19.11.02 (5 of 12)

EVOS Trustee Council Final Report

Project Number:	02535
Restoration Category:	Public Information
Proposer:	Restoration Office, *Exxon Valdez* Oil Spill Trustee Council
Lead Trustee Agency:	Restoration Office (ADFG)
Cooperating Agencies:	None
Alaska SeaLife Center:	No
Duration:	2nd year of a 2-year project
Cost FY 01:	$69,800
Cost FY 02:	$50,100
Cost FY 03:	$0
Geographic Area:	
Injured Resource/Service:	All injured resources and services

ABSTRACT

This project will provide a final report for the activities of the Trustee Council, starting with the earliest damage assessment efforts and ending with the FY 02 Work Plan and disbursements of the final payment from Exxon. It will also include a complete history of the litigation leading to the civil settlement, which funds the Trustee Council. This project will increase public awareness and understanding of EVOS restoration activities, policies, and procedures. It will provide agencies and groups (facing a similar trustee situation) with a detailed history of the *Exxon Valdez* Oil Spill Restoration process, including highlights and pitfalls, so that others can benefit from lessons learned in the EVOS groundbreaking effort. This published history will include references and an index.

INTRODUCTION

This project arises from the need to provide a single source documenting 12 years of litigation, damage assessment, and EVOS restoration activities, policies, and procedures. It is appropriate to issue such a final report after the Trustee Council decides on its final work plan (FY 02), all the payments from Exxon are received and disbursed, and long-term programs for monitoring/research and habitat protection are in place. The final report would cover:

Introduction
Chapter One: Litigation and the Settlements
Chapter Two: Damage Assessment
Chapter Three: Early Trustee Council
Chapter Four: Habitat Protection
Chapter Five: Research, Monitoring, and Restoration
- including the Work Plan process
Chapter Six: Restoration Reserve, Investments, GEM, Long-term Habitat Protection
Chapter Seven: Public Advice and Public Information
Appendix 1: The Restoration Plan (abbreviated)
Appendix 2: Recovery Status
Bibliography
Index

NEED FOR THE PROJECT

A. Statement of the Problem

The scope of EVOS litigation and restoration is unprecedented in U.S. environmental history. Although there were laws and regulations in place to guide the process, there was no manual available for a combined federal-state trustee council with such an enormous task ahead of it, guaranteed financial resources available to it, and a varied constituency taking part every step of the way. Much of what the Trustee Council did broke new ground and the entire process needs to be synthesized into a documented, readable history available to the public, government agencies, and any group that might face similar circumstances.

Over the years, the Trustee Council has received dozens of inquiries from other trustee groups and hundreds of inquiries from college students wanting to report on different aspects of the EVOS process. This final report would provide a single referenced source for these needs and others that might arise in the future.

B. Rationale/Link to Restoration
This effort provides vital information to the public, government agencies, and private groups concerning processes of litigation, damage assessment, and restoration efforts.

C. Location
No field work is planned for this project.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

This project will help document community involvement and TEK efforts, providing an argument for such efforts in future trustee situations.

PROJECT DESIGN

A. Objectives
Create a book documenting the settlement, damage assessment, and restoration following the *Exxon Valdez* oil spill. The book should be published and available to the public by October 1, 2002.

B. Methods
Phase One (FY01) of this project (research and writing) is expected to be completed by September 30, 2001. Phase Two (FY02) of this two-year project will involve 1) gathering photos, graphics, tables, artwork, cartoons, maps and other materials for publishing; 2) working with a publisher to develop a general design concept for the book, 3) creating a digital layout for the book, and 4) editing and rewriting the manuscript as needed based on input from independent reviewers and the publisher.

The final report will be researched, written, and designed by the former communications coordinator for the Trustee Council. To help ensure objectivity an outside publisher will be sought to provide peer-review, editing and design help for the finished product (with financial assistance from the Trustee Council). The University of California Press has expressed interest in publishing the book, subject to approval by the UCPress Editorial Board. If no publisher is willing to take on the project, then the final report will be published by the Trustee Council.

