entire intertidal assemblage in areas of uplift

that were on the order of 1 m or more (Haven 1971) and resulted in a mortality of roughly one third (11 to 41% depending on species) of the hard shell clams at 12 sites within the uplifted portions of the sound (Baxter 1971). Future earthquakes of comparable tectonic movement, either uplift or subsidence, will likely cause comparable mortality in most intertidal organisms.

Oil spills and other accidental disturbances Accidental disturbances such as oil or other contaminant spills are likely to occur. These events are unpredictable in terms of where and when they will occur and the magnitude and duration of the perturbation.

Unpredictable and relatively undetectable events It is naive to think that we can predict all potential perturbations or even recognize them when they occur. For example, the introduction of pesticides into the nearshore system could result from future efforts to control pests such as the spruce bark beetle and this may have subsequent impacts on nearshore wildlife. Yet an increase in the concentration of pesticides cannot be detected easily without chemical sampling. We can not plan a study to detect impacts of all possible environmental perturbations, but the broad scale coverage that we propose is likely to detect most perturbations that are of regional significance.

Overview - Tests of hypotheses

This preliminary plan calls for testing the above hypotheses regarding large- and moderate-scale changes in the nearshore system by sampling a series of approximately 10 to 20 sites along the GOA coast between Sitka and Kodiak. Sampling will be conducted within a restricted number of habitat types that are representative of the region, sensitive to change, and tractable to sample. At each site, representative nearshore intertidal and subtidal species will be enumerated. The focus will be on species that are numerically dominant, keystone predators, economically important, or of subsistence value. At these same sites, the concentrations of potential toxicants in sediments and in the tissue of mussels will be measured. Also, the abundance or other metrics (e.g., cytochrome P450 1A levels, survival rates, or age and sex ratios) in representative nearshore vertebrate predator species (e.g., sea otters and harlequin ducks) may be measured. At a subset of these sites that span the geographic range, more intensive sampling will be done to detect GOA-wide changes that may occur as a result of climate change or other large-scale events. This intensive sampling will include a more thorough evaluation of species composition (perhaps within selected taxonomic groups) so that changes in latitudinal distributions of species can be detected. More directed studies will be conducted to assess change due to accidental disturbances such as oil spills. Sampling will focus on determining criteria used to select pairs of impact and reference sites in the event of a future spill or other accidental disturbance, and to help satisfy the assumption that these sites would be similar in species composition and relative abundance of species in the absence of the disturbance. Finally, process studies will be conducted as needed to determine mechanisms of change. For example, studies of metals concentrations in the tissue of predators may be required to establish a link between contamination and a reduction in the abundance of the predator.

Monitoring approaches and rationale

Use of a multi-pronged sampling approach The scales of a potential impact, both in terms of space and time, are extremely important in designing a monitoring plan. Disturbances have been classified as "pulse" or "press" (Bender *et al.* 1984) depending on whether they are a one-time event, or a continuing impact. In reality, disturbances generally occur over a broader range represented by a continuum from an event that might occur over the course of hours or days (e.g.,

an earthquake) to one that occurs over multiple decades (global warming). Spatial scales also vary from small (e.g., a single bay in Prince William Sound) to large (Gulf of Alaska wide). The scales of space and time of a perturbation then determine what temporal and spatial sampling scales should be used to detect an effect.

Because it is not practical to address all potential impacts with a single design, we propose an approach that is multi-pronged and focuses on detection of changes due to (1) predictable large-scale events (e.g., climate change), (2) predictable moderate-scale events (e.g., impacts of toxins from land- based development), and (3) unpredictable events (e.g., oil spills). The plan also makes provisions for the study of mechanisms that will help to elucidate causes for observed changes. The elements of the plan are as follows:

1. Monitoring of moderate-scale (local) disturbance events Yearly (or less frequent) monitoring of 10 to 100 sites spread throughout the GOA. It is anticipated that monitoring will be initiated at fewer (on the order of 10 to 20) sites. However, if less than annual visits to sites are judged to be adequate, perhaps after the first few years, then broader spatial coverage may be possible allowing monitoring with better statistical inference to the entire GOA. Less frequent visits will also require less dependence on professional judgment for selection of study sites. These studies will focus on moderate-scale perturbations (e.g., input of toxic substances from land-based development, logging activities, harbor development). Sampling will take place at particular sites selected within an area where potential perturbations may be expected (e.g., in areas of harbor expansion) and at sites that are expected to serve as reference sites in the near future. The exact procedure for selection of study sites is yet to be developed, but when feasible, the sites will be selected by an unbiased procedure, probably systematic, from a list of potentially affected sites and a corresponding unbiased selection from a list of reference sites. Some judgment selection of potentially affected sites and references may be conducted to meet the objectives in this section. While it is often the responsibility of other agencies (e.g., US Fish and Wildlife Service or the US Army Corps of Engineers) to investigate impacts of site-specific events such as the construction of harbors, such programs generally lack a larger scale perspective in which these impacts can be evaluated. Also, there is no monitoring program that evaluates impacts from less site-specific events or from heretofore-undiscovered sources of disturbance. Therefore, long-term monitoring at a number of sites will provide a region-wide framework upon which other monitoring or impact assessment programs can build, and which can be used to identify potential problem "hot spots" or regional trends.

2. Monitoring of large scale (GOA wide) disturbance Yearly (or less frequent) monitoring of select resources within a subset of the reference sites (probably 3 to 10 in number) that represent a broad geographic range representative of gulf-wide conditions. These more intensively sampled sites are designed to detect GOA-wide changes that may result from climate change or other large-scale perturbations.

3. Monitoring of impacts from accidental disturbance Special studies will provide guidelines for selection of pairs of impacted and reference sites to be used in the event of future accidental disturbance such as an oil spill. Although "fixed" sites monitored on a regular basis (as described in No. 1 above) will be of use in this regard; it is anticipated that

evaluations of impacts of unpredictable events such as an oil spill will need to be supplemented by sampling conducted after the event. The proposed work will focus on developing methods to help satisfy the assumption that reference and impact sites would be similar in the absence of an impact.

4. Monitoring of processes Directed process studies will investigate mechanisms of change observed. These will be designed to relate changes in biological systems to changes in the physical or chemical environment and will be the cornerstone of predictions as to future impacts.

Noise reduction through stratification and process studies As stated above, the objectives of the nearshore monitoring plan includes detection of change and study of relationships between variables measured in temporal or spatial studies. However, there are some sources of variation that are of little concern to GEM. For example, there is strong vertical zonation within rocky-intertidal communities, and abutting sand beaches and rocky shore can have almost totally different communities with little or no overlap of species. A strictly random sampling of the intertidal would almost surely result in such a high level of variability among sites (noise) that one would be unable to detect even very large changes that are of concern (the signal). Designing a study to account for noise is critical to detecting a signal.

While the nearshore habitat can still be temporally and spatially variable (e.g., Menconi *et al.* 1999, Underwood and Chapman 1998) much of the spatial variation within the nearshore can be accounted for by using a stratified sampling design. Noise in the system can be greatly reduced by stratifying vertical zone geomorphologic characteristics, or other factors (e.g., Schoch and Dethier 1996, Zacharias *et al.* 1999, Chapman and Underwood 1999). However, while increasing the number of strata adds to the ability to detect change, it also makes it more difficult to make inferences based on observations within a particular strata to the system as a whole. Furthermore, even with a relatively few strata identified, it is often impractical to sample all of them. As a result, choices need to be made regarding the level of noise that is acceptable and the breadth of inference that is desired. In the sampling designs proposed, noise is reduced by stratifying intertidal habitats and then selecting only a few strata for monitoring. Strata that are sensitive indicators of change and representative of broader scale changes within the nearshore community will be selected for study.

Even with stratification some noise will undoubtedly persist. Process studies may identify sources of noise and that information can be incorporated into future stratified designs. In the meantime, the plan will rely on preliminary sampling to identify the current level of noise within the system, and the design will include sufficient replication that an effect of a reasonable size can be detected given the amount of noise expected.

Selection of metrics In addition to selecting the kinds of communities one might study on selected sites (e.g., intertidal communities on protected rocky shores), it is also important to determine what metrics to examine (Underwood and Peterson 1988, Underwood 1994, Jones and Kaly 1996). These include decisions with regard to the species chosen for study as well as the kinds of measurements one will make on those species. The metrics can range from whole community biomass to immune response functions within a particular organ of a particular species. It is clearly not practical to measure everything, and as with the stratified sampling

programs described above, there is often a trade-off between sensitivity and the ability to make broader inferences. In our preliminary monitoring plan, metrics are selected that are sensitive to change at a more community-wide level.

Process studies A well-founded monitoring program will be able to detect changes that may occur, but making reliable predictions of future changes will rely on process studies that describe the mechanisms for change (Peterson 1993). For example, extensive studies of mechanisms of likely impact on the nearshore community adjacent to the proposed San Onofre Nuclear Generating led to the accurate prediction of many (but not all) eventual impacts that occurred after the plant was constructed (Ambrose et. al. 1996). Studies of mechanisms are also important in helping to make judgments about causes of observed effects. For example, detailed mechanistic studies of oil impacts on nearshore vertebrate predator species (Holland-Bartels *et al.* 1999) led to the strongly supported conclusion that the lack of recovery of several nearshore vertebrate species following the *Exxon Valdez* oil spill was inhibited by continued exposure to residual oil. In the case of the GOA monitoring program, it is difficult to predict what types of mechanisms will need to be investigated. These should be more evident as the monitoring program progresses and changes are identified. While no specific recommendations of process studies are included in the plan, it is important that provisos be made to fund process studies to reveal mechanisms responsible for changes that may occur.

Preliminary evaluation of details of sampling

Site selection A site is defined as an area on the order of 10 square kilometers (about the size of Herring Bay). Sampling is to be conducted at sites throughout the GOA to detect moderate to large-scale changes. The number and location of these sites will be determined, but it is anticipated that approximately 10 to 20 sites will be sampled in the initial years and possible expanded over time. The sites will be spread along the GOA coastline from Sitka to Kodiak, and will be concentrated within the Prince William Sound and Cook Inlet regions. We anticipate selection of relatively accessible sites close to Sitka, Yakutat, Cordova, Valdez, Whittier, Seward, Homer, Kasitsna Bay, and Kodiak and sites historically sampled following the EVOS in Prince William Sound. Some sites will be subjectively placed in areas of anticipated development while others will be selected according to some combination of random or systematic procedure, if possible. Many of these represent centers for future development. More intensive sampling will be conducted at a subset of three or four sites in order to detect changes that are anticipated as a result of climate change or other large- scale events. Sites in Sitka, Prince William Sound, and Kodiak will likely be selected for this purpose. The Sitka and Kodiak sites represent geographic range limitations for many species within the intertidal community (Table 1). Changes in species distributions that may result from climate change or other large- scale effects should be most easily detected by examining changes that may occur near these natural boundaries.

A strategy that will be considered to extend the spatial range of inference of the monitoring program is to select a larger number of sites and visit the sites every two years to five years. We will investigate the trade-offs between the expanded spatial coverage and decreased temporal coverage. For example, for detection of most long-term effects and to give broader spatial coverage, it may be advisable to select 60 to 100 sites and schedule visits every three to five

years.

Habitats Sampling within sites will be stratified by habitat type, and only one to three habitats are likely to be sampled. Stratification by habitat will reduce inter- site variation and increase the power to detect changes. The number of habitats sampled will be restricted to reduce costs. Criteria for selection of habitats will include how representative they are of the GOA region, how important they are to the system, how sensitive they are to disturbance, and how tractable they are to sample. Based on a preliminary analysis, we anticipate that habitats characterized by mixed cobble and gravel substrate in the intertidal region, and bordered by eelgrass beds in the nearshore subtidal region will be among the habitats considered.

Frequency of sampling The frequency of sampling will be determined based on preliminary analyses of existing data to determine the range of temporal variation that may be expected within the nearshore community. However, it is anticipated that sampling will be no more frequent than once per year. Also, it is anticipated that different sampling frequencies may be applied to different metrics (see a discussion of metrics below). For example, examination of abundance of several indicator species may be required on an annual basis, but determination of concentrations of toxicants in mussel tissues may be required only once every four years. It is also likely that the frequency of sampling for a given metric may not be constant over time. For example, yearly sampling may be required initially on a subset of the sites, but a better estimate of temporal variation obtained after several years may allow for a reduction in sampling frequency and broader spatial coverage.

Metrics to be sampled The metrics to be sampled at each site will be determined after a preliminary analysis of existing data and an estimation of cost. However, it is anticipated that metrics may include a suite of physical variables (e.g., geomorphologic characteristics, temperature, and salinity), the concentration of toxicants in mussel tissues, abundance of dominant intertidal plants and invertebrates (e.g., *Fucus*, mussels, clams, limpets, and littorines), abundance of invertebrate keystone predators (e.g., sea stars), the size or age distribution of several representative species (e.g., clams), abundance of representative subtidal species (e.g., eelgrass, greenlings, and cod), and the abundance of nearshore vertebrate predators (e.g., sea otters and harlequin ducks). Photographs may also be taken to provide documentation of the distribution of dominant intertidal species at a site. It is also anticipated that a more comprehensive determination of species composition and abundance will be made at a subset of sites. These will be used to examine potential shifts in the distribution of species caused by climate change. More detailed measures of physical oceanography and vertebrate demography may also be conducted at the subset of sites.

Specific sampling methods Sampling of the intertidal community at each site will be within replicated shoreline segments of given habitat types. The number and distribution of segments to be sampled, as well as the specific methods of sampling and the area to be sampled within each segment are to be determined based on analysis of existing data, or on preliminary sampling.

Sampling in anticipation of accidental disturbances Monitoring will also be conducted that focuses on development of methods for selection of paired sites to be chosen in the event of future oil spills and other unpredictable disturbances such as local natural disturbances (e.g., small earthquakes, rapid expansion of a glacier, etc.). We will develop a list of characteristics

that would likely describe a biological community, measure these at a number of systematically selected sites, determine the geomorphologic or physical characteristics that best correlate with the biological community, and determine how similar the community is between site pairs selected on this basis. The focus will be on those habitats and metrics that are most vulnerable to oil spills and have proven to be reliable indicators of impact during the *Exxon Valdez* oil spill. Sampling at fixed sites within a given habitat, as described above, will be used in our initial determination of how to select site pairs. These data will also be used to determine the level of similarity that can be expected in biological communities at geomorphologically similar sites over various spatial scales. Additional sampling will be conducted in other habitats over time. The timing for this sampling, the frequency of sampling, and methods to be employed will depend on sampling designs as determined in the initial fixed-site monitoring program.

Process studies No specific process studies are included in this preliminary plan. However, it is anticipated that process oriented investigations of the mechanisms of change will be a vital part of the long-term monitoring effort. As changes are identified, specific projects are to be funded to address questions regarding the cause. For example, if a regional decline in eelgrass abundance is observed and is associated with harbor construction, then a mechanistic study of harbor construction on reduction in water clarity and associated relationships between water clarity and eelgrass growth may be warranted.

Analyses, interpretation, and the use of results

The results of the monitoring program described above will be used to detect changes from various causes. How this is done, what level of change can be detected, and how quickly change can be detected will depend in large part on the patterns of natural temporal and spatial variation observed. We have some idea of the extent of spatial variability within a site and among sites of close proximity based on data obtained in post oil spill sampling programs funded by the Trustees. However, there are no data that span the entire GOA as we are proposing to collect, and there are no long- term data sets (spanning more than a decade) from which we can determine the extent of this variability.

To illustrate the generalities of the data analysis and interpretation process, we provide a simple hypothetical data set that shows changes the abundance of a representative species (the sea star, *Pisaster ochraceus*) over a 20- year period (Figure 1). The mean of all sites sampled within the GOA as well as the yearly abundance values for a given site impacted by harbor development are shown. Two patterns of change can be observed in this figure. First, there has been a long-term increase in the average abundance of *Pisaster* within the GOA region. This is first detectable in 2018, when the mean abundance increased above the 95% confidence intervals for mean of the previous years estimates. The pattern of long-term change is more clearly evident when data through 2022 are analyzed and indicate a significant increase in *Pisaster* abundance over time (a regression line with slope significantly greater than zero). The northern limit of the distribution of *Pisaster* is the northern Gulf of Alaska and the center of its distribution is in central California. Furthermore, we know from past experimental studies that the feeding efficiency of *Pisaster* increases with increasing temperature (Sanford 1999) and presumably the abundance and production of *Pisaster* are positively correlated with temperature. Thus, we speculate that the long-term increase in *Pisaster* abundance is due to increasing temperature. The causes for increasing temperatures (i.e., anthropogenically induced climate change or naturally occurring

regime shifts) are to be determined from other studies outside the scope of the nearshore program.

The second pattern is that the abundance of *Pisaster* at site x is significantly less than the mean for all GOA sites beginning in 2016. The deviation of site x from the longer-term trend of increasing abundance of *Pisaster* became evident shortly after the construction of a harbor at site x. Based on this, and perhaps on follow-up studies to more directly determine the causes for the relative decline in *Pisaster*, we conclude that the harbor construction had a significant adverse effect on local populations of *Pisaster*. Note that there was no significant reduction of *Pisaster* at site x over time, and the impact of harbor development was evident based only on the relative decrease in abundance observed by comparing the data from site x to that from other GOA sites.

It is likely that changes in the abundance of invertebrates that result from range contraction or expansion as a function of changes in climate, will have cascading effects throughout the nearshore communtity. Some of those cascading changes may be predictable, many will not, but our ability to detect and understand those changes will improve with a sampling design that includes a diversity of taxa, including those that are directly important to humans.

To illustrate how effects of changes in the abundance of *Pisaster* might cascade through the community we can look at both the direct effects on their prey and further, how other predators may be indirectly affected. In the example of increasing *Pisaster* densities and foraging efficiency, we could see a decline in their principal intertidal prey, the blue mussel, *Mytilus trossulus. M. trossulus* also serves as an important prey for harlequin and goldeneye ducks (Vermeer 1982, Goudie and Ankney 1986) and may be an important sea otter food item, particularly for juveniles (Doroff and Bodkin 1994). If increasing *Pisaster* densities reduce mussel densities, we might anticipate cascading adverse effects on other consumers of mussels, such as sea ducks and sea otters. For nearshore resources important to humans, including invertebrates, fishes, birds and mammals, it will be valuable for managers and consumers to understand how large-scale climate change affects nearshore marine communities.

The data sets that will be generated from the long-term monitoring in the nearshore will obviously be much more complex than the examples given. However, the examples illustrate several main points. First, the detection of larger scale trends due to global climate change or to other factors will be detected by comparing changes in means from the entire GOA over long time scales. While we may be able to obtain an indication that changes are occurring over a several year period, the trend can only be confirmed with longer-term sampling. Second, moderate scale changes will be detected by comparing trends at given sites with the means from other sites within the GOA. This is essentially a BACI design with multiple reference sites. Finally, in the examples given, the interpretation of the causes for change is strengthened because they represent confirmation of predicted patterns. The GOA-wide increase in the density of *Pisaster* was predicted as a change that would result from impacts of global warming on species with more southerly distributions, and the decrease in abundance at site x was a predicted impact of harbor development.

Data from the nearshore program are likely to lead directly to management decisions. For example, a severe GOA- wide reduction in sea otters or harlequin ducks may lead to more stringent restrictions on hunting or increased habitat preservation for this species. Other

management decisions may stem from as of yet undetermined process studies. For example, if studies indicate a decline in eelgrass in the vicinity of newly constructed harbors, and process studies suggest that this is the result of a reduction in water clarity, then mitigation may be required and future harbor construction either prohibited or the designs modified to lessen impacts on water clarity.

Leveraging of studies and cooperation with other agencies

The goals of the program we have described overlap those of several agencies that are currently carrying out monitoring programs in the Gulf of Alaska region. For example, Prince William Sound and Cook Inlet RCACs and NOAA Status and Trends Programs are also examining longer- term trends in environmental quality within the region. A cornerstone of the RCAC and Status and Trend programs is 'mussel watch' sampling efforts that estimate levels of contamination in mussel tissue. Our program will coordinate with these existing efforts in order to insure that data are gathered under similar protocols and that the overlap is complementary rather than redundant. For example, we may be able to utilize existing 'mussel watch' sites for our program, thereby extending the historical record of mussel contamination and eliminating much of the future costs of sampling mussel tissue at these sites.

We also anticipate that the data gathered under this program will serve as a framework for more specific impact assessments carried out by other agencies. For example, the US Fish and Wildlife Service (USFWS) is currently concerned about impacts of harbor development in the Whittier and Tatitlek portion of Prince William Sound, and may require that impacts of harbor development on the nearshore environment be investigated. Funding for Trustee studies may be offset by funding from other sources that are required to study harbor development impacts at these sites.

We also anticipate that there will be opportunities to leverage the Trustee funded studies by cooperating with other agencies conducting investigations. For example, USFWS is also concerned about impacts of harbor development at several sites along the western portion of the Alaska Peninsula. Cooperative agreements with the USFWS may lead to the sampling at these sites using a similar protocol to what we will use within the Kodiak to Sitka portion of the GOA arc. Thus, there may be opportunities to extend the monitoring effort over larger geographic areas, at least for some short periods of time. The combining of efforts and the standardization of protocols wherever practical should lead to development of an efficient yet comprehensive nearshore monitoring effort that, in turn, will lead to the preservation of GOA resources.

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Table 1. Estimated distributional ranges for common intertidal invertebrates that are at or near the northern limit in the Gulf of Alaska. (Compiled from O'Clair *et al.* 1996 and O'Clair and O'Clair 1998)

Species with a northern limit in Northern GOA	Current Range
Tectura persona	Alaska to Isla Socorro, Mexico
Ceratostoma foliatum	PWS to San Diego
Calliostoma ligatum	PWS to San Diego
Crassadona gigantea	Kachemak Bay to San Diego
Tresus nuttallii	Kodiak to Baja California
Tresus capax	Shumagin Island to California
Macoma nasuta	Kodiak Island to Baja California
Macoma yoldiformis	Afognak Island to Baja California
Cancer gracilis	PWS to Baja California
Cancer productus	Kodiak Island to Baja California
Lophopanopeus bellus bellus	Resurrection Bay to Point Sur, Ca.
Lophopanopeus bellus diegensis	PWS to San Diego
Hemigrapsus oregonensis	Resurrection Bay to Baja California
Pisaster ochraceus	PWS to Baja California
Orthasterias koehleri	PWS to southern California
Dermasterias imbricata	PWS to Baja California
Amphiodia occidentalis	Kodiak to San Diego
Strongylocentrotus franciscanus	Kodiak to Baja California
Strongylocentrotus purpuratus	Cook Inlet to Baja California
Chelyosoma productum	PWS to southern California

Species with a northern limit in Southern GOA	Current Range
Calliostoma canaliculatum	Sitka to Baja California
Haliotis kamtschatkana	Yakutat to Point Conception
Bittium eshrichtii	Sitka to Baja California
Tegula pulligo	Sitka to Baja California
Corambe pacifica	Sitka to Baja California
Cadlina luteomarginata	Lynn Canal to Baja California
Cadlina modesta	Juneau to La Jolla
Acanthodoris nanaimoensis	Baranof Island to Santa Barbara
Aldisa cooperi	Hogan Island to California
Flabellina verrucosa	Hogan Island to San Juan Islands
Crytolithodes sitchensis	Sitka Alaska to San Diego
Pugettia producta	Chichagof Island to Asuncion Point, Mexico
Hemigrapsus nudus	Yakobi Island, Alaska to Baja California
Pinnixa faba	Prince of Wales Island to Baja California
Pinnixa littoralis	Sitka to Baja California
Asterina miniata	Sitka to Baja California
Pisaster brevispinus	Sitka to San Diego

Distaplia occidentalis	Chichagof Island to San Diego
Aplidium californicum	Chichagof Island to San Diego
Ritterella pulchra	Yakutat to southern California
Ritterella rubra	Chichagof Island to Monterey, CA
Eudistoma ritteri	Chichagof Island to San Diego
Perophora annectens	Chichagof Island to San Diego
Styela yakutatensis	Yakutat to Vancouver Island
Halocynthia igabota	Chichagof Island to Santa Catalina Island

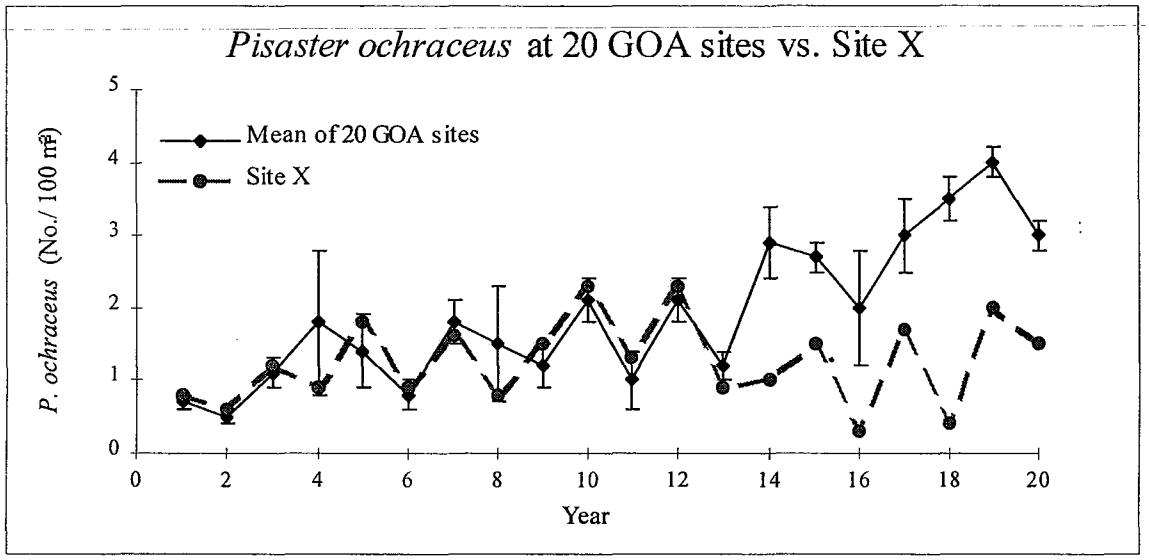

Figure 1. Hypothetical example of possible changes in the abundance of the sea star, *Pisaster ochraceus*, in the Gulf of Alaska over the next twenty years. Means (± 95% confidence intervals) for 20 GOA sites and the average from a single site (site x) are given.

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001	PROPOSED FY 2000 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
							$129.3	$81.2
Personnel	$0.0	$57.7						
Travel	$0.0	$11.9						
Contractual	$0.0	$119.3						
Commodities	$0.0	$4.6						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$193.5			Estimated FY 2002	Estimated FY 2003		
General Administration	$0.0	$17.0						
Project Total	$0.0	$210.5			$145.0	$0.0		
Full-time Equivalents (FTE)	0.0	0.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0			$0.0	$0.0		

Comments:

FY01

Prepared: 4/13/00

Project Number: 01~~XXX~~ 395
Project Title: Planning for Long-Term Monitoring in the Nearshore
Lead Agency: DOI--USGS

FORM 2A
MULTI-TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 1999	Proposed FY 2000	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$20.5						
Travel		$2.1						
Contractual		$96.3						
Commodities		$0.6						
Equipment		$0.0						
Subtotal	$0.0	$119.5			Estimated FY 2002	Estimated FY 2003		
General Administration		$9.8						
Project Total	$0.0	$129.3						
Full-time Equivalents (FTE)		0.3						
			Dollar amounts are shown in thousands of dollars.					
Other Resources								

Comments:

FY01

Prepared: 4/13/00

Project Number: 01xxx
Project Title: Planning for Long-Term Monitoring in the Nearshore
Agency: USGS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FY 2000
Name	Position Description					
						0.0
J. Bodkin	Principal Investigator		1.0	7.2	0.0	7.2
D. Esler	Principal Investigator		1.5	6.8	0.0	10.2
D. Monson	Research biologist		0.5	6.2	0.0	3.1
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.0	20.2	0.0	
					Personnel Total	$20.5

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 2000
Description					
					0.0
					0.0
RT Anchorage Sitka	0.6	1	2	0.2	1.0
RT Anchorage to Portage with vessel					0.2
Fuel for vessel					0.4
Food for Field Days					0.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.1

FY01

Prepared: 4/13/00

Project Number: 01xxx
Project Title: Planning for Long-Term Monitoring in the Nearshore
Agency: USGS

FORM 3B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed FY 2000
Description	
Coastal Resources, Inc. See Linkage to 4AB	58.9
Western Ecosystems Technologies, Inc. See Linkage to 4AB	37.4
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$96.3

Commodities Costs:	Proposed FY 2000
Description	
Misc. field supplies	0.4
Shipping costs	0.2
Commodities Total	$0.6

FY01

Prepared: 4/13/00

Project Number: 01xxx
Project Title: Planning for Long-Term Monitoring in the Nearshore
Agency: USGS

FORM 3B
Contractual & Commodities
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

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
25-ft vessel	1	USGS
skiff	1	USGS
computers, printers, software	3	USGS

FY01

Prepared:

Project Number: 01xxx
Project Title: Planning for Long-Term Monitoring in the Nearshore
Agency: USGS

FORM 3B
Equipment
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$37.2						
Travel		$9.8						
Contractual		$23.0						
Commodities		$4.0						
Equipment		$0.0						
Subtotal	$0.0	$74.0			Estimated FY 2002	Estimated FY 2003		
General Administration		$7.2						
Project Total	$0.0	$81.2						
Full-time Equivalents (FTE)		0.5						
			Dollar amounts are shown in thousands of dollars.					
Other Resources								

Comments:

NOAA's Contribution:
Personnel: 1 month salary for Jeff Short, 1 month's salary for Chuck O'Clair

FY01

Prepared:

Project Number: 01xxx
Project Title: Planning for Long-Term Monitoring in the Nearshore
Agency: NOAA Auke Bay Lab

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
						0.0
Jeff Short	Senior Research Chemist	GS- 13/8	1.0	10.1		10.1
Charles O'Clair	Fisheries Research Biologist	GS- 12/10	1.0	9.2		9.2
Mandy Lindeberg	Fisheries Research Biologist	GS- 9/4	3.5	5.1		17.9
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		5.5	24.4	0.0	
					Personnel Total	$37.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
RT Juneau/ Anchorage Trustee Workshop	0.6	2	2	0.2	1.6
O'Clair, Lindeberg					0.0
RT Juneau/Sitka	0.3	2	2	0.2	1.0
O'Clair, Lindeberg					0.0
RT Juneau/Kodiak	0.8	2	2	0.2	2.0
O'Clair, Lindeberg					0.0
RT Juneau/PWS	0.6	2	2	0.2	1.6
O'Clair, Lindeberg					0.0
RT Juneau/Anchorage planning meeting					0.0
O'Clair, Lindeberg, Short	0.6	3	9	0.2	3.6
					0.0
					0.0
				Travel Total	$9.8

FY01

Prepared:

Project Number: 01xxx
Project Title: Planning for Long-Term Monitoring in the Nearshore
Agency: NOAA--Auke Bay Lab

FORM 3B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:				Proposed FY 2000
Description				
Vessel Charter:	$1500/day	7 days	Sitka field work	10.5
Vessel Charter:	$1500/day	7 days	Kodiak field work	10.5
Sample Processing	1 mo			2.0
When a non-trustee organization is used, the form 4A is required.			**Contractual Total**	$23.0

Commodities Costs:	Proposed FY 2000
Description	
Field Supplies	2.0
Lab Supplies	2.0
Commodities Total	$4.0

FY01

Project Number: 01xxx
Project Title: Planning for Long-Term Monitoring in the Nearshore
Agency: NOAA-Auke Bay Lab

FORM 3B
Contractual & Commodities DETAIL

Prepared:

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

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
computers/printers	3	NOAA
skiff w/ outboard	1	NOAA
cameras	2	NOAA