C. Cooperating Agencies, Contracts, and Other Agency Assistance
None

SCHEDULE

A. Measurable Project Tasks for FY 01

October - December, 2001
a. Gather photos, graphics, tables, cartoons, maps, and other artwork for inclusion in book
b. Work with publisher on design and content
c. Layout book using PageMaker
d. Edit and rewrite as needed
e. Provide finished inside pages of the book to editor
(if published by a university press, then the publisher will design the cover)

January – September 2002
a. Book is published

B. Project Milestones and Endpoints
The final report should be in 2002. Publication date will depend on the schedule of a publisher. The Restoration Office will seek to have the publication available by September 2002.

C. Completion Date
September 2002

PUBLICATIONS AND REPORTS

The final report will be published and an as-yet-undetermined number of copies will be made available to the public, stakeholders, PIs and agencies.

PROFESSIONAL CONFERENCES

Participation in professional conferences is not anticipated.

NORMAL AGENCY MANAGEMENT
This project would not fall under normal agency management.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT
Research for this project is underway in FY 00 with funds from the 00100 budget.

PROPOSED PRINCIPAL INVESTIGATOR
Joe Hunt
11221 Town Hall St.
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PRINCIPAL INVESTIGATOR
Joe Hunt has 17 years of experience in Alaska in communications, journalism, public relations, publications, and advertising. He served as communications coordinator of the Trustee Council from 1996-2000. Joe's role will be to conduct all research and interviews, write the final report, work with an outside consultant/editor, rewrite the report (as needed), coordinate activities with the Restoration Office and Trustee Council, arrange for photographs and artwork (as needed), and design and publish the final report (or work with a publisher to design and publish the report).

OTHER KEY PERSONNEL
None

2000 EXXON VALDEZ TRUS' :OUNCIL PROJECT BUDGET

October 1, 1999 ..ptember 30, 2000

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel	$60.0	$22.5
Travel	$4.5	$1.7
Contractual	$0.0	$21.0
Commodities	$0.0	$0.0
Equipment	$0.0	$0.0
Subtotal	$64.5	$45.2
General Administration	$5.3	$4.9
Project Total	$69.8	$50.1
Full-time Equivalents (FTE)	0.7	0.2
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2003			
		$0.0			

Dollar amounts are shown in thousands of dollars.

Comments:

FY02

Prepared:

Project Number: 02535
Project Title: EVOS Trustee Council Final Report
Agency: Dept. of Fish & Game, EVOS Restoration Office

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRUS' COUNCIL PROJECT BUDGET
October 1, 1999 ptember 30, 2000

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FY 2000
Name	Position Description					
Joe Hunt	writer/researcher		3.0	7.5		22.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.0	7.5	0.0	
					Personnel Total	$22.5

Travel Costs:		Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 2000
Description						
						0.0
						0.0
Minneapolis/San Francisco/Seattle	Editing w/publisher	0.7	1	5	0.1	1.2
	Meeting with Molly					0.0
						0.0
						0.0
						0.0
rental cars				5	0.1	0.5
						0.0
						0.0
						0.0
					Travel Total	$1.7

FY01

Prepared:

Project Number: 02535
Project Title: EVOS Trustee Council Final Report
Agency: Dept. of Fish & Game, EVOS Restoration Office

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed FY 2000
Description	
Publishing costs or publishing subsidy	21.0
Publishing costs estimated at 2,500 books at $8.00 each or 2,000 books at $10 each ($20,000). * Publishing subsidy estimated as purchase of 600 copies of the book at $35 each ($21,000).	
* This is preferred method; discussions currently underway with UCPress	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	

Commodities Costs:	Proposed FY 2000
Description	
Commodities Total	

FY02

Prepared:

Project Number:
Project Title: EVOS Trustee Council Final Report
Agency: Dept. of Fish & Game, EVOS Restoration Office

FORM 3B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRUS' :OUNCIL PROJECT BUDGET
October 1, 1999 ptember 30, 2000

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

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY02

Prepared:

Project Number:
Project Title: EVOS Trustee Council Final Report
Agency: Dept. of Fish & Game, EVOS Restoration Office

FORM 3B
Equipment
DETAIL

Synthesis of Spill Damaged Resource Information into the Heritage Data Management System

Project Number:	02536
Restoration Category:	Ecosystem Synthesis/GEM Transition; Synthesis and Retrospective Analyses
Proposer:	Tracey Gotthardt Keith Boggs Alaska Natural Heritage Program Environment and Natural Resources Institute University of Alaska Anchorage
Lead Trustee Agency:	
Cooperating Agencies:	
Alaska SeaLife Center:	No
Duration:	1st year, 1-year project
Cost FY 02:	$110,500
Cost FY 03:	$0
Geographic Area:	No field work
Injured Resource/Service:	All species and ecosystem resources