FY01

Project Number: 01xxx
Project Title: Planning for Long-Term Monitoring in the Nearshore
Agency: NOAA--Auke Bay Lab

FORM 3B
Equipment
DETAIL

Prepared:

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY2000	Proposed FY2001						
Personnel	$0.0	$27.7						
Travel	$0.0	$5.8						
Contractual	$0.0	$0.0						
Commodities	$0.0	$1.6						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$35.1			Estimated FY2002	Estimated FY2003		
Indirect		$23.1						
Project Total	$0.0	$58.2						
Full-time Equivalents (FTE)	0.0	4.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Indirect costs calculated as follows:

Indirect costs = Overhead + General and Administrative costs + Fee

Overhead = 59.5% of personnel costs

G&A = 12.85% of personnel + overhead + other direct (excluding contractual)

FY01

Prepared:3/16/00

Project Number: 00xxx
Project Title: Planning for Long-Term Monitoring in the Nearshore
Name: Coastal Resources Associates, Inc., contract to USGS

FORM 4A
Non-Trustee
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2001
T.A. Dean	Senior Scientist, P.I.		3.0	8.0	0.0	24.0
D. Jung	Field Operations Manager		1.0	3.7	0.0	3.7
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		4.0	11.7	0.0	
					Personnel Total	$27.7

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2001
RT San Diego-Anchorage		0.6	3	10	0.15	3.3
RT San Diego-Sitka		0.6	1	4	0.15	1.2
RT San Diego - Kodiak		0.7	1	4	0.15	1.3
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$5.8

FY01

Prepared 4/11/00

Project Number: 00xxx
Project Title: Planning for Long-Term Monitoring in the Nearshore
Name: Coastal Resources Associates, Inc. contract to USGS

FORM 4B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed
Description	FY 2001
Contractual Total	$0.0

Commodities Costs:	Proposed
Description	FY 2001+K32
Misc. field supplies	0.8
Shipping costs	0.8
Commodities Total	$1.6

FY01

Prepared 4/11/00

Project Number: 00xxx
Project Title: Planning for Long-Term Monitoring in the Nearshore
Name: Coastal Resources Associates, Inc. contract to USGS

FORM 4B
Contractual &
Commodities
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2001
Description			
None			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 of Units
Description	
None	

FY01

Project Number: 00xxx
Project Title: Planning for Long-Term Monitoring in the Nearshore
Name: Coastal Resources Associates, Inc. contract to USGS

FORM 4B
Equipment
DETAIL

Prepared:

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001
Personnel	$0.0	$14.9
Travel	$0.0	$3.8
Contractual	$0.0	$0.0
Commodities	$0.0	$0.0
Equipment	$0.0	$0.0
Subtotal	$0.0	$18.7
Indirect		$18.7
Project Total	$0.0	$37.4
Full-time Equivalents (FTE)	0.0	2.5

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2002	Estimated FY 2003		

Dollar amounts are shown in thousands of dollars.

Comments:

Comments:

FY01

Prepared 4/11/00

Project Number: 00xxx
Project Title: Planning for Longterm Monitoring in the Nearshore
Name: Western Ecosystems Technologies, Inc. contract to USGS

FORM 4A
Non-Trustee
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2001
L. McDonald	Senior Scientist, P.I.		1.0	8.1	0.0	8.1
M. Bourassa	Biometrician I		1.5	4.5	0.0	6.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.5	12.6	0.0	
					Personnel Total	$14.9

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2001
RT Laramie to Anchorage		0.8	3	9	0.15	3.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$3.8

FY01

Prepared 4/11/00

Project Number: 00xxx
Projet Title: Planning for Monitoring in the Nearshore
Name: Western Ecosystems Technologies, Inc. contract to USGS

FORM 4B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed FY 2001
Description	
None	
Contractual Total	$0.0

Commodities Costs:	Proposed FY 2001
Description	
None	
Commodities Total	$0.0

FY01

Prepared 4/11/00

Project Number: 00xxx
Project Title: Planing for Long-Term Monitoring in the Nearshore
Name: Western Ecosystems Technologies, Inc. contract to USGS

FORM 4B
Contractual & Commodities DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2001
Description			
None			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 of Units
Description	
None	

FY01

Prepared 4/11/00

Project Number: 00xxx
Project Title: Planning for Long-Term Monitoring in the Nearshore
Name: Western Ecosystems Technologies, Inc. contract to USGS

FORM 4B
Equipment
DETAIL

Alaska Salmon Shark Assessment Project

RECEIVED
APR 14 2000
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Project Number:	01396
Restoration Category:	Research
Proposer:	Leland B. Hulbert NMFS, Auke Bay Laboratory ABL Project Manager: Dr. Stan Rice NOAA Project Manager: Bruce Wright
Lead Trustee Agency:	NOAA
Cooperating Agencies:	ADF&G, USGS, Prince William Sound Science Center, University of Washington, University of Alaska Fairbanks, Virginia Institute of Marine Science
Alaska Sea Life Center:	no
Duration:	Year 2 of 2 year project
Cost FY 01:	$131,600
Cost FY 02:	$50,000
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pacific salmon, Pacific herring, rockfish, harbor seals

ABSTRACT

This project's objective is to estimate an unbiased estimate of salmon shark abundance and consumption in PWS. This second year focuses on continued field sampling and analyses of salmon shark abundance and consumption from data collected in FY00 with an emphasis on data collected from directed stratified random line transect sampling and from aerial survey counts from the ADF&G and USGS . Satellite tags and data archival tags will be employed to describe salmon shark movements and migrations, and critical feeding areas and depths. This research is needed to assess the role of a predominant shark species as indicators of change in the dynamic ocean climate and trophic structures in PWS and the GOA.

Alaska Salmon Shark Assessment Project

Project Number:	01396
Restoration Category:	Research
Proposer:	Leland B. Hulbert NMFS, Auke Bay Laboratory ABL Project Manager: Dr. Stan Rice NOAA Project Manager: Bruce Wright
Lead Trustee Agency:	NOAA
Cooperating Agencies:	ADF&G, USGS, Prince William Sound Science Center, University of Washington, University of Alaska Fairbanks, Virginia Institute of Marine Science
Alaska Sea Life Center:	no
Duration:	Year 2 of 2 year project
Cost FY 01:	$131,600
Cost FY 02:	$50,000
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pacific salmon, Pacific herring, rockfish, harbor seals

ABSTRACT

This project's objective is to estimate an unbiased estimate of salmon shark abundance and consumption in PWS. This second year focuses on continued field sampling and analyses of salmon shark abundance and consumption from data collected in FY00 with an emphasis on data collected from directed stratified random line transect sampling and from aerial survey counts from the ADF&G and USGS . Satellite tags and data archival tags will be employed to describe salmon shark movements and migrations, and critical feeding areas and depths. This research is needed to assess the role of a predominant shark species as indicators of change in the dynamic ocean climate and trophic structures in PWS and the GOA.

INTRODUCTION

Salmon sharks, *Lamna ditropis,* are one of the predominant shark species in coastal Gulf of Alaska (GOA), yet very little is known of their trends in abundance, demographics, ecology, or seasonal movements. Throughout the 1990's shark sightings and bycatch increased dramatically in Prince William Sound (PWS) and the eastern GOA. In regions of high abundance, salmon sharks have the potential to affect the recovery of oil spill damaged species including wild salmon, herring, and rockfish. This proposed study will continue stratified random line transect sampling surveys developed during the FY00 study that will refine and quantify salmon shark abundance and consumption estimates for PWS. The study will also employ a conventional tagging and sampling effort, aerial survey counts, and the latest advances in marine biotelemetry technology to collect data on salmon shark abundance, surface-to-subsurface abundance ratios, movements and migrations, and seasonal residency in PWS and the eastern GOA.

Conventional tag-and-recapture programs studying sharks are dependent on fisheries for tag recoveries, and as indicators of movement and behavior have limited resolution. Due to the low exploitation rate of salmon sharks in commercial fishing gear, they are inaccessible to most conventional methods of study. Salmon sharks don't readily lend themselves to observation, they are rarely tagged, and consequently, very little is known about their movements and ecology in Alaska waters, particularly in winter. The new technology of satellite telemetry makes it possible for researchers to study effectively for the first time the migratory habits and seasonal residency of large predatory sharks in the GOA and PWS ecosystems. Data collected from conventional tagging efforts and aerial abundance surveys, will be supplemented with data from satellite tags and archival data storage tags. These advanced data-gathering technologies provide state-of-the-art methods to acquire otherwise difficult to collect or unattainable data on the movements and ecology of these apex fish predators in the PWS and GOA ecosystems.

Successful satellite platform transmitter terminal (PTT) applications have been demonstrated recently for monitoring the movements, thermal physiology, feeding habits, and diving behavior of large pelagic vertebrates including pinnipeds (Lowry et al. 1997, Boyd et al. 1998), cetaceans (Mate et al. 1998), tunas (Block et al. 1998), penguins (Culik and Jorquera 1997), and sea turtles (Morreale 1999). The most advanced versions of PTT tags, the pop-up archival transmitting (PAT) tag, and the smart position-only transmitting (SPOT) tag are now commercially available from Wildlife Computers.

PAT tags measure and record temperature, depth, and light intensity for up to one year. Data are collected each minute and summarized into 1 to 24 hour blocks of time. Depth and temperature are measured to within 0.5m and 0.05°C resolution. Time blocks, depth and temperature bin ranges are user-defined. The tag releases (pops-up) from the animal on a predetermined date and time, and transmits archived data and position. Location of the tag after pop-up is calculated from Doppler shift in the transmitted signal as the satellite approaches and then moves away from the PTT. Long-term depth and temperature data from PAT-tagged salmon sharks will be supplemented with shorter duration high resolution archival tags.

Smart position-only transmitting (SPOT) tags, the newest and smallest Argos transmitters, track the geographic location of marine animals. The tag can be also be mounted on salmon shark dorsal fins and transmits only when the tag is out of water. Salmon sharks are well suited to this technology because they frequently swim with their dorsal fin above the surface during summer months (May-September) in PWS. Whether or not the sharks spend time at the surface at other times is not known. The tag is capable of 30,000 transmissions and can be pre-programmed to limit total number of transmissions per day, and transmit only when the satellite is in view. Therefore, tag life can potentially be extended for up to three years (Dr. Roger Hill, Wildlife Computers, 1999 pers. comm.). Geographic location is determined by Doppler shift from two or more transmissions during one satellite pass (~11-15 minutes). Detailed position data from SPOT tagged salmon sharks will make it possible to determine migration routes and seasonal residency patterns in GOA and adjacent waters with a high degree of resolution.

Utilization of the latest advances in remote sensing technology will yield previously inaccessible data that are necessary to study salmon shark movements and ecology. Combined with expanded line transect surveys, aerial surveys counts, conventional tagging efforts, and demographic and diet data the study will yield high quality information on abundance, movements, and predatory interactions of salmon sharks in PWS and the GOA.

Information on abundance indices, seasonal residency patterns, and food habits are needed to describe shark predator-prey interactions. This information will be of great value in evaluating the ecological role of sharks in the PWS and GOA ecosystems. One of the more cost-effective methods of assessing complex interactions of a food web is diet analysis from stomach contents. Cooperation has been established with commercial and sport fishermen and various agencies to acquire shark stomachs and other lethal samples from salmon sharks in PWS and the GOA.

NEED FOR THE PROJECT

A. Statement of the Problem

We are seeing surface aggregations of salmon sharks in numbers never described before. Evidence collected in 1999 indicates that salmon sharks prefer the depth range between 10 and 50m and the majority of sharks in a given area are well below the surface and therefore not visible from above (Hulbert 1999 unpublished data).

Salmon sharks have been poorly documented in most fisheries survey and commercial bycatch data. Information on salmon shark abundance, residency patterns, and seasonal movements in PWS and the GOA does not exist. The project PI has already established cooperative salmon shark sampling, data collection, and data sharing among State and Federal agencies, University researchers, and sport fishing charter operators. A short-term objective of the project is to continue to improve cooperative salmon shark data collection and data sharing opportunities.

The ecological role of sharks in PWS and their affects on the recovery of spill injured resources in the region will vary with temporal and spatial patterns of movement. Large numbers of sharks coupled with high food consumption to support above ambient body temperatures may mean that shark predation may be dominant and directly limit other key species (salmon, herring, rockfish).

Salmon shark body temperature averages 26.5^{0}C (80^{0}F) (Goldman 1999 unpublished data) and may be the highest of any shark. Because of this and the cold waters they inhabit in the GOA, salmon sharks likely possess a high metabolism and high daily ration. Eighteen salmon shark stomachs collected in late July during peak pink salmon returns contained as many sablefish as salmon and also contained herring and rockfish (Hulbert 1999 unpublished data). In regions of high abundance salmon sharks have the potential to affect the recovery of oil spill injured species, including Pacific herring, Pacific salmon, rockfish, and harbor seals. Salmon shark movement patterns are currently unknown.

Sharks inhabiting Alaskan waters have low fecundity, long life, and slow maturation. Because of this, evidence of changes in their abundance may be important indicators of long-term changes in trophic community structure. Once sharks reach a dominance level in the community they are likely to continue that dominance for a long time. Observations suggest salmon sharks may be a dominant predator in PWS now and for some time into the future , but we do not understand the significance of this role to other species and the ecosystem.

B. Rationale

FY '01 field sampling and data analysis is needed to refine our understanding of the role of salmon sharks in the dynamic ocean climate and trophic structures in PWS and the GOA. Continued stratified random line transect sampling following protocol developed in FY00 will support the overall objective of the project; to estimate salmon shark abundance and consumption in PWS. The ecological role of salmon sharks in PWS and their affects on the recovery of spill injured resources in the region will vary with temporal and spatial patterns of movement. Data on salmon shark movement patterns will continue to be collected and analyzed in FY01 to expand our knowledge and understanding of their ecological significance in the region. This research will provide a valuable contribution to the understanding of shark ecology in the GOA and PWS and will document and help quantify predator/prey interactions in the region.

Biomass estimates from analyses of FY01 aerial survey counts collected by ADF&G and USGS will be incorporated in the results. This project will utilize a standardized index ratio of surface-to-subsurface distribution patterns from data collated from FY00 directed studies utilizing satellite and data archival tags, side-scanning sonar, down-sounder, and remote operated vehicle video. The index ratio will be applied to aerial survey counts collected by ADF&G (Dan Sharp), USGS (Jim Bodkin), and UAF (Evelyn Brown) in PWS. Estimates of salmon shark abundance from aerial counts in PWS will be made based on the index ratio of surface-to-subsurface abundance from the FY00 project and methods in Bodkin and Udevitz 1999.

Shark tissue samples will be collected opportunistically in the field during directed sampling efforts and from various agencies for fatty acids, stable isotopes,and genetic analyses. Archived samples from this work are needed to address a potentially larger scope of future work on salmon sharks and other shark species of interest.

The Alaska Salmon Shark Assessment Project will cooperate with Jennifer Nielsens project: Defining Critical Habitat for Marine Reserves: Spatial and Temporal Distribution of Pacific Halibut in the Gulf of Alaska. We will work with Dr. Nielsen to deploy her PAT tags on sharks

and will share all light sensor and depth data recovered from tags. This collaboration will be mutually beneficial to both projects.

University of Washington stock assessment specialist Dr. Vincent Gallucci has volunteered to provide technical consultation on stratified random line transect sampling design and data analyses (Vincent Gallucci 2000 pers. comm.).

C. Location

Prince William Sound and Gulf of Alaska

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

A traditional and local knowledge component will be incorporated in this study. People from Cordova, Chenega, and Tatitlik will be asked to contribute their knowledge of shark temporal abundance and distribution. Community members may also be hired to recover PAT tags if they "pop-up" in PWS.

PROJECT DESIGN

A. Objectives and Hypotheses

The overall objective of the project is to estimate salmon shark abundance and consumption estimates in PWS, with an emphasis on data collected from directed vessel based stratified random line transect sampling, and aerial survey salmon shark counts collected by ADF&G and USGS (analyses will follow methods in Bodkin and Udevitz 1999). Salmon shark abundance, diet, and movement data collected by the project will be useful in assessing their role in the marine ecosystem. All permits necessary for this work are in place.