ABSTRACT

The project would synthesize conservation information pertaining to species and ecosystems damaged by the *Exxon Valdez* oil spill into the Heritage Data Management System (HDMS). HDMS is part of an effort by The Nature Conservancy and 86 Natural Heritage Programs throughout the Western Hemisphere to document information on terrestrial and near-shore endangered species and ecosystems. It is the largest biodiversity conservation effort of its kind. The incorporation of spill affected resource information into HDMS would ensure linkage of EVOS information to broader based conservation efforts. We would also evaluate the effectiveness of using HDMS as an integral tool within GEM to track the recovery status the injured resources.

INTRODUCTION

This proposal was originally submitted to the *Exxon Valdez* Oil Spill Trustee Council (EVOS) in 2001. The Chief Scientist's recommendation was that "this project is not appropriate at this stage in the restoration program, but this proposal may be responsive to the invitation that will be issued in 2002 for the Trustee Council's long-term research and monitoring program (GEM)." The Alaska Natural Heritage Program (AKNHP), consequently, is resubmitting the proposal with revisions reflecting the needs of the EVOS Trustee Council and GEM.

AKNHP is proposing to synthesize information on species and ecosystems damaged by the *Exxon Valdez* oil spill into the Heritage Data Management System (HDMS). This state of the art data-system—originally developed by The Nature Conservancy—represents the largest ongoing effort in the Western Hemisphere to gather standardized data on terrestrial and near-shore endangered animals, plants and ecosystems. The results would ensure that EVOS conservation information would be applied at both regional (i.e. Gulf of Alaska) and coarse scales (i.e. Western Hemisphere). This project would also allow HDMS to be tested as a method for GEM to track the status of the oil damaged species and ecosystems (Table 1) over time.

Table 1. The project would address the following list of injured species and ecosystems listed by recovery status.

Recovered	***Not Recovering***
Bald Eagle	Common loon
River Otter	Cormorants (3 species)
	Harbor seal
Recovering	Harlequin duck
Black oystercatcher	Killer whale (AB pod)
Clams	Pigeon guillemot
Common murre	
Intertidal communities	***Recovery Unknown***
Marbled murrelet	Cutthroat trout
Mussels	Designated wilderness areas
Pacific herring	Dolly Varden
Pink salmon	Kittlitz's murrelet
Sea otter	Rockfish
Sockeye salmon	
Subtidal communities	***Additional Species***
	Black-legged kittiwake

We feel that HDMS can be an integral part of the EVOS Gulf Ecosystem Monitoring synthesis projects because it analyzes and synthesizes existing data sets and historical records for conservation purposes. HDMS is not, however, meant to supplant the GEM system, but is simply a method of focusing EVOS funded information into a conservation biology effort that has proven highly effective in protecting and identifying endangered species and ecosystems, and for transferring the information to users.

HDMS links together diverse sets of data on species and ecosystems throughout the world in a standardized and scientifically rigorous manner. It evolved from the Biological Conservation

Database, and is based on the computer programs Oracle, ArcInfo and ArcView. It is maintained by a network of Natural Heritage Programs, The Nature Conservancy and the Association of Biodiversity (ABI). There are now 86 Natural Heritage Programs operating in the Western Hemisphere, covering all 50 US states, several US Bioreserves and National Parks, Puerto Rico, nine Canadian provinces, and 13 countries in Latin America. They are based within State agencies, Universities and The Nature Conservancy. Alaska's Natural Heritage Program was established in 1989 within The Nature Conservancy, and in 1993 became part of the University of Alaska Anchorage, residing in the Environment and Natural Resources Institute.

To build HDMS, Heritage Programs assign a rank to each species or ecosystems in its state, indicating its occurrence (i.e. common, uncommon, rare). Ecosystems are approached at multiple scales and include units such as tidal marshes or old growth Sitka spruce (*Picea sitchensis*). Information from a wide variety of sources supply the data for this effort, such as State departments of Fish and Game, various Federal agencies such as DOI-FWS and the USFS, and from Universities, environmental groups and museums. The Nature Conservancy and ABI use the combined data from Heritage Programs to generate a global (G) rank. For species, Heritage Programs then develop profiles of each concentrating on their distributions and habitat needs. Distributions are mapped using a Geographic Information System (GIS) and then each site is assigned a rank, indicating its suitability as a place to sustain the species. A more detailed description of HDMS is given in the methods section.

The Nature Conservancy/ABI, industry and government agencies then use this information to ensure the conservation of rare species and ecosystems over time. For fully documented species, Heritage researchers can ask if most of the suitable regions for a species are in protected areas, suggesting a stable future for that species, or whether sites are exposed to threats that may lead to a future decline of the species. For resource use purposes (i.e. fishing or timber harvesting), HDMS can distinguish between a marginal region where a species is only hanging on and a highly suitable region that may be much more important to the species' future. When used in planning, Heritage data can reduce or avoid resource use conflicts and surprises. For example, cataloging the location of marbled murrelet nests in old growth forests can help guide timber harvest practices to avoid future resource conflicts. For more information on HDMS at the National level please see the web page www.abi.org, and for Alaska see uaa.alaska.edu/enri/aknhp_web/index.html

NEED FOR THE PROJECT

A. Statement of Problem

One problem that the EVOS Trustee Council has identified is the ongoing need to transfer study results to resource managers and stakeholders so that they may take full advantage of what has been learned through the EVOS program. At present, information transfer tends to be between researchers and not to resource managers. HDMS provides a proven method to transfer conservation biology information to resource managers and other data users. For example, the newly launched NatureServe web page (www.natureserve.org) provides in-depth information on more than 50,000 plants, animals, and ecological communities of concern in the United States

and Canada. AKNHP, also, answers hundreds of data requests concerning Alaskan rare species and ecosystems.

Another problem is that spatial and temporal gaps in most data sets are the norm rather than the exception resulting in gaps in information necessary to assess a species' status. The multiple research projects on EVOS damaged species have employed various sampling methodologies that have produced scattered and inconsistent population data, often with conflicting results. In addition, many of the EVOS studies— Sea Ecosystem Assessment (SEA) and Alaska Predator Ecosystem Experiment (APEX)—have ended leaving temporal gaps in field data useful for monitoring efforts. Because HDMS synthesizes all available conservation information, these spatial and temporal gaps in data can be addressed to the best of our abilities.

An additional problem is that to fully understand the rarity and threats to individual species and ecosystems, conservationists need to integrate available species and ecosystem information at both the regional (i.e. Prince William Sound) and global scales (i.e. North America or Western Hemisphere). Incorporation of EVOS funded conservation information into HDMS would insure that the information is used for biodiversity purposes at all spatial scales. For example, NatureServe information can be accessed at both regional and global scales.

B. Rationale/Link to Restoration

The project would help the recovery of damaged species and ecosystems by providing an accurate and cost-effective means to monitor the recovery of species and ecosystems in the spill-affected region. HDMS allows resource managers and the public the ability to view the recovery of the oil-affected area from both a coarse (ecosystem) and fine (species) ecological framework. The data would also help determine what marine and terrestrial areas are most important to protect in view of their biological significance.

The project should also be considered because monitoring the health of species and systems is important for both economic and biodiversity issues, as is the case in the oil spill affected area in which the two are closely linked. Many of the coastal villagers in Prince William Sound are heavily dependent on fisheries resources, in terms of commercial and subsistence harvests.

C. Location

This project would be conducted at the Alaska Natural Heritage Program, Environment and Natural Resources Institute, University of Alaska Anchorage. AKNHP's office is located off-campus at 707 A Street, Anchorage, Alaska.

All communities in the oil-affected area would realize benefits by having access to the data-system through data requests, a Web page and HDMS presentations.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Communities would be informed about the project through presentations of EVOS conservation biology results to community groups and resource managers. This community information outreach includes communication of results in non-technical terms.

All relevant information—including traditional knowledge—would be incorporated into the data-system. Dr. Henry P. Huntington and the WHISKERS database (ADFG) would be contacted to understand the status of traditional knowledge and how to access it. AKNHP has a strong history of working with Native American groups and villages and would continue this tradition during the proposed project. Examples of this work include a current project with the Bristol Bay Native Association to develop environmental indicators for the Nushagak-Mulchatna watershed, and a project on medicinal flora of the Alaska Natives (Garibaldi 1999).