Primary Hypotheses

H1: Salmon shark abundances have increased in the GOA in response to a shift in the GOA of their primary prey (salmon) to the north as a result of global warming.

H2: Salmon shark abundances have increased in the GOA in response to changes abundance of high trophic level groundfish which are important salmon shark prey.

Project Objectives

1. *Deploy SPOT, PAT, and data archival tags and recover tag data for analyses.

2. Collect salmon shark abundance data from stratified random line transects.

3. Estimate salmon shark abundance by analyzing directed line transect sampling data.

4. Acquire and analyze salmon shark stomachs for diet composition estimates.

5. Estimate whether the salmon shark population in PWS and the GOA is sufficiently large to exert significant influence on any prey fish population.

6. Collect non-lethal tissue samples for stable isotope tracers, send to Dr. Kline for analyses. Stable isotope analyses effectively provide empirical evidence of trophic relationships in marine food webs (Kline 1997).

7. Support salmon shark demographic analyses by collecting, analyzing, and sharing length, weight, sex, and maturity data.

8. Establish and foster improved shark bycatch records, sampling, and data sharing among agencies, universities, and other sources.

***Biotelemetry Data Objectives**:

1. SPOT tags: high resolution salmon shark movement data and seasonal PWS residency patterns

2. PAT tags: large-scale geographic movement data, time spent at depth, ratios of surface-to-subsurface abundance, seasonal PWS residency patterns

3. Archival tags: high resolution (depth and temperature every minute for 11.4 days) salmon shark body temperature, feeding periodicity, foraging depths, time at depth

Objectives in FY02 closeout year:

1. Recover data from SPOT and PAT tags deployed on sharks in FY01

2. Analyze data

3. Complete reports and manuscripts

B. Methods

Directed salmon shark field sampling:

Directed sampling will involve two primary methods: (1) a stratified random sampling for collecting surface and sub-surface salmon shark abundance data from simultaneous visual counts and down sounder and side-scanning sonar data, and (2) opportunistic use of purse seine gear for capturing salmon sharks.

1. Data sampling for calculating unbiased estimates of salmon shark abundance will follow a pre-determined stratified random line transect sampling design. The sampling protocol will measure two variables (a) sharks at the surface (visually), and (b) sharks detected below the

surface (down sounder and side-scanning sonar). Data collated in FY00 will be used to ground-truth real-time sonar and down-sounder target strength and configuration with below-surface salmon shark target verification (ROV video).

2. Aerial abundance survey and statistical methods will follow the methodology for sea otter abundance estimates detailed in Bodkin and Udevitz (1999). Aerial salmon shark counts used in the analysis will be contributed by cooperating aerial survey projects (USGS and ADF&G). Assumptions regarding detection probabilities will be supported by real-time coordination of aerial and vessel-based observations when possible.

3. Captured sharks will be sexed and measured for length, and weight (or estimated from length/girth measurements). After measurement, if a shark is to be released, tissue samples will be collected for stable isotope tracers, fatty acids, and genetic analyses. The shark will then be double tagged with numbered spaghetti tags (Floy) and released. Sharks released with internal data loggers will be tagged on the dorsal fin with fluorescent Jumbo Roto tags (cattle ear tags) to facilitate later detection and recovery. If a shark is killed, vertebrae and stomach content samples will be collected and frozen for subsequent laboratory analysis. Maturity state will be recorded and urogenital tract collected and preserved in 10% formalin solution or frozen: presence or absence of eggs or embryos in females, and male clasper length will be recorded. A maximum of ten salmon sharks will be collected. Permits allowing this are in place.

4. Other noteworthy information will be recorded when possible, including: date and location of capture, water depth and surface temperature, feeding behavior, localized seasonal aggregations, predator-prey interactions, proximity to known prey concentrations (i.e. spawning events etc.).

5. Vertebrae samples will be frozen and sent to Ken Goldman at VIMS for age determination. Mr. Goldman will be producing an age-growth relationship and modeling the demographics of salmon sharks in Gulf of Alaska waters.

6. Stomach contents analyses methods will follow "Standardized diet compositions and trophic levels of sharks" (Cortes 1999).

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Prince William Sound Science Center, via Tom Kline, will perform shark stable isotope analyses.

University of Washington stock assessment specialist Dr. Vincent Gallucci has volunteered to provide technical consultation on data analyses (Vincent Gallucci 2000 pers. comm.). This cooperative effort will enable high quality, low cost analyses of shark abundance indices, demographics, and trophic interactions in PWS and the GOA.

Alaska Department of Fish and Game will provide PWS aerial salmon shark counts, shark spaghetti tags and tagging equipment, and salmon shark stomachs and tissue samples.

United States Geological Survey will provide pop-up (PAT) satellite tags (Jennifer Nielsen 2000 per. comm.) and PWS aerial salmon shark counts (Jim Bodkin 1999 pers. comm.).

University of Alaska Fairbanks (Evelyn Brown) will provide PWS aerial salmon shark counts.

Virginia Institute of Marine Science (Ken Goldman) will provide salmon shark stomachs.

SCHEDULE

A. Measurable Project Tasks (Milestones) for FY 01 (October 1, 2001-September 30, 2002)

October- March 2000:	Organize and analyze data from FY00 field season
January 2001:	Attend annual restoration workshop
April 2001:	Complete collection of pop-up tag data
April 15, 2001:	FY00 Annual report
July 2001:	Conduct field research
August- September 2001	Organize and analyze data from FY01 field season

B. Measurable Tasks (Milestones) for FY 02 closeout

October 2001-March 2002	Analyze data recovered from SPOT and PAT satellite tags in winter/spring 02, complete reports/manuscripts

C. Completion Date

June, 2002

D. Budget Summary

Budget Category:	**FY01**
Personnel	$52.8
Travel	$ 5.6
Contractual	$30.3
Commodities	$24.6
Equipment	$ 0.0
Subtotal	$113.3
General Administration	$ 10
Project Total	$123.3

Budget category:	**FY02 closeout**
Personnel	$35.2
Travel	$ 1.6
Contractual	$ 2.0
Commodities	$ 0.0
Equipment	$ 0.0
Subtotal	$ 38.8
General Administration	$ 5.4
Project Total	$ 44.2

PUBLICATIONS AND REPORTS

An EVOS annual report will describe the results and accomplishments of the research to date.

PROFESSIONAL CONFERENCES

The PI will attend the EVOS Annual Restoration Workshop in the winter of 2001.

NORMAL AGENCY MANAGEMENT

NOAA/NMFS has statutory stewardship for most living marine resources; however, if the oil spill had not occurred, NOAA would not be conducting this project. NOAA/NMFS proposes to make a significant contribution (as stated in the proposed budget) to the operation of this project, making it truly cooperative.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The information gathered in this study may be useful to understanding the lack of recovery of some non-recovering species (harbor seals, Pacific herring).

PRINCIPAL INVESTIGATOR

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E-MAIL: Lee.Hulbert@noaa.gov

Lee has been employed as a Fisheries Research Biologist at the Auke Bay Laboratory, NMFS for 3 years and has two years prior work experience in fisheries biology at ABL. He is currently a CO-PI on the EVOS Alaska Predator Ecosystem Experiment (APEX) Forage Fish Assessment Project (163A). He holds a B.S. degree (1992) in Fisheries Biology from Humboldt State University. He has extensive commercial fishing experience in Prince William Sound and has also fished commercially in Bristol Bay, Togiak, Cook Inlet, the Gulf of Alaska, and S.E. Alaska. He has worked on the APEX Forage Fish Component (163C) for over 3 years. He recently presented a paper at the International Pelagic Shark Workshop in Monterey California titled: Shark Abundance following Regime Shifts in the Gulf of Alaska as an Indicator of Trophic Community Restructuring.

OTHER PERSONNEL

Scott Johnson, NMFS, Auke Bay Laboratory
Fisheries research biologist

Thomas Kline, Jr., Prince William Sound Science Center, Cordova AK
Oceanographer/Fisheries ecologist

Scott Meyer, ADF&G, Homer AK
Sport fisheries biologist, manages port sampling program

LITERATURE CITED

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Mate, B.R., R. Gisiner, and J. Mobley. 1998. Local and migratory movements of Hawaiian humpback whales tracked by satellite telemetry. Canadian Journal of Zoology/Review Canadien de Zoologie, vol. 76, no. 5, pp. 863-868.

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PERSONAL COMMUNICATIONS

Bodkin, James: USGS, Alaska Biological Science Center, Anchorage

Brown, Evelyn: UAF, Fairbanks, (907) 474-(5801) or 7938, ebrown@ims.uaf.edu

Goldman, Ken: VIMS, (804) 684-7556, keng@vims.edu

Hill, Roger: Wildlife Computers, Redmond, WA, (425) 881-3048, tags@wildlifecomputers.com

Kline, Thomas: PWSSC, Cordova, (907) 424-5800

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FFY 2000	Proposed FFY 2001	LONG RANGE FUNDING REQUIREMENTS					
Personnel	$26.4	$60.0						
Travel	$4.0	$5.6						
Contractual	$25.3	$30.3						
Commodities	$24.6	$24.6						
Equipment	$0.0	$0.0						
Subtotal	$80.3	$120.5	Estimated FFY 2002	Estimated FFY 2003				
General Administration	$5.7	$11.1						
Project Total	$86.0	$131.6	$50.0	$0.0				
Full-time Equivalents (FTE)	0.5	1.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: The second year of the Alaska Salmon Shark Assessment Project focuses on continued field sampling and analyses of salmon shark abundance and consumption data following protocol developed from results of FY00 field work.

NOAA contribution: Scott Johnson, Fishery Biologist 1mo @ 8.K

Prepared: 4/11/00

2001

Project Number: 01396
Project Title: Alaska Salmon Shark Assessment Project
Agency: NOAA

FORM 3A
AGENCY
PROJECT
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FFY 2001
Name	Position Description					
L. Hulbert	PI	GS9/3	12.0	5,004		60.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Subtotal			12.0	5,004	0	
					Personnel Total	$60.0

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FFY 2001
Description					
Juneau to Cordova (directed salmon shark survey)	374	1	13	225	2.0
Juneau to Cordova (Scott Johnson)	374	1	4	225	1.0
Homer to Cordova (Scott Meyers, ADF&G invitational Trtavel)	100	1	13	150	1.0
RT Juneau to Anchorage for EVOS Annual Meeting	450	1	5	225	1.6
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.6

2001

Prepared: 4/11/00

Project Number: 01396
Project Title: Alaska Salmon Shark Assessment Project
Agency: NOAA

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 2001
vessel charter (11 days at $1,575/day)	17.3
fuel charges for vessel	2.0
shipping	2.0
ARGOS platform ($350/tagx4 PAT tags plus SPOT tag charges= $1.5K-5.0K)	3.0
seine net repair	1.0
USFWS aerial survey data analysis ($3.0K-$5.0K)	5.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$30.3

Commodities Costs:	Proposed
Description	FFY 2001
Wildlife Computers SPOT tag ($2.5K per tag x 6 tags)	10.0
Wildlife Computers PAT tag ($4.0k per tag x 3 tags)	12.0
Star-Oddi Temperature-Depth Recorders ($260 x 10 tags)	2.6
Commodities Total	$24.6

2001

Prepared: 4/11/00

Project Number: 01396
Project Title: Alaska Salmon Shark Assessment Project
Agency: NOAA

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 2001
			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
ROV		NOAA
scale		NOAA
sonar		NOAA
purse seine		ADFG

2001

Prepared: 4/11/00

Project Number: 01396
Project Title: Alaska Salmon Shark Assessment Project
Agency: NOAA

FORM 3B
Equipment
DETAIL

PROJECT TITLE: DEVELOPING MASS-BALANCE SIMULATION MODELS AS FISHERIES MANAGEMENT TOOLS IN ALASKA

Project Number:	01397
Restoration Category:	Ecosystem Synthesis
Proposer:	Thomas A. Okey, Fisheries Centre, University of British Columbia, Vancouver
Lead Trustee Agency:	ADFG
Cooperating Agencies:	ADFG
Alaska Sea Life Center:	no
Duration:	1st year, 2-year project
Cost FY 01:	$137,500 (includes Close Out)
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pacific herring, Pink Salmon, Subtidal Communities, and Rockfish/Commercial, Recreation, and Subsistence

ABSTRACT

This project will develop a mass-balance simulation model to be used to better understand and manage important fisheries resources within Prince William Sound and adjacent marine areas affected by the Exxon Valdez Oil Spill. Mass-balance models of trophic flows in Prince William Sound (PWS) were previously developed through funding from the *Exxon Valdez* Oil Spill Trustee Council. This work was primarily done to synthesize ecological information collected prior to and after the 1989 *Exxon Valdez* spill, and to provide insights into the whole food web implications of such catastrophic perturbations. Although analyses using this model indicate intriguing effects of fisheries, the current PWS model was not specifically structured to evaluate harvest strategies or policies that real fisheries managers are currently considering. Specific objectives of this project are: 1) to obtain and incorporate more detailed information on selected species and species groups from ADF&G and other sources; 2) to modify the existing PWS model to provide output useful for fisheries management; 3) to include environmental forcing components in the model to allow simulation of possible environmental, as well as anthropogenic effects, on species of interest; 4) to make the model and data available in the public domain on the Internet.

RECEIVED
APR 14 2000
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

INTRODUCTION

A mass-balance model was developed (*Mass Balance Model of Trophic Fluxes in Prince William Sound*, Restoration Project 98330) which integrated and synthesized information collected by several research and monitoring projects within the *Exxon Valdez* Oil Spill (EVOS) restoration program (Dalsgaard and Pauly 1997; Okey and Pauly 1999a and 1999b). This work has enabled Trustee Council agencies "to view the effects of the oil spill and the long-term restoration and management of injured resources and services from an ecosystem-level perspective" (EVOS Trustee Council, 1996, p. 53). The existing trophic model is based on well-documented and widely used *Ecopath with Ecosim* software (Christensen and Pauly 1992a, b, 1995, Pauly and Christensen 1993, Pauly and Christensen 1995, and other authors in Christensen and Pauly 1996). The Prince William Sound model, as well as the latest version of *Ecopath*, including *Ecosim and Ecospace* software, can be downloaded, free of charge, from the University of British Columbia Fisheries Centre website, http://www.ire.ubc.ca/related/ubcfish.htm, or obtained via mail on CD-ROM disks.

The current proposal seeks to further develop the existing Prince William Sound model into a useful tool for the primary management agency for Prince William Sound fishery resources, the Alaska Department of Fish and Game (ADFG). To do this, either a graduate or post-doctoral student, under the supervision of the Principal Investigator, will work directly with ADFG staff from the Prince William Sound management area, as well as interested resource users and the public. The student will obtain data and seek recommendations on modifying the existing model so that it can be refined to address issues of direct relevance to managing selected fish and invertebrate populations.

NEED FOR THE PROJECT

A. Statement of Problem

The need for an ecosystem approach for restoration, research, monitoring and management was one of 14 resource clusters identified by the EVOS Trustee Council for continued funding in fiscal year 2001 (EVOS Trustee Council 2000). The council has stated it is particularly interested in projects which integrate and synthesize information from completed and ongoing damage and restoration projects, as well as projects that provide innovative tools and strategies to improve monitoring. The existing Prince William Sound *Ecopath* model integrated and synthesize much of the available information collected about biotic components, and provided an easy to use, broadly accessible tool for restoration and resource planning. However, the existing model does not provide sufficient resolution of commercially and recreationally important biota to provide a useful tool for aquatic resource management agencies such as ADFG. With modifications, the model can be used by ADFG to provide valuable insights into the temporal and spatial population dynamics of key species that were affected by EVOS and which are harvested during commercial, subsistence and recreational fisheries. These species include Pacific herring, pink salmon, sockeye salmon, rockfish, and various invertebrates (Dungeness, tanner and king crab; spot and sidestripe shrimp) inhabiting subtidal areas. It could also be used to evaluate the broader (i.e., indirect) ecological affects of various management strategies and user trends. The general goal of the proposed project is to add this trophic modeling approach to the cadre of management tools that are routinely used by ADFG.