PROJECT DESIGN

A. Objectives

1. Synthesize conservation biology information that relates to spill damaged species and ecosystems in the North Gulf of Alaska into HDMS.

2. Test HDMS as a method for GEM to track the status of the oil damaged species and ecosystems over time.

3. Transfer the EVOS funded conservation biology information to people in need of it such as resource managers, conservation groups, and other users.

B. Methods

The overall methodological steps are to: gather information on oil spill damaged species and ecosystems regardless of source or age of the data, synthesize the information into HDMS, and transfer it to resource managers and other users.

Gather Information

The geographic range of the project would be the Northern Gulf of Alaska. All conservation biology information (Table 2) related to the spill damaged species and ecosystems would be gathered from a variety of federal, state and private sources. This includes data from other databases such as the EVOS Research and Restoration Project Database and the National Marine Fisheries Service. Maps and data would be reviewed and digitized using ArcInfo GIS software for spatial data not already in GIS coverages. To provide consistency and the ability to process between maps, AKNHP would integrate pertinent GIS maps into a common format and projection. For data that are automated but do not reside as a GIS layer, formatting would be performed to import the data with associated coordinate and attribute information.

Table 2. Examples of types of information incorporated into HDMS.

Species Information	*Ecosystem Information*
Population size by area, year and season	Ecosystem description
Population range by year and season	Ecosystem distribution
Species health and trend	Ecosystem health and trend
Suggested protection needs	Suggested protection needs
Species rarity ranking	
Species-important life history components	*Bibliographic Information*
Food source range by year and season	Abstract
Food source status	Citation
Food source size	Results or conclusions

HDMS Description

HDMS is a powerful state-of-the-art information management tool designed to address conservation biology issues. It is based on the computer programs Oracle, ArcInfo and ArcView. The system is maintained at the local level (State or Province) by Natural Heritage Programs and at the National and Global level by both The Nature Conservancy and the Association of Biodiversity Information.

HDMS is built upon a set of standard fields and files. These are the basic structures that make it possible for different Heritage Programs in different parts of the world to collect, exchange, and disseminate information. By establishing this set of standard data fields and files, the HDMS system helps to promote a common vocabulary that unites people and purposes. These types of information, alternatively called the "major logical entities", include such types as:

- Source: A unit of information about an element, element occurrence, site, managed area, etc., (e.g., a book, article, thesis, field notes, etc.).

- Element: A unit of natural biological diversity. Fine "filters" of diversity include plants and animals; coarse filters include communities (repeatable assemblages of species that share a common environment) and "other" types (e.g., marine mammal haulouts, migratory bird concentrations, breeding bird concentrations, etc.). Some Heritage Programs also define geologic and aesthetic Element types.

- Element Occurrence: A specific example of an Element at a specific geographic location that represents a habitat capable of sustaining or contributing to the survival of that Element. This is the fundamental unit which drives all further protection and land management activities.

- Site: A land unit of ecological or other scientific interest, usually defined for purposes of conservation planning (but may be defined for any area for which ecological or other scientific information is needed).

- Managed Area: A land unit, generally a natural area that is under distinct protective or potentially protective natural resource management.

Four entities are unique in that they have geographic characteristics and may be mapped. These include element occurrences, sites, managed areas, and tracts (not defined). For any element

occurrence (species or ecosystem location) the user would be able to access coarse scale maps of the Northern Gulf of Alaska for orientation purposes including bathymetry, and USGS 1:63360 quads, and zoom in on any region of interest. Finer scale layers such as species range, haulouts, bird colonies, seasonal locations, and habitat would be included. Ancillary data per location would include such variables as population size, dates of occurrence, causes of population change, photographic records, etc. (Table 2).

Whereas the GIS used in conjunction with HDMS can separate different entities (element occurrence, site, etc.) onto different overlays, the HDMS data system, relies on conceptual distinctions to segregate data: scientific and ecological data goes in the Site files, management data in the Managed Area files, and legal ownership data in the Tract files. HDMS provides a tool for sorting out data for a complex conservation geography of rare element occurrences, conservation sites, protected managed areas, and legal ownership patterns.

These geographic entities, together with the Elements, form the backbone of the HDMS System. All other entities that characterize the biological diversity inventory, protection, and land management endeavor revolve around these fundamental entities representing biodiversity itself, and the land or marine unit that supports it. Information, however, is dynamic and in order to meet the diverse and growing needs of an extensive network of users, HDMS must be flexible. Toward this end, the data system has been equipped with a set of accessory files known as the Optional files. When standard fields cannot support specific local needs, these optional files would generally provide the flexibility needed.

A full bibliography would also be incorporated into HDMS. Fortunately, most citations have already been compiled through various sources for the study region (USGS-Biological Resources Division Prince William Sound Ecosystem Initiative, Cook Inlet Information Management System, Kachemak Bay Ecological Characterization, and HDMS). AKNHP would work cooperatively with these groups to ensure a thorough integration of the bibliographies.

Transfer of information

Web pages and data request procedures already exist through AKNHP, The Nature Conservancy and the Association of Biodiversity Information to transfer the results of the proposed project to end users (www.tnc.org, www.abi.org and uaa.alaska.edu/enri/aknhp_web/index.html). Also, AKNHP staff typically give up to ten talks a year on available HDMS information.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

No other Trustee agency is requesting funds for the project, and no components of the project would be contracted to the private sector or government agencies.

SCHEDULE

A. Measurable Project Tasks for FY 02 (October 1, 2001 – September 30, 2002)

February 30:	Finish gathering all conservation biology information related to spill damaged species
June 30:	Enter information into the HDMS
August 30:	Enter geographic information into ArcView or ArcInfo
September 30:	Place results on AKNHP WebPage and transfer information to the Association of Biodiversity Information

B. Project Milestones and Endpoints

September 30, 2002: All objectives would be met

C. Completion Date

September 30 2002: All objectives completed.
April 15, 2003: Final EVOS report due

PUBLICATIONS AND REPORTS

No peer-reviewed manuscripts would be produced. The final report would be completed April 15, 2003.

PROFESSIONAL CONFERENCES

Trustee Council's Annual Restoration Workshop, Anchorage, Alaska.
One paper would be presented on the transfer of the EVOS conservation biology information to HDMS and how to access the results.

NORMAL AGENCY MANAGEMENT

Not applicable

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The main emphasis of the proposed project is the integration of the Gulf of Alaska's restoration and conservation information into HDMS. This includes current and historical data from the region, and linking it to broader scale data.

AKNHP also coordinates with other conservation efforts at both regional and global scales. For example, Natural Heritage information forms core elements of the DOI-FWS's endangered species program. Since Category 2 of the U.S. Federal Endangered Species Act was eliminated

in the mid 1990's there exists no mechanism at the federal level to provide regulatory control on those species whose populations are in serious decline. Consequently, species are either listed as Threatened or Endangered or are not recognized as having a problem. In light of this regulatory gap, Natural Heritage Programs nationwide have been providing the information—through the HDMS rarity ranking system and assembled scientific data—that allows DOI-FWS to evaluate species status. These data are used by the DOI-FWS Endangered Species Program to prioritize species for their consideration for Threatened and Endangered status and to assemble status reports in preparation for listing under the federal law.

Natural Heritage data has also provided the key vegetation classification information for the DOI-FWS's Gap program (Grossman et al. 1998). The key elements in this relationship are the development of the National Vegetation Classification Standard—in cooperation with other groups such as the Ecological Society of America—and full Alliance level descriptions developed by the Natural Heritage Programs and the Biological Resources Division of DOI-USGS.

AKNHP also developed the USFS Alaska Region's sensitive species list (West 1993). Other examples include developing the Environmental Protection Agency's endangered species list, and developing many endangered species maps for the Federal–State of Alaska sensitive areas working group for hazardous spills and for environmental assessments on federal and state lands. AKNHP is currently conducting species inventories for DOI-NPS, developing hierarchical classifications and land cover maps for the DOI-NPS, developing monitoring protocols for the US Air Force, and animal surveys for the DOI-FWS.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATORS

Tracey Gotthardt

Tracey Gotthardt would review the majority of the marine information for inclusion in HDMS. She has a Masters of Science degree from the University of Alaska Anchorage on foraging ecology of harbor seals in southcentral Prince William Sound, 1994-1997. One aspect of this project involved synthesizing interagency (i.e. APEX, SEA, and ADFG) datasets on forage fish abundance and distribution, which included collaborating with numerous EVOS funded PI's. Tracey has ten years experience working in marine environments in Alaska, and has performed research on several EVOS damaged species, including Pacific salmon, harbor seals, and marbled murrelets. She has five years experience working with the APEX project, and is familiar with much of the sampling and research that is being conducted on seabird and forage fish interactions in Prince William Sound. She also has extensive GIS experience, and has worked on projects ranging from sand lance habitat selection modeling in Prince William Sound, to a marbled murrelet habitat suitability model. Her HDMS experience includes compiling all harbor seal literature and sightings throughout Alaska. She is currently working on a data inventory for all mammal and bird species in Alaska's National Parks.