The existing *Ecopath* model of Prince William Sound provides a quantitative description of the trophic structure of this area and allows results of other EVOS research programs, such as Alaska Predator Ecosystem Experiment, Nearshore Vertebrate Predators, and Sound Ecosystem Assessment to be integrated in a thermodynamically plausible context. Such a synthesis did not previously exist in PWS. Additionally, *Ecopath* data files can be directly used in simulation models of the system (*Ecosim* and *Ecospace*). Such dynamic models allow rapid exploration of the predicted consequences of various interventions or events such as fishery management actions or harvest strategies, as well as environmental effects (which can be simulated by physical forcing functions). Marine resource policy planning can now be approached on an ecosystem level (multi-species as opposed to single-species).

Results of such simulations can help resolve issues vital to the understanding and wise management of the system, including vulnerability of individual species, sensitivity and characteristic response modes to changes, as well as estimates of recovery times. Monte Carlo experiments will also be important for investigating "what if" questions, but having *a priori* insights into basic system characteristics from *Ecosim* runs will sharpen the iterative process and make adaptive management far more efficient. New developments to the ECOPATH approach, such as a spatially explicit routine called *Ecospace*, will provide opportunities for increasing realistic simulations and allow a better understanding of possible outcomes from system perturbations.

Collaborative work with PWS ADFG staff will provide needed information and guidance for tailoring the model to meet identified resource management needs. A great deal can be learned from *Ecosim* simulation models to aid resource managers in making decisions. Outputs and implications of model runs are easily graspable because the user interface and graphics are clear and intuitive. The accuracy, precision and ease of use of the enhanced PWS model should allow resource mangers to determine and predict functional and structural responses of the ecosystem to a wide range of harvest strategies and policies focused on management of individual species. The interactive nature of *Ecopath* software, and its ability to clearly display possible temporal and spatial changes resulting from the direct or indirect effects of management actions, should provide novel approaches to explaining basic ecological principles and species interactions in PWS to the general public as well as special interest groups. Finally, incorporating new information and updating the model will also help identify gaps in knowledge and guide research planning and management.

C. Location

The modified *Ecopath* model will cover the biotic community inhabiting Prince William Sound. Improved understanding and management of specific fisheries resources within this area will benefit local communities within Prince William Sound, such as Cordova, Valdez, Whittier, and Tatitlek, as well as communities outside this area whose residents participate in commercial, recreational and personal use fisheries and tourism activities.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The experience of fishers and people from local communities will be sought and considered when specifying models. A start towards this goal was made during development of the existing model for which a database was developed based on local names of fishes and other marine organisms within the study area. Model modifications made under the current proposal will include efforts to incorporate traditional knowledge of selected fishes and shellfishes into simulations.

PROJECT DESIGN

A. Objectives

Specific objectives of this project are to:

1. Work with ADFG, as well as other agencies and the public, to obtain information, including biological data, on important species harvested in commercial, subsistence and recreational fisheries;
2. Modify existing Prince William Sound *Ecopath* model through extended study and coordination with ADFG staff so that greater resolution of trophic flow and relationships of species harvested in commercial, subsistence, and recreational fisheries is provided;
3. Examine temporal and spatial aspects of fishery management strategies, including potential effects of factors such as climate change, through use of dynamic simulation routines such as *Ecosim* and *Ecospace*;
4. Co-host one or more workshops with ADFG to explain and demonstrate the revised Prince William Sound *Ecopath* model to interested resource users and the public;
5. Allow public access to an interactive graphic version of the revised Prince William Sound *Ecopath* model, as well as databases used for the model, via the Internet.

B. Methods

This project seeks to facilitate the adoption of an ecosystem approach by fisheries managers by providing a sophisticated, yet easy to use, whole food web modeling tool. While there has been a great deal of interest in considering effects of fisheries management actions on predators, competitors and prey, lack of methods to do this has resulted in continued reliance on single species assessment techniques within professional fisheries management. Trophic mass-balance models are becoming widely accepted as useful tools for examining effects of various perturbations on ecosystems and ecosystem components, and the *Ecopath* modeling approach has already been applied and well documented for Prince William Sound (e.g. Dalsgaard and Pauly 1997; Okey and Pauly 1999a). However, the existing model needs to be refined for use by fisheries management agencies. To accomplish this, the Principal Investigator, who is experienced in *Ecopath* model development and application, will work directly with ADFG, the primary fisheries resource management agency for Prince William Sound, to modify the existing model for use as a fisheries management and research tool. The Principal Investigator will also meet with experts and researchers from other agencies, organizations, and local communities during this process, to obtain information, ensure that local knowledge is incorporated into the modified model, and help ensure acceptance of the finished product as a tool for managing fishery resources. All participants will be included in a list-server group, to facilitate continued

information exchange and facilitate model development, and acceptance. Many of these participates may already be familiar with the *Ecopath* approach from meetings and workshops held in conjunction with development of the existing model.

A considerable amount of work will be involved in refining and modifying the existing PWS model. This work consists mainly of the following activities:

1. Obtaining and incorporating new information through coordination with ADFG staff and others;
2. Modifying the existing Prince William Sound *Ecopath* model, which may include separating or aggregating existing groups, adding new groups, developing environmental forcing routines, and changing the outputs;
3. Balancing the modified model based on an iterative process of collaboration with ADFG staff and others;
4. Analyzing potential outcomes of specific fishery management and harvest strategies and policies using *Ecosim* and *Ecospace*;
5. Writing reports to document refinements and results;
6. Holding one or more workshop, with the assistance of ADFG, to demonstrate and introduce the model to interested researchers, managers, and the public.
7. Providing public domain Internet access to the modified PWS *Ecopath* model, including *Ecosim* and *Ecospace* features and databases used for model construction.

Extended work and study is needed by the Principal Investigator to accomplish these goals. Much of this work can be done at the University of British Columbia Fisheries Centre in Vancouver and ADFG offices in Anchorage and Cordova, but travel to other locations within Alaska will be necessary to develop initial contacts, and to host at least one public workshop.

Cooperating Agencies, Contracts and Other Agency Assistance

The PI has worked closely with ADFG to develop this proposal. ADFG personnel, staffs from other agencies and organizations, and various local experts involved with Prince William Sound fisheries will be invited to contribute information, propose modifications, and assist with validation. ADFG will provide support for the following project components: logistics and scheduling; work space and staff support in Alaska for the PI; staff collaboration with the PI to provide information and ensure that refinements enhance the model's usefulness as a fishery management tool; and staff time for model validation and at least one public workshop. Additionally, ADFG will develop a PWS model interface on the ADFG web site so that the general public can access the model and associated information. Fisheries Centre faculty or affiliates, or project staff will handle all other items.

SCHEDULE

A. Measurable Project tasks for FY 2001 (October 1, 2000 - September 30, 2001)

October 1-January 31:	Obtain information and suggestions for model modifications.
March 15:	Complete modifications and balance model.
April 15	Submit annual report of FY2001 results and findings.
May 1 - July 31:	Conduct analyses of potential outcomes of specific fishery management and harvest strategies and policies using *Ecosim* and *Ecospace*.
August 15	Complete first draft of model documentation report and first draft of peer reviewed, collaborative paper on the use of the PWS model in Alaska fisheries management.
August 31:	Design and develop strategy for Internet access to the model and data bases.
September 1-30	Hold one or more public workshops in Alaska to introduce model.

B. Project Milestones and Endpoints

FY2001:

November:	Incorporate new information collected on important species harvested in commercial, subsistence and recreational fisheries.
January:	Submit abstract for annual Restoration Workshop
March:	Produce modified PWS *Ecopath* model.
July:	Complete analyses of fishery management strategies.
August:	Complete first drafts of report, paper
September:	Disseminate project results and products at workshop.

FY-2002:

February:	Submit manuscript to peer reviewed journal.
April:	Submit final report.

C. Completion Date

Project will be completed in April of 2002 (FY 2002)

PUBLICATIONS AND REPORTS

The above project milestones identify anticipated publications, reports, and other deliverables. The Principal Investigator will coordinate the publication of results from this collaborative work in the primary literature with at least one peer-reviewed paper. Publication of additional papers by other contributors and partners will also be encouraged.

PROFESSIONAL CONFERENCES

The principal investigator has been invited to present talks at various conferences (see resumes) and will use available opportunities to present the results of the proposed work.

NORMAL AGENCY MANAGEMENT

The proposer is not an employee of a government agency.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The proposed work will continue to synthesize available data from projects funded by the Trustee Council as well as data available through Trustee agencies.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This is effort was not funded in FY2000.

PROPOSED PRINCIPAL INVESTIGATOR

Thomas A. Okey, MS
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University of British Columbia
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(604) 822-8934 (fax)
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PRINCIPAL INVESTIGATOR

Thomas A. Okey, MS – Mr. Okey is a Marine Ecologist associated with the Fisheries Centre, University of British Columbia, Canada. As Project Coordinator for EVOS Restoration Project 98330, he developed the tailored collaborative process in which investigators provided information and evaluated model construction, coordinated *Ecopath* workshops in Anchorage, edited reports on the model, and supervised the design and production of a CD ROM featuring several Ecopath models of Alaska. He has participated in several other workshops and training courses at which the *Ecopath* approach was presented and used.

OTHER KEY PERSONNEL

UBC Graduate Student – A graduate student will be selected and supervised by the PI and Daniel Pauly (see below).

Dr. Daniel Pauly - Dr. Pauly initiated, while at ICLARM, Manila, Philippines, the activities, which led to the emergence of the *Ecopath* approach and software, for FishBase. He has authored a large number of primary literature publications documenting various applications of these tools, and has organized several workshops (including one in the Pacific Northwest) and training courses at which the *Ecopath* approach has been taught and used. Dr. Pauly will be consulted at various times by the Principal Investigator on various aspects of model development and use.

Dr. Stephen M. Fried – Dr. Fried is the Regional Research Biologist for Region 2 (Prince William Sound, Cook Inlet, and Bristol Bay) for the Alaska Department of Fish and Game, Division of Commercial Fisheries. He has authored a number of publications in the primary literature concerning various topics in fisheries biology, assessment, and management. Dr. Fried will serve as the liaison between the Principal Investigator and ADFG staff. He will also assist in developing modifications for the model, suggesting scenarios for simulations, evaluating results, and editing reports and publications.

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2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$9.80						
Travel		$0.0						
Contractual		$118.0						
Commodities		$0.0						
Equipment		$0.0						
Subtotal	$0.0	$127.8				Estimated FY 2002		
General Administration		$9.7						
Project Total	$0.0	$137.5						
Full-time Equivalents (FTE)		0.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

NOTE: - Costs shown include a year of studies as well as the report writing costs.
- Final Report will be delivered 15 April 2002; report writing will be between 1 October 2001 and 15 April 2002
- Entire costs and time required for this project will be included in one contract (for studies and a deliverable) by ADF&G.

FY01

Prepared:

Project Number: 01397
Project Title: Developing Mass-Balance Simulation Models as Fisheries Management Tools in Alaska
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2001
<vacant>	FWT II	9 A/A	3.0	3250.0	0.0	9,750.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.0	3250.0	0.0	
					Personnel Total	$9,750.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2001
					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

FY01

Prepared:

Project Number: 01397
Project Title: Developing Mass-Balance Simulation Models as Fisheries Management Tools in Alaska
Agency: Alaska Department of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed
Description	FY 2001
4A Linkage	118,025.6
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$118,025.6

Commodities Costs:	Proposed
Description	FY 2001
Commodities Total	$0.0

FY01

Prepared:

Project Number: 01397
Project Title: Developing Mass-Balance Simulation Models as Fisheries Management Tools in Alaska
Name: Alaska Department of Fish and Game

FORM 3B
Contractual & Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2001
			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

FY01

Project Number: 01397
Project Title: Developing Mass-Balance Simulation Models as Fisheries Management Tools in Alaska
Name: Alaska Department of Fish and Game

FORM 3B
Equipment
DETAIL

Prepared:

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001						
Personnel		$64,500.0						
Travel		$25,880.0						
Contractual		$6,728.0						
Commodities		$500.0						
Equipment		$550.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$98,158.0				Estimated FY 2002		
Indirect		$19,867.60						
Project Total	$0.0	$118,025.6				$25.2		
Full-time Equivalents (FTE)		1.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: Indirect costs are for UBC Fisheries Centre, standard UBC contract overheads and cover general services, administration, space and buildings, computer facilities, basic office supplies and communications. They are calculated at the standrad UBC contract rates for ' non-commercial government and NGOs' of 30% of the cost of personnel and 2% or travel costs. This project will close-out in FY2002. Costs for that year include salaries (1 mo. for PI, 4 mo,. for gradudate student), travel costs for a professional meeting, printing/copying costs for final report, publication charges for journal articles.

FY01

Prepared:

Project Number: 01397
Project Title: Developing Mass-Balance Simulation Models as Fisheries Management Tools in Alaska
Name: Fisheries Centre UBC

FORM 4A
Non-Trustee
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2001
Thomas A. Okey	PI - UBC Fisheries Centre		5.0	6500		32,500
Graduate Student	to be appointed		16.0	2000		32,000
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		21.0	8500.0	0.0	
					Personnel Total	$64,500.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2001
Travel for Okey and Grad. Student to work with ADFG and others:					
UBC to Anchorage or Cordova (round trip)	1400	5	80	130	17,400
Travel for Okey or Grad. Student to attend EVOS annual workshop:					0
UBC to Anchorage	1400	2	6	130	3,580
Travel for Okey and Grad. Student to give talk at professional meeting:					0.0
UBC to ?	1800	2	10	130	4,900
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$25,880.0

FY01

Prepared:

Project Number: 01397
Project Title: Developing Mass-Balance Simulation Models as Fisheries Management Tools in Alaska
Name: Fisheries Centre UBC

FORM 4B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRU[illegible]E COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed
Description	FY 2001
Air charter to various Prince William Sound communities (e.g. Tatiklek, Valdez, Whittier)	4,000
Car rental (35 days @ $35)	1,225
Telephone - long distance	198
Printing/Copying	305
Professional journal publication costs	1,000
Contractual Total	$6,728.0

Commodities Costs:	Proposed
Description	FY 2001
CD-RW disks (50 @ @$4)	200.0
Zip disks (10 100 mb @ $10)	100.0
Eithernet card (1)	200.0
Commodities Total	$500.0

FY01

Prepared:

Project Number: 01397
Project Title: Developing Mass-Balance Simulation Models as Fisheries Management Tools in Alaska
Name: Fisheries Centre UBC

FORM 4B
Contractual & Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2001
Portable CD-RW	1	350.0	350.0
Portable Zip Drive	1	200.0	200.0
			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**	$550.0

Existing Equipment Usage: Description	Number of Units

FY01

Project Number: 01397
Project Title: Developing Mass-Balance Simulation Models as Fisheries Management Tools in Alaska
Name: Fisheries Centre UBC

FORM 4B
Equipment
DETAIL

Prepared:

Eastern Prince William Sound Human Use and Wildlife Disturbance Model

Project Number:	01399
Restoration Category:	General Restoration & Habitat Protection
Proposer:	Chugach National Forest
Lead Trustee Agency:	USFS
Cooperating Agencies:	ADNR
Alaska SeaLife Center:	No
Duration:	1st year; 3-year project
Cost FY00:	$185.4
Cost FY01:	$80
Cost FY02:	$60
Geographic Area:	Eastern Prince William Sound
Injured Resources/Service:	All Wildlife Resources

RECEIVED
APR 14 2000
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT

This project is an expansion of the human-use and wildlife disturbance model developed for the western Prince William Sound (PWS). The project will use geographic information system (GIS) techniques to describe current human-use patterns in eastern PWS and to model potential changes in those use patterns as a result of additional development (e.g., increased access). GIS generated maps of present and projected human-use patterns will be incorporated with GIS maps of the distribution of resources injured as a result of the *Exxon Valdez* oil spill. This will provide a basis to identify areas where there may be existing and potential conflicts between human use and wildlife concentrations resulting in disturbance. Disturbance of injured wildlife may result in decreased productivity exacerbating the effects of the oil spill and prolonging the time to recovery. Identification of potential areas of disturbance will allow development of recommended management practices that may eliminate or minimize the negative effects of increasing human use. All injured wildlife resources and wildlife subsistence species will be addressed with specific management recommendations. The model of projected human-use patterns and resulting management recommendations are expected to be useful to Federal, State, and private land managers in their land management planning efforts.