Keith Boggs

Keith Boggs is the Interim Program Manager and vegetation ecologist for AKNHP. His qualifications in relation to this project are in project management and the coordination of databases. He has experience as principal investigator coordinating multiple projects at UAA, and is currently principal investigator on two projects both with DOI-NPS. Past projects ranged from describing tidal marshes, to conducting representativeness assessments using GIS (Boggs and Shephard 1999, Duffy et al. 1999). His experience in coordinating databases includes involvement with a current National Park Service project that integrates satellite image processing, GIS, Web Page and database programs to develop a Web based satellite map product. He is also knowledgeable of the various programs used to maintain and distribute AKNHP information (ArcInfo, ArcView and HDMS). He would also review the HDMS synthesis of terrestrial and intertidal community information such as old growth habitat for marbled murrelets and tidal marsh communities.

OTHER KEY PERSONNEL

Julie Michaelson

Julie Michaelson would coordinate the data entry into HDMS. Her qualification in relation to this project is her expertise in summarizing Alaskan biological information into a GIS format that is useful for end users. Her current position is as data manager for AKNHP, and is currently working on the creation of the zoological database layers that reside in the ArcInfo GIS system running on the SUN UNIX work station. Another project is creating GIS data-layers for the EVOS funded APEX study. She has constructed all export files that have been used to create the Internet graphics and has had extensive experience in the transfer of data into a variety of textual and graphic formats across platforms.

Alaska Natural Heritage Program

AKNHP's overall mission and linkage to other conservation organizations also provides significant qualifications for completing the project at the highest level of quality possible. AKNHP is a leader in the field of conservation biology in Alaska, maintaining the only statewide database—HDMS—on rare species and ecosystems. AKNHP's close ties to The Nature Conservancy and the Association of Biodiversity Information ensures that the latest conservation techniques are employed and that Alaska's conservation information is used at both regional and global scales. AKNHP also has extensive experience producing products in the field of conservation biology including managing the APEX project, and conducting seabird, marine fish, and marine mammal projects (Sherburne 1993, Wilbor 1999, Gotthardt 2001).

AKNHP is part of UAA, yet has a distinct mission—tracking Alaska's biodiversity—and is relatively independent of University demands such as teaching and committees. This allows AKNHP to be cost effective and highly efficient. AKNHP would also be cost-effective because some of the needed information for the project is already in-house. For example, AKNHP has information on 12 of the 24 species and ecosystems that are proposed for monitoring. AKNHP also has the computer resources to efficiently conduct the project including two Sun Unix Ultra with ArcInfo software, HP series E color plotter, HP color LaserJet 5M, ArcView/Spatial Analyst, Pentium PC's with Excel, Microsoft Word, Access databases (plus others), Macintosh Internet software and a scanner.

LITERATURE CITED

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FY 02 *EXXON VALDEZ* TRUS COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 2003					
Personnel		$77.4						
Travel		$0.0						
Contractual		$0.0						
Commodities		$7.0						
Equipment		$4.0						
Subtotal	$0.0	$88.4						
Indirect		$22.1						
Project Total	$0.0	$110.5						
Full-time Equivalents (FTE)		1.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:
The UAA indirect cost rate is 25% for all Exxon Valdez oil spill restoration projects.

The proportion of project costs for NEPA compliance is 0%, annual restoration workshop attendence 1%, report writing 5%, publications and professional conferences 0%, and community involvement 5%.