INTRODUCTION

This project is an expansion of the pilot project (98339) to model human use and wildlife disturbance in Western Prince William Sound. By developing the model for activities in the Eastern PWS a model of the entire sound would be available as a management tool. This proposal is an extension of the original pilot project proposal. The same techniques to develop the model would be applied for the rest of PWS. There are two exceptions. First, the original proposal included a literature review of human disturbance on wildlife. This review would not need to be repeated. Secondly, the pilot project included an emphasis on three of the injured resources. Since the Trustee Council funded the NOAA environmentally sensitive index maps for PWS, these data layers will be applied to the model and more of the injured resources will be covered.

The Prince William Sound ecosystem has experienced many changes in the last decade. The most notable of these is related to the *Exxon Valdez* oil spill (EVOS) of 1989. The EVOS caused direct and indirect effects on many resources throughout the oil spill area (EVOS Restoration Plan). Some of the oil spill effects have resulted in changes in human use patterns in PWS and other areas. For example, subsistence harvest patterns changed after EVOS (Seitz and Fall 1995), and commercial harvest of herring was closed in PWS for several years due to pathological problems believed to be caused by the spill. Land acquisition through the EVOS restoration program has made more land available for public use and habitat protection.

In addition to changes directly linked to EVOS, other changes in human use of PWS are occurring. Tourism patterns in PWS have changed as cruise ships altered their routes and new glacier tour cruises have been added. While the extensive commercial salmon fishery is expected to remain at about the same level, recreational boating and kayaking has increased dramatically in the last decade and is expected to continue to increase (ADOT 1995). Alaska Pacific University professor, Paul Twardock, has been monitoring the kayak use patterns in western PWS since 1988. His data show that kayak use through Whittier has increased by 6% per year over the last decade. Additional changes in human use are expected as projects such as the Whittier access road and potential development of Chenega and Tatitlek lands are completed. The Whittier access road will make western PWS much more accessible to Alaska's largest population base and may redirect use that originates in Valdez and Cordova because of crowding. This improved access is expected to result in increased human use in PWS (ADOT 1995).

Increased human activity in PWS may affect the recovery of species injured by EVOS. Human-caused disturbance has been shown to have negative effects on a wide variety of species (e.g. York 1994; Boyle and Samson 1983). Some types of boat-based disturbance have been shown to reduce productivity in many species of birds (e.g. Sowls and Bartonek 1974) and in some seal species (e.g. Richardson et al. 1995). The potential effect of human disturbance varies with species, frequency and type of disturbance, season, and other factors (Knight and Cole 1991). As human use increases in PWS the potential for disturbance-related effects on resources also increases. Human disturbance to marine mammals, seabirds, and shorebirds often occurs as people approach for viewing or photos or when beach activities such as camping and hiking disturb nesting birds.

Managing human use in large geographic areas is often very complex; management of PWS is the responsibility of numerous State and Federal Agencies, and private landowners. Presently, there is no single source of information on human use in PWS. This may create difficulties in resource management if human use increases as predicted and populations of injured resources are affected by human disturbance.

This project provides a foundation for displaying and understanding existing and future human use patterns in PWS, the potential disturbances on injured resources, and would make recommendations for management actions to minimize adverse effects of increased human use on injured resources. This proposal would expand the on-going pilot project in western PWS to include the entire PWS. The project consists of three components:

1. Describe existing human use patterns in PWS through computer simulations,

2. Develop a model to project changes in human use patterns as a result of development and management actions in PWS, and

3. Relate these human use patterns to environmentally sensitive areas.

The final product of this project will be a report with management recommendations for State and Federal agencies and a geographic computer database. The report and GIS data files will be available to agencies and to PWS communities to assist land owners and managers to better understand the potential human use of an area and to make appropriate management decisions.

This project will provide a useful tool in many aspects of the EVOS restoration program. The model will help in the identification of appropriate research and monitoring sites to understand the effects of human disturbance on specific injured resources or services. It will assist Alaska Department of Natural Resources on evaluating the effects of proposed developments in Eastern PWS. It will help in identifying areas where subsistence harvests may be affected by increased recreation and other uses. In addition to benefiting restoration activities, the model and recommendations will benefit State and Federal agencies, and the various Alaskan Native Corporations, in land management planning and in the protection of resources.

NEED FOR PROJECT

A. Statement of Problem

Human activity in PWS is expected to increase significantly in the next decade (ADOT 1995). This project provides a management tool that will increase the effectiveness of management of resources and human use in PWS. The project has direct application under Habitat Protection and General Restoration as described in the EVOS restoration plan (EVOS Trustee Council 1994), and has the potential to aid in the restoration of most of the identified injured resources and services. The pilot phase of this project placed an emphasis on describing potential disturbance effects and developing management recommendations for harbor seals, pigeon guillemots, and cutthroat trout on public lands in western PWS. This project will incorporate all injured species utilizing the updated NOAA maps of environmentally sensitive areas in PWS.

By expanding the modeling effort to the eastern PWS, areas in the Sound that receive use from Valdez and Cordova, as well as Whittier, will be more accurately represented than in the pilot project which addressed only Whittier and Chenega Bay as access points.

B. Rationale/Link to Restoration

The Trustee Council has made significant progress in understanding the effects of the EVOS and in restoring and protecting the resources and services injured by the spill. However, the recovery of these resources and services may be affected by a dramatic increase in human use in PWS. The ADOT has predicted that the Whittier access road will result in an increase of over 600% in recreational and tourism boat traffic in parts of western PWS by the year 2015 (ADOT 1995). However, the Whittier road is one of several changes that will affect human use in PWS. For example, new cruise lines have incorporated Cordova onto their schedules and permits for float house businesses are increasing in eastern PWS. As more people recreate and work in PWS, there will be higher levels of interactions between people and injured resources. Research has shown that human disturbance can cause a wide range of problems for wildlife and fish populations. At its most severe levels, disturbance can cause mortality or reduced productivity (Knight and Cole 1991). As human use increases in PWS, the potential for problems related to human disturbance to delay recovery of injured species also increases. By identifying existing and potential human use patterns in PWS, the Trustee Council would be providing a tool that would assist in habitat protection, general restoration, and would also provide valuable information for research and monitoring projects.

C. Location

By expanding the pilot project to include the eastern PWS, the entire PWS will be modeled. The project will benefit all State and Federal agencies with management responsibilities in PWS. The project will also benefit other landowners, especially the Tatitlek, Eyak and Chugach Alaska Corporations and the community of Tatitlek.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Involvement from PWS communities is an important component of this project. In order to fully understand human-use patterns in PWS, human use to and from each village must also be incorporated into the model. The communities would be requested to participate in describing human-use patterns around their communities. After presenting preliminary results from the western PWS human use modeling project, we were approached by a member of the Valdez Community council seeking information out of Valdez. This interest indicates that we are likely to have the same enthusiastic support from individuals and businesses in Valdez and Cordova that we have had in Whittier.

PROJECT DESIGN

A. Objectives

There are two objectives associated with this project:

1. Describe existing and potential human-use patterns in eastern PWS;

2. Identify areas where human disturbance has a high potential to affect injured resources.

B. Methods

These methods are similar to those described in the original proposal for project 98399, except for the description of a literature review of wildlife disturbance. This proposal also covers two primary transportation origin points (Cordova and Valdez) while the original proposal incorporated one primary origination point.

Description of Current Use Patterns

Water-based transportation and aircraft will be considered in the description of human-use patterns in eastern PWS. For water-based use, vessel classes will be established to more accurately describe use patterns. Classes will be based primarily on size and function (e.g., kayaks, other personal pleasure craft, charter, tour, commercial fishing). Current number, locations, and trips of vessels by class in eastern PWS will be determined through registration records, fuel records, and harbor master information on slip rental, moorage and launches. Additional information will be provided through user surveys.

The extent of human use in PWS will be described through an analysis of the distribution of water craft and aircraft in association with preferred destinations (e.g., recreational and commercial fishing areas, mooring buoys, camping sites, recreation cabins). Distribution of use will be determined through survey information and records of use by charter operators. "Preferred" destinations will be described from existing information such as recreation sites maintained by land management agencies (e.g., U.S. Forest Service, Alaska Department of Natural Resources), commercial fishing areas (e.g., Alaska Department of Fish and Game, Prince William Sound Aquaculture Association), sport fishing areas (e.g., Alaska Department of Fish and Game), and tour destinations (e.g., tour operators associations). Potential use levels of these sites will be determined from mail surveys of the patrons of the Cordova and Valdez harbors and air charter operators. The surveys will be distributed to individuals and groups known to work and recreate in PWS. These surveys will help to refine model parameters on frequency and duration of trips associated with different vessel classes.

Cell-based modeling using the GRID feature of the ARC/INFO GIS will form the basis of our approach to evaluate human-use patterns in eastern PWS (Environmental Systems Research Institute, Inc. 1994). Weighted distance functions will be used to describe areas that are available to and may be used by vessel operators. Separate grids of the water portion of eastern PWS will be created for the analysis of dispersion of vessels in each class. For each vessel class a source grid will be created to represent trip initiation points (e.g., marinas, launch sites). The

COSTDISTANCE function will be used to determine the minimum accumulative-travel cost from the source through each cell on the grid to a specific destination on the grid. This function allows for the control of factors that influence movement of water vessels. First, source cells will be identified. Then the cost to travel to each neighbor that adjoins a source cell will be determined. Next, each of the neighbor cells will be ordered from least costly to most costly. The cell location with the least cost will be removed. Finally, the least-accumulative cost to each of the neighbors of the cell just removed will be determined. This process will be repeated until all cells on the grid have been assigned an accumulative cost to reach a specific destination.

Corresponding cost grids will also be established for each vessel class. A cost grid will assign an impedance value to each cell that reflects choices involved in moving through any particular cell (e.g., avoidance of open water, avoidance of navigation risks). The value of each cell in the cost grid will represent the ease of a particular vessel type in passing through the cell (Environmental Systems Research Institute, Inc. 1994:253). Each cell location will be given a weight proportional to the relative cost incurred by a vessel passing through a cell.

ARC/INFO GRID functions will be used to create grids that represent dispersion of water craft by vessel class in eastern PWS. These dispersion grids for each vessel class will be combined through map algebra to describe density of use in eastern PWS by use class (e.g., low, medium, high vessel densities). The dispersion and density grids will be combined with grids of sensitive areas for injured species to identify those areas where conflict may occur.

These initial grids will provide representations of movements and concentrations of water vessels in the study area. This information will be used to initially characterize areas of PWS as having high, medium, and low densities of vessels by vessel class and total vessels on a monthly basis. Separate grids will be constructed for each month from May through September. Actual vessel densities in representative areas will be determined, by month, through field surveys.

A stratified random sampling method will be used to select areas throughout eastern PWS where aerial surveys will be conducted to evaluate and refine representations of current use patterns. Counts of vessels present in each of the sample areas will be made each month from June through September during high-use (e.g., weekends) and low-use (e.g., mid-week) periods. Counts will be conducted from fixed-wing aircraft; all vessels observed during flights within the sample areas will be recorded by vessel-class. Most vessels within sample areas are anticipated to have high sightability. However, small, nonmotorized vessels (e.g., kayaks) may not be obvious to the observers, especially if they are near the shoreline. Simultaneous surveys from aircraft and boats will be conducted in areas of each of the density classes during June, July, and August to help quantify sightability factors for the aerial surveys.

Results of the field surveys will be used to determine if ranges of actual vessel densities in the sample areas correspond to the vessel density classes represented in the dispersion grids under current conditions. If vessel densities are not corroborated by the results of the field counts, use patterns will be examined and modified to bring the dispersion grids into compliance with field counts.

Model Development

Upon completion of the dispersion grids describing current use patterns, a model will be

developed to estimate future use of PWS under potential management changes (e.g., improved access, additional fuel sources provided). The relationship of current use patterns to factors associated with dispersion (e.g., distance from port; proximity to camp sites, fishing areas, scenic areas; availability of fuel) will be analyzed through multivariate techniques. The resulting best-fit model will be used to predict future use of PWS. Information from the user surveys and from the literature will be used to modify model variables to project future use under varying development scenarios. Analyses will be completed which will incorporate projections of increased use of eastern PWS to demonstrate expected temporal and spatial changes in use patterns. ARC/INFO grids of the resulting potential human-use patterns will be combined with existing GIS maps of the distribution and areas of essential habitat for injured wildlife and fish resources. Areas of potential conflict (e.g., high-density human-use areas coinciding with essential habitat) will be identified.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Forest Service personnel will be responsible for the development and evaluation of the current dispersion patterns of human use. Evaluation and modification of dispersion grids will be based on the results of field surveys. Development of the future-use model will be based on the current human-use patterns and expected responses to development scenarios. The Forest Service will apply the results of the previous literature search on human disturbance effects on injured resources, and develop management recommendations in cooperation with the State. Forest Service personnel will incorporate the model with known information for injured species. Coordination with other agencies will be the responsibility of the Forest Service.

The State of Alaska, Department of Natural Resources (ADNR) is a partner on this project. The Chugach National Forest, ADNR, and Tatitlek, Eyak and Chugach Alaska Corporations are responsible for most land management within the study area. An ADNR Natural Resources Manager will provide input and coordination with the Division of State Parks and Outdoor Recreation, and the Division of Lands. This partnership will ensure that relevant State activities are included in the model, and that the management recommendations are compatible with State management responsibilities. The State will also conduct the user surveys, and incorporate results of previous surveys, to refine the information about existing use patterns and to provide the basis for future use patterns.

Contracts for this proposal include airplane costs associated with conducting the aerial surveys and consultations with statisticians on design of data collection protocols and data analysis. Tatitlek, Eyak, and Chugach Alaska Corporations will be asked to collaborate on this project to ensure that the human use model accurately displays existing activities on Corporation lands and activities associated with the different communities.

SCHEDULE

A. Measurable Project Tasks for FY01

Oct. 1–December 1:	Design and distribute user surveys, begin data collection, and determine appropriate destination points

December 1– April 30:	Collect human-use activity data, analyze user survey results, develop GIS layers of current use patterns
January:	Attend EVOS workshop
May 1 - Sept. 30:	Collect field data (aerial surveys) on dispersion patterns associated with current use data, complete draft existing use model

B. Project Milestones and Endpoints

Both of the objectives described in this proposal will be fully completed at the end of the project in April 2003. Project milestones are described in the following schedule.

FY01

Oct. 1–December 1:	Design and distribute user surveys, begin data collection
December 1– April 30:	Collect human-use activity data, develop GIS layers of current use patterns, and analyze user survey data
January:	Attend EVOS workshop
May 1- Sept. 30:	Collect field data on dispersion patterns associated with current use

FY02

Oct. 1 – January 1:	Modify GIS layers of current use patterns based on field data, develop model to predict future use patterns.
January 1 - February 28:	Apply the model to predict future patterns of use Prepare preliminary results for presentation at the annual EVOS workshop
March 1 - May 31:	Continue application of the predictive model; assemble information on sensitive areas for injured resources
March 15 – April 15:	Prepare annual report
June 1 - August 31:	Evaluate current and projected human-use patterns relative to sensitive areas for injured resources
Sept. 1 - Sept. 30:	Begin development of management recommendations

FY03

Oct. 1 – April 15:	Finalize model; prepare final report

C. Completion Date

This project will be completed by April 15, 2003. This includes a final GIS data files. This does not include development of a user-based version of the dispersion model for direct use by land managers.

PUBLICATIONS AND REPORTS

An annual progress report will be submitted in April 2002. The final report for this project will be submitted in April 2003.

PROFESSIONAL CONFERENCES

The principal investigators will request support to present the model at annual GIS and The Wildlife Society conferences in FY02 or FY03.

NORMAL AGENCY MANAGEMENT

This project is outside the scope of normal management for the Chugach National Forest. Development of human dispersion models similar to the proposed project has not been done previously in the context of National Forest management. The Forest Service has conducted public use surveys in 1992 and 1995 on the Chugach National Forest to provide information for the Forest Plan Revision process. Additional surveys are not planned for eastern PWS. This project is also outside of normal agency management because of the combination of species being addressed. Populations of species injured by the EVOS are potentially some of the most vulnerable to disturbance associated with increased human use. Many of these species, such as harbor seals, rarely occur on National Forest land; however, activities and management associated with National Forest land can affect these marine species.

Ultimately, managing human use in PWS will be an interagency responsibility which will require coordination between multiple agencies. This project will provide useful information for all of these agencies.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Opportunity exists to integrate this project with many of the other restoration projects. The updated NOAA Environmentally Sensitive Area maps for PWS will be merged with the complete human use model for PWS. This combination will be important in the management of these sensitive areas for the recovery of injured resources and services.

This project will also be integrated into State and Federal agency management plans. It will also provide useful information to Alaska Native Corporations and local communities in their ecotourism development plans for PWS. The resulting maps and recommendations will also benefit resource managers who make project-level decisions for the Chugach National Forest and for the Alaska Department of Natural Resources. Many of these individuals will be involved in the development of this project and will have the opportunity to apply the information to all aspects of land management. It is anticipated that other Federal agencies, such as National Marine Fisheries Service, will also benefit from this project in their management activities.

The Alaska Department of Natural Resources is a partner on this project. This partnership will ensure that activities undertaken by State agencies are incorporated into modeling exercises and that the resulting products will be beneficial to the State of Alaska.

PROPOSED PRINCIPAL INVESTIGATORS

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Voice: (907) 271-2836
FAX: (907) 271-2460
Email: lsuring@fs.fed.us

PRINCIPAL INVESTIGATOR

Lowell H. Suring

Lowell H. Suring received his M.S. in wildlife science from Oregon State University in 1974. His thesis involved assessing habitat use and activity patterns of the endangered Columbian white-tailed deer. This work lead to co-authorship of two major scientific publications. Lowell was leader of the Endangered Species and Wildlife Biometrics units in New York State from 1974 through 1977. In 1977 and 1978 he conducted research on secondary succession patterns in pinyon-juniper woodlands in northwest Colorado. From 1978 to 1984 Lowell held biologist positions with the Fish and Wildlife Service and Forest Service in New Mexico and Minnesota where he was involved with determining wildlife habitat relationships and the assessment of effects of management actions on wildlife habitats and populations. Since 1984, Lowell has been a primary participant in the development of GIS-based wildlife habitat relationships and cumulative effects models in the Alaska Region of the Forest Service. Lowell's professional expertise and interests focus on analyzing habitat-use patterns of wildlife and the development and application of computer-based habitat assessment techniques. He has authored or co-authored more than 30 technical and semi-technical articles describing accomplishments in these areas. Currently, Lowell is employed by the Chugach National Forest where he is implementing analytic techniques and tools that may be used to evaluate the capability of habitats to support wildlife and the effects of land management activities on habitat capability. To support these efforts he has had extensive training and experience in the application of ESRI's ARC/INFO geographic information system.

OTHER KEY PERSONNEL

Dan Logan, Wildlife Biologist, with the Cordova Ranger District (USFS) will assist in acquiring information for this project. He is a long-time resident of Cordova and has the local knowledge and personal contacts needed to expand this model to the eastern PWS.

LITERATURE CITED

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2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	ropose FY 2001	PROPOSED FY 2001 TRUSTEE AGENCIES TOTALS ADEC	ADF&G	ADNR	USFS	DOI	NOAA
					$50.1	$135.8		
Personnel	$0.0	$106.0						
Travel	$0.0	$7.4						
Contractual	$0.0	$51.5						
Commodities	$0.0	$1.5						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$166.4			Estimate	stimated		
General Administration	$0.0	$19.5				FY 2002		
Project Total	$0.0	$185.9				$80.0	$60.0	
Full-time Equivalents (F	0.0	1.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0			$0.0	$0.0		

Comments:

FY01

Prepared:4/11, KEH

Project Number: 01399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Lead Agency: USFS

FORM 2A MULTI-TRUSTEE AGENCY ~~SUMMARY~~

2001 EXXON VALDEZ TRU[illegible]E COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 1999	roposed FY 2000	LONG RANGE FUNDING REQUIREMENTS					
					Estimate	stimated FY 2002		
Personnel		$69.7						
Travel		$5.5						
Contractual		$45.5						
Commodities		$1.5						
Equipment		$0.0						
Subtotal	$0.0	$122.2						
General Administration		$13.6						
Project Total	$0.0	$135.8						
Full-time Equivalents (FTE)		1.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY01

Prepared:

Project Number: 01399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: USFS

FORM 3A TRUSTE E

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	udgeted	Costs	vertime	FY 2000
						0.0
Steve Babler	Wildlife Biologist	GS09	5.0	4.5		22.5
Lowell Suring	Wildlife Biologist	GS12	3.0	6.4		19.2
Dan Logan	Wildlife Biologist	GS11	1.0	5.6		5.6
Karin Preston	GIS Technician	GS11	1.5	5.3		8.0
Linda Kelly	GIS Technician	GS9	1.5	4.5		6.8
unknown	Biological Technician	GS7	2.0	3.8		7.6
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		14.0	30.1	0.0	
					Personnel Total	$69.7

Travel Costs:	Ticket	Round	Total	Daily	roposed
Description	Price	Trips	Days	er Diem	FY 2000
RT Anchorage - Cordova	0.5	6	3	0.2	3.6
RT Anchorage - Valdez	0.5	3	2	0.2	1.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.5

FY01

Prepared:

Project Number: 01399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: USFS

FORM 3B Personnel

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed FY 2000
Description	
Aerial Survey Contr	30.0
Boat Chart (3 trips - 3 days each) @ 1K/day	9.0
air charter to Tatitlek	1.5
Statistical Consulting	5.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$45.5

Commodities Costs:	Proposed FY 2000
Description	
miscellaneous supplies	1.5
Commodities Total	$1.5

FY01

Prepared:

Project Number: 01399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: USFS

FORM 3B Contractual &

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

New Equipment Purchases:	Number	Unit	roposed
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.	New Equipment Total		$0.0

Existing Equipment Usage:	Number	nventory
Description	of Units	Agency

FY01

Prepared:

Project Number: 01399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: USFS

FORM 3B Equipment

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	roposed FY 2001
Personnel		$36.3
Travel		$1.9
Contractual		$6.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$44.2
General Administration		$5.9
Project Total	$0.0	$50.1
Full-time Equivalents (FTE)		0.6

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2002			

Dollar amounts are shown in thousands of dollars.

Other Resources								

Comments:

FY01

Prepared:

Project Number: 01399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: ADNR

FORM 3A TRUSTEE

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	udgeted	Costs	vertime	FY 2000
unknown	Natural Resource Office II		2.5	6.5		16.3
unknown	Natural Resource Officer 1		3.0	4.5		13.5
unknown	Park Ranger 1		1.5	4.3		6.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		7.0	15.3	0.0	
					Personnel Total	$36.3

Travel Costs:	Ticket	Round	Total	Daily	roposed
Description	Price	Trips	Days	er Diem	FY 2000
					0.0
RT Anchorage - Valdez	0.5	3	2	0.2	1.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.9

FY01

Prepared:

Project Number: 01399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: ADNR

FORM 3B Personnel

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:		Proposed
Description		FY 2000
print and mail user surveys (includes postage to mail to everyone in Valdez and Cordova)		6.0
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$6.0

Commodities Costs:		Proposed
Description		FY 2000
	Commodities Total	$0.0

FY01

Prepared:

Project Number: 01399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: ADNR

FORM 3B Contractual &

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

New Equipment Purchases:	Number	Unit	roposed
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.	New Equipment Total		$0.0

Existing Equipment Usage:	Number	nventory
Description	of Units	Agency

FY01

Prepared:

Project Number: 01399
Project Title: Eastern PWS Human Use and Wildlife Disturbance Model
Agency: ADNR

FORM 3B Equipment

Assessment of Spot Shrimp Abundance in Prince William Sound a Decade after the Exxon Valdez Oil Spill

Project Number:	01401
Restoration Category:	General Restoration
Proposer:	Charles E.O'Clair and Mandy Lindeberg NMFS, Auke Bay Laboratory ABL Project Manager: Dr. Stan Rice NOAA Project Manager: Bruce Wright
Lead Trustee Agency:	NOAA
Cooperating Agencies:	Valdez Native Tribe/Charlie Hughey Prince William Sound Economic Development Council
Alaska Sea Life Center:	No
Duration:	3rd year, 4 year project
Cost FY 01:	$95,000
Cost FY 02:	$33,000
Geographic Area:	Prince William Sound
Injured Resource/Service:	Spot Shrimp/Subsistence

RECEIVED
APR 14 2000
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT

The goal of this study is to determine whether the spot shrimp population in Prince William Sound is recovering from depletion. This proposal is for year three of a four year project. Our results in FY00 are consistent with those of the ADF&G annual survey and indicate a cessation in the apparent decline of spot shrimp abundance in western PWS that had taken place from 1992 to 1998. Evidence of the beginning of recovery of the spot shrimp population, though encouraging, is inconclusive. In year three we will provide a second estimate of the abundance of spot shrimp to determine if the trend hinted at in FY00 is real, and we will model growth and estimate recruitment potential by sampling juveniles.

INTRODUCTION

The commercial spot shrimp fishery in Prince William Sound (PWS) was closed in 1992 after a rapid decline in the commercial catch following the peak harvest of over 110 tonnes in 1986 (Trowbridge 1994, Orensanz et al. 1998). The commercial fishery remains closed and further restrictions are being implemented for the sport and subsistence fishery. Annual surveys of the abundance of spot shrimp in PWS begun in 1989 by the Alaska Department of Fish and Game (ADF&G) continue to the present. The surveys sample spot shrimp at six to eight sites in the seven major statistical reporting areas that divide the Traditional Harvest Area in western PWS (Trowbridge 1992, 1994). From 1989 to 1998 the survey catch per unit effort (CPUE) declined from 0.6 kg/pot to 0.1 kg/pot (Trowbridge 1994; ADF&G, unpublished data). Catches of the present study and those of ADF&G in 1999 averaged CPUE's of 0.3 kg/pot and 0.2 kg/pot, respectively. However, these values were not significantly greater than those obtained by ADF&G in 1998. These results indicate that although the decline in spot shrimp CPUE between 1989 and 1998 did not continue into 1999, there is yet clear evidence of the beginning of recovery in the spot shrimp population in western PWS.

This proposal covers year three of a four year study designed to augment the ADF&G annual survey data for 1999 and 2000 by adding population information from other areas in PWS. We seek to enhance our understanding of spot shrimp population dynamics by providing information on juvenile distribution, abundance, and size structure, and will ultimately aid ADF&G in developing a management plan for spot shrimp when the population recovers. In FY'99 NMFS personnel took input from the Valdez Native Tribe and former PWS commercial shrimpers to identify potential sampling sites. A preliminary, exploratory cruise was conducted in August 1999 to evaluate potential sites. The first sampling cruise of the study took place in October 1999 a week or two after the annual ADF&G. The second full year of the study (FY'01) will, in addition to estimating spot shrimp relative abundance, population structure and reproductive potential, determine recruitment potential of the spot shrimp population by expanding the depth range of the sampling into shallow water to assess the relative abundance of juveniles in the population and develop a growth for spot shrimp in western PWS.

NEED FOR PROJECT

A. Statement of Problem

Evidence for depletion of the spot shrimp resource in PWS after 1989 is convincing (Trowbridge 1994). The role that the *Exxon Valdez* oil spill (EVOS) may have played in the reduction of spot shrimp abundance in western Prince William Sound is unclear. Trowbridge (1992) found reduced CPUE in weight and number of spot shrimp in oiled vs unoiled areas in 1989 and 1990 in PWS. The differences in CPUE (number and weight of shrimp) did not persist into 1991. Mean size of shrimp was reduced in the oiled area in all three years. However, Trowbridge

(1992) could not find conclusive evidence "that spot shrimp within PWS were themselves affected by the EVOS" owing, in large part to limitations in time and funding for spot shrimp damage assessment. Spot shrimp were not considered a high priority species by the EVOS damage assessment process. Lack of pre-spill abundance information coupled with confounding reductions in spot shrimp abundance prior to the spill rendered the species less favorable for a definitive damage assessment study. Trowbridge (1992) ultimately concluded that the observed abundance and structure of the spot shrimp stock in PWS in the first few years after the *Exxon Valdez* oil spill could mostly be explained by fishing pressure. Nevertheless, he hypothesized that highly sensitive shrimp larvae which were probably in the water column and near the surface during the oil spill were adversely affected by oil toxicity. No damage assessment study focused on larvae was initiated after the spill. The impact on the shrimp population after 1989 of exposure to oil of the 1989 year class in the larval stage is unknown.

Of additional concern is the increased pressure on the spot shrimp resource by sport and subsistence shrimpers as a result of greater access to western PWS following the completed access road connecting Portage and Whittier. Increased cruise ship traffic in and independent tourist visitations to western PWS in recent years may be having adverse impacts on spot shrimp habitat within PWS.

B. Rational/Link to Restoration

This project falls under the category of monitoring. We seek to assess the extent to which spot shrimp abundance has recovered since the population decline which began just prior to 1989. Although the major cause of the decline was probably overfishing rather than the EVOS, there is great interest by subsistence users of shrimp as well as sport shrimpers and individuals who fished for spot shrimp commercially in PWS prior to 1992 in the present status of the spot shrimp population in PWS. The ADF&G currently surveys spot shrimp abundance at selected locations in PWS annually. The goal of this study is first to broaden the geographical coverage and increase the amount of replication within existing major statistical reporting areas of the assessment of spot shrimp abundance in PWS. Second by focusing on the reproductive potential of females and recruitment potential as indicated by the abundance of juveniles in the population we seek to determine whether the population is recovering. The results of this work should greatly enhance the information base underpinning ADF&G management decisions.

C. Location

This study focuses on 12 sites in the Traditional Harvest Area for spot shrimp in western Prince William Sound. The project includes six sites currently surveyed by ADF&G as well as six additional sites in statistical reporting areas currently surveyed. Elements of the communities of Whittier, Valdez and Cordova that are now or have in the past been associated with the sport, subsistence or commercial harvest of spot shrimp may be affected by the results of the project.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Charles Hughey of Valdez Native Tribe acts as community facilitator for the project. Shrimpers in the Valdez Native Tribe provided information on potential sampling sites. Shrimpers in Valdez participate in the project, providing vessels, crew, shrimp pots, buoys, line, etc.

PROJECT DESIGN

Two important considerations enter into the project design. First, the project overlaps existing survey sites of ADF&G as well as samples new sites, and, to the extent possible, the project duplicates the methods that ADF&G uses in their surveys. This will accomplish two ends: 1) It will allow us to compare with greater confidence our data with that previously collected by ADF&G on spot shrimp abundance in western PWS in order to determine, more convincingly, whether spot shrimp population recovery is taking place in PWS, and 2) It will be more likely to provide data of the greatest value to ADF&G for future management of the spot shrimp resource in PWS.

The second consideration is that to maximize community involvement and to make the best use of traditional ecological knowledge, shrimpers associated with the Valdez Native Tribe are encouraged participate in the project and have timely access to project results. The shrimpers had input into the selection of the additional sampling sites and, to the extent possible, will participate in the sampling. Because the shrimp pots and other fishing equipment used by the present study differ in configuration from that used by ADF&G, the extent to which the project can overlap the ADF&G sites and sampling dates may permit the calculation of correction factors for comparison of the project's data with that of ADF&G.