FY02

Prepared: April 12, 2001

Project Number: 02536
Project Title: Synthesis of Spill Damaged Resource Information into the Heritage Data Management System
Name: Alaska Natural Heritage Program

FORM 4A
Non-Trustee
SUMMARY

FY 02 *EXXON VALDEZ* TRUS COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2002
	T. Gotthardt	Zoologist	10.0	4.4		44.0
	J. Michaelson	Database manager	4.0	6.5		26.0
	K. Boggs	Ecologist	1.0	7.4		7.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	15.0	18.3	0.0	
					Personnel Total	$77.4

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2002
						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

FY02

Project Number:
Project Title: Synthesis of Spill Damaged Resource Information into the Heritage Data Management System
Name: Alaska Natural Heritage Program

FORM 4B
Personnel
& Travel
DETAIL

Prepared: April 12, 2001

FY 02 *EXXON VALDEZ* TRUS COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed
Description	FY 2002
Contractual Total	$0.0

Commodities Costs:	Proposed
Description	FY 2002
Biotics Program and Oracle: These specialized computer programs must be purchased to develop HDMS.	7.0
Commodities Total	$7.0

FY02

Prepared: April 12, 2001

Project Number:
Project Title: Synthesis of Spill Damaged Resource Information into the Heritage Data Management System
Name: Alaska Natural Heritage Program

FORM 4B
Contractual & Commodities DETAIL

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2002
Description			
PC Pentium: cost estimate obtained from University of Alaska	1	4.0	4.0
			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**	$4.0

Existing Equipment Usage:	Number of Units
Description	
PC: Windows	2
PC: Mac for Web work	1
HP color LaserJet printer	1
HP series E color plotter	1

FY02

Project Number:
Project Title: Synthesis of Spill Damaged Resource Information into the Heritage Data Management System
Name: Alaska Natural Heritage Program

FORM 4B
Equipment
DETAIL

Prepared: April 12, 2001

EXXON VALDEZ Oil Spill Trustee Council
FY 02 Detailed Project Description

Evaluation of two methods to discriminate Pacific herring (*Clupea pallasi*) stocks along the northern Gulf of Alaska

Project Number:	02538
Restoration Category:	Research
Proposer:	Ted Otis (ADF&G) Ron Heintz (NMFS-Auke Bay)
Lead Agency:	ADF&G
Cooperating Agencies:	ADF&G, NMFS-Auke Bay
Alaska SeaLife Center:	No
Duration:	Closeout in FY02
Cost FY 2001:	$ 10.1K
Cost FY 2002:	$ 47.3K
Cost FY 2003:	$ 0.0K
Cost FY 2004:	$ 0.0K
Geographic Area:	PWS, Kodiak, Lower Cook Inlet
Injured Resource/Service:	Pacific herring/commercial fishing

ABSTRACT

Pacific herring within the spill area, and particularly within Prince William Sound, were injured by the 1989 *Exxon Valdez* oil spill and have not yet fully recovered. Because herring are important prey for many marine species, as well as humans, their stock health is relevant to the recovery of other injured resources and services. To increase our understanding of the distribution and mixing of Northwest Gulf of Alaska (NWGA) herring stocks and to help identify important habitats and rearing areas for individual populations, it is relevant to be able to determine the stock of origin for herring sampled during field investigations. This 1-year pilot study will perform a comparative investigation of two promising stock identification techniques (elemental analysis of otoliths and fatty acid profile analysis of select soft tissues). Limited samples from Sitka Sound, PWS, Kamishak Bay, Kodiak Island, and Togiak will be collected and analyzed to determine if stock differences are detectable by each procedure, and at what scale. Successful results from this pilot study should be followed up with future evaluations of the temporal and structural (i.e., sex, age, maturity) stability of these biomarkers.

INTRODUCTION

Pacific herring *Clupea pallasi* within the spill area, and particularly within Prince William Sound (PWS), were injured by the 1989 *Exxon Valdez* oil spill (Brown 1995) and have not yet fully recovered (EVOS Restoration Plan 1998). Elevated levels of physical and genetic abnormalities in newly hatched larvae and reduced hatching success of embryos were documented in 1989 (Brown 1995). Significant histopathological damage was measured in adults collected in oiled areas in both 1989 and 1990 confirming exposure of the fish to toxins (Brown 1995). In 1993, the herring population in PWS collapsed. The total observed spawning population was less than one third of preseason predictions and the average sizes of herring in each age class were some of the smallest on record. The total commercial harvest for that year was also one of the lowest on record. In 1994, the total observed spawning population was below the threshold biomass required to conduct a commercial harvest and no fishing occurred. Pathology studies indicated that