A. Objectives

1. Estimate abundance (CPUE) of spot shrimp by weight and number of individuals (years two and three).

2. Determine the sex and size composition of spot shrimp at the study sites (years two and three).

3. Estimate spot shrimp fecundity and relative number of egg-bearing females at the study sites (years two and three).

4. Estimate juvenile abundance and compare between sites (year three).

5. Develop a growth model for spot shrimp (year three).

6. Compare abundance, sex and size composition, fecundity and proportion of ovigerous females between sites and years (year three).

7. Compare abundance data and data on population structure obtained under the present project with historical data collected by ADF&G to determine if the population is recovering and to assess the potential for full recovery of the spot shrimp population in PWS (year four).

8. Work with ADF&G, using data collected from this study, to develop a spot shrimp management plan for PWS.

B. Methods

The methods that used in the proposed study are modified after Trowbridge (1992, 1994). Shrimp pots will be fished at six sites in northern and western PWS previously surveyed by ADF&G (Figure 1). The sampling sites will be located in Unakwik Inlet, at Golden in Port Wells, in lower Culross Passage, in Herring Bay, at northeast Chenega Island and at northern Green Island. Six additional sites located

At least two strings of shrimp pots will be set at each site. Each string will consist of 11 pots spaced 18.9 m (62 ft) apart along a groundline and buoyed at both ends. Standard, round, nesting pots will be used. The diameter of the base and of the top of each pot is 107 cm (42 in) and 91 cm (36 in), respectively. The frame of the pot is mild steel with a black plastic coating and covered with a tar-coated mesh having stretched openings of 2.9 cm (1 1/8 in). There are two opposing tunnels in the side of each pot which have a 7.6 cm (3 in) opening. These pots differ in configuration from those of ADF&G which are rectangular pots measuring 41 cm x 41 cm x 91 cm (16 in x 16 in x 36 in). In 1999 we interspersed pots similar in configuration to, but somewhat smaller than (33 cm x 33 cm x 81 cm) those of ADF&G to test the relative efficiency of the two pot designs. The pots will be fished in the depth range 27-183 m (15-100 fm) for a minimum of 18 h at each site. In year three additional pot sets will be made in the depth range 0-27 m (0-15 fm) to assess the abundance of juvenile spot shrimp. The pots will be 56 cm (22 in) in diameter, round pots covered with nylon mesh with 5 mm openings. The pots will have four tunnel entrances placed at equal intervals around the side of the pot. Each tunnel entrance will have an opening of 6.4 cm (2.5 in).

Upon retrieval of the pot strings all pandalid shrimp in each pot will be speciated. Spot shrimp will be counted and the catch weighed to the nearest two grams on an electronic balance. Other species of pandalid shrimp (eg. *P. eous* and *P. hypsinotus*) will be counted. All non-shrimp bycatch will be speciated and counted. The carapace length of all spot shrimp will be measured to the nearest mm. Carapace length will be measured with calipers except when catches are large in which case the shrimp will be photographed with a digital camera and carapace length determined with image analysis. A subsample of each catch will be collected for staging and sexing. Additional observations of ovigerous spot shrimp will include egg condition (eyed vs uneyed) and egg color. The egg clutches of a total of 30 ovigerous females will be sampled at each site for estimates of fecundity and the number of dead eggs in the clutch. For nonovigerous females, the presence or absence of breeding dress [characterized by "...the presence of long,

simple, and plumose setae on the protopodites of pleopods" (Butler 1980)] will be recorded. Breeding dress indicates a mature female.

The sampling cruise will be conducted in October (the time of year when ADF&G normally conducts the annual survey) for the purposes of comparing the catch data collected by this project with that collected by ADF&G.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This project is a partnership between the National Marine Fisheries Service, the Valdez Native Tribe with Charlie Hughey as facilitator and Prince William Sound Economic Development Council.

SCHEDULE

August 1999:	Completed selection and preliminary fishing of supplimental sites in PWS.
October 1999:	Completed full scale sampling cruise of ADF&G sites and supplimental sites.
January 2000:	Completed presentation of abstract and poster to the Trustee workshop.
Nov.-March 2000:	Completed processing of egg samples and analysis of spot shrimp abundance, sex and size composition, and relative number of egg-bearing females and fecundity in first sampling year.
April 15, 2000:	will have completed annual report to the Trustee Council.

A. Measurable Project Tasks for FY01 (October 1, 2000 - September 30, 2001)

October 1 - 31:	Sample spot shrimp at ADF&G sampling sites as well as six additional sites.
Nov.1 - March 31:	Process egg samples and analyse data on spot shrimp abundance, sex and size composition, and relative number of egg-bearing females and fecundity of spot shrimp at the study sites in year three.
April 1 - Sept.30:	Produce growth model and annual report. Analyse spot shrimp fecundity and juvenile abundance at the study sites in year three.

B. Project Milestones and Endpoints

October 15, 2000:	Complete sampling for spot shrimp in second full sampling year.
February 20, 2001:	Complete estimates of abundance, sex and size composition, and relative number of egg-bearing females of spot shrimp at the study sites in year three.
April 15, 2001:	Submit annual report (FY01 findings).
June 15, 2001:	Complete estimates of spot shrimp fecundity and juvenile abundance at the study sites in year two.
October 31, 2001:	Complete comparison of spot shrimp abundance, sex and size composition, fecundity and proportion of ovigerous females between sites and years.
January 15, 2002:	Complete comparison of the abundance data and the data on population structure obtained under the project with historical data collected by ADF&G.
April 15, 2002:	Submit final report and recommendations to ADF&G for development of a PWS shrimp management plan.

C. Completion Date

September 30, 2002

PUBLICATIONS AND REPORTS

An annual report will be submitted on 15 April FY01. A final report will be submitted on 15 April in FY02. It is anticipated that at least two publications will derive from this project.

PROFESSIONAL CONFERENCES

Travel funds are requested for attendance of two individuals at the annual Exxon Valdez Restoration Workshop in January 2001.

NORMAL AGENCY MANAGEMENT

The National Marine Fisheries Service (NMFS) does not manage shrimp resources in Alaska and has never been required by statute or regulation to survey spot shrimp populations in PWS. No project similar to the one proposed here has been conducted by NMFS in the past without funds from the Trustee Council. Spot shrimp are managed by ADF&G which conducts annual surveys in PWS to assess the status of the resource.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The Valdez Native Tribe Facilitator Charles Hughey and Prince William Sound Economic Development Council will work with NMFS scientists to successfully complete this spot shrimp project. The ADF&G will be asked to review the proposal and subsequent reports to improve their quality and to increase their relevance to management goals.

The Prince William Sound Economic Development Council has coordinated other projects for EVOS in the past. Recent projects include the Chenega Bay Beach Clean-up and the five Oil Waste Management buildings in Valdez, Whittier, Cordova, Chenega Bay and Tatitlek.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

In fall 1999 circular pots were substituted for the rectangular pots that ADF&G uses. These circular pots will be used again in the fall of 2000. The pots are identical to the pots that ADF&G uses in their surveys in southeastern Alaska. In 1999 the circular pots were cross-calibrated with rectangular pots similar to those used by ADF&G in Prince William Sound.

PROPOSED PRINCIPAL INVESTIGATORS

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PRINCIPAL INVESTIGATORS

Charles G. Hughey is a commercial fisherman, EVOS community facilitator for Valdez, and serves on the Alaska Fish and Game Advisory Committee.

Sue Cogswell is executive director of Prince William Sound Economic Development Council and has experience in project management.

Charles E. O'Clair will be responsible for sampling, data analysis and interpretation and report writing.

Mandy Lindeberg will be responsible for arranging logistics (vessels, equipment, contracts, etc.), will participate in sampling, data processing, and will assist in report writing.

BIOGRAPHICAL SKETCHES FOR SCIENTIFIC PRINCIPAL INVESTIGATORS

Dr. Charles E. O'Clair, B.S. in Zoology from the University of Massachusetts, Ph.D. in Fisheries from the University of Washington. He is currently a Fishery Research Biologist with the National Marine Fisheries Service, Auke Bay Laboratory in Juneau, Alaska. He has 17 peer-reviewed scientific publications. His research experience includes 11 years of damage assessment and restoration process research related to the *Exxon Valdez* Oil Spill. Other research experience includes 15 years of field and laboratory work on the effects of oil pollution and logging practices on marine benthic invertebrates and research on the ecology and behavior of Dungeness, king and Tanner crabs.

Mandy R. Lindeberg has been involved in *Exxon Valdez* oil spill research for the last 10 years. Her research includes intensive studies on intertidal invertebrates and seaweeds, mussel populations, and currently she is a co-principal investigator of spot shrimp populations in Prince William Sound. Her responsibilities include quality control of field and laboratory sample processing, data analysis, graphics, and proposal and report preparation.

LITERATURE CITED

Orensanz, J. M., J. Armstrong, D. Armstrong and R. Hilborn. 1998. Crustacean resources are vulnerable to serial depletion - the multifaceted decline of crab and shrimp fisheries in the Greater Gulf of Alaska. Reviews in Fish Biology and Fisheries 8: 117-176.

Trowbridge, C. 1992. Injury to Prince William Sound spot shrimp. Final report for Exxon Valdez Oil Spill State/Federal Natural Resource Damage Assessment Subtidal Study Number 5. 141 p.

Trowbridge, C. 1994. Spot shrimp *Pandalus platyceros* surveys in the Prince William Sound management area, 1989 -1993. Regional Information Report No. 2A94-31. Alaska Department of Fish and Game. Anchorage, Alaska. 30 p.

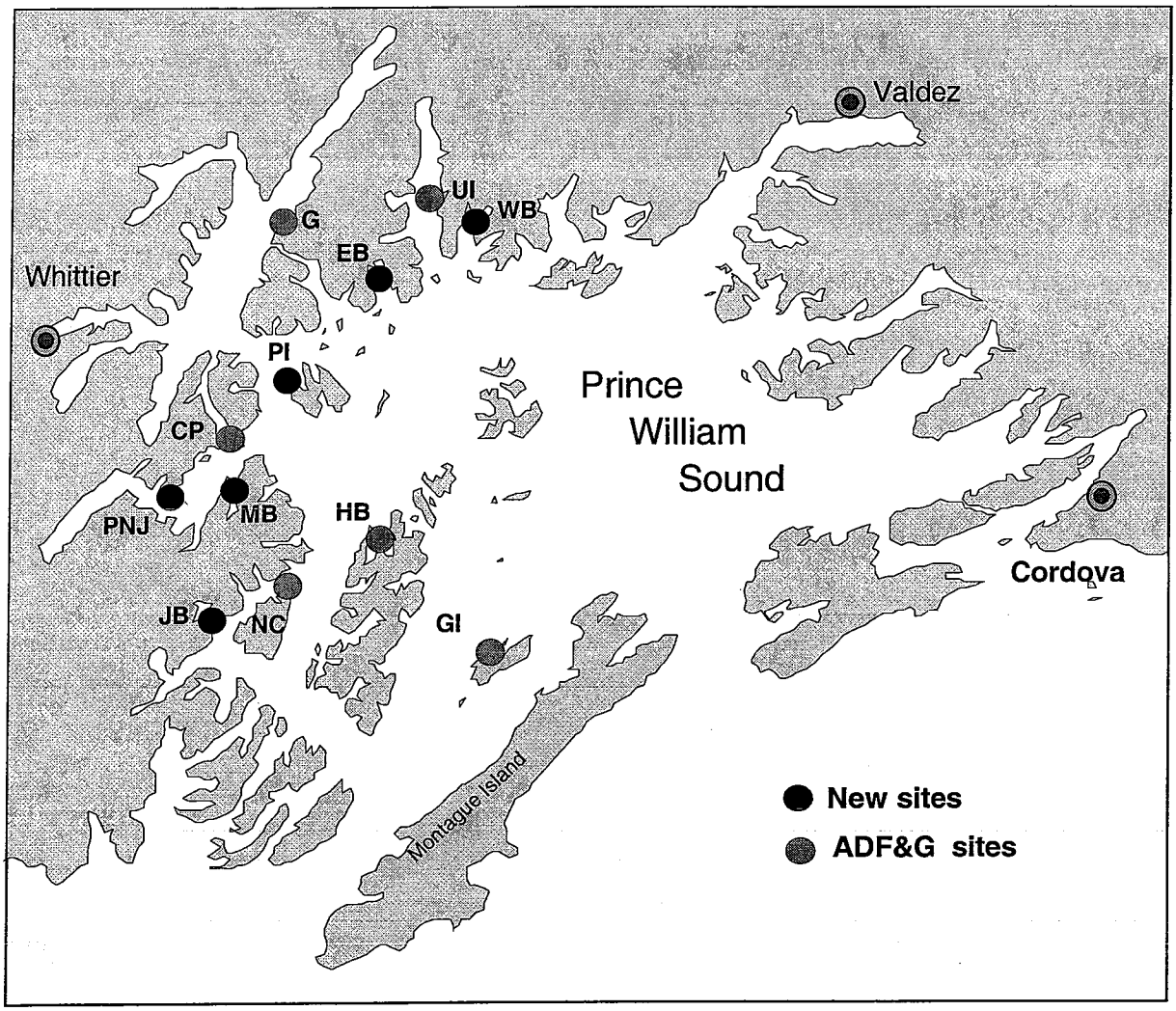

Figure 1. Proposed sampling area (shaded) and core sampling sites (closed circles) for spot shrimp abundance and population structure in western Prince William Sound. Alaska Department of Fish and Game major statistical areas for reporting commercial shellfish catch are outlined within the shaded area. (Major statistical areas are numbered). The Traditional Harvest Area is that area west of a line drawn between Bidarka Pt. and Montague Pt. (Modified after Trowbridge 1992)

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001
Personnel		$39.3
Travel		$4.1
Contractual		$41.1
Commodities		$1.7
Equipment		$0.0
Subtotal	$0.0	$86.2
General Administration		$8.8
Project Total	$0.0	$95.0
Full-time Equivalents (FTE)		0.5
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 2002		
			$33.0		

Dollar amounts are shown in thousands of dollars.

Comments:

The Prince William Sound Economic Council will administer the contract with the Valdez Native Tribe who will supply the survey vessel including fuel, Captain, deck hand, gear, and food.

NOAA's Contribution:
Pincepal Investigator, Fisheries Research Biologist Charles E. O'Clair (5mos @ $9.2/mo), Fisheries Research Biologist Mandy Lindeberg (2mos @ $5.1/mo).

Other:

FY01

Prepared:

Project Number: 01401
Project Title: **Assessement of Spot Shrimp Abundance in PWS**
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2001
Charles E. O'Clair	Fisheries Research Biologist	GS-12-10	1.5	9.2		13.8
Mandy Lindeberg	Fisheries Research Biologist	GS-9-3	5.0	5.1		25.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Subtotal			6.5	14.3	0.0	
					Personnel Total	$39.3

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2001
					0.0
RT Juneau - PWS	0.7	3	2	0.2	2.5
					0.0
RT Juneau - Anchorage	0.6	2	2	0.2	1.6
EVOS Trustee workshop					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.1

FY01

Prepared:

Project Number: 01401
Project Title: **Assessement of Spot Shrimp Abundance in PWS**
Agency: NOAA

FORM 3B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUST COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed
Description	FY 2001
Vessel Charter	26.6
Temporary Labor Laboratory processing of samples	12.0
Temporary Labor Field sampling	2.5
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$41.1

Commodities Costs:	Proposed
Description	FY 2001
shrimp pots for juvenile fishing (12 @ $90 ea)	1.1
replacement long-line	0.3
misc. fishing gear	0.3
Commodities Total	$1.7

FY01

Prepared:

Project Number: 01401
Project Title: **Assessement of Spot Shrimp Abundance in PWS**
Agency: NOAA

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2001
none			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
Shrimp Pots		2.5
long line		0.5
scale		10
misc fishing gear		0.5
computer (2)		5

FY01

Project Number: 01401
Project Title: **Assessement of Spot Shrimp Abundance in PWS**
Agency: NOAA

FORM 3B
Equipment
DETAIL

Prepared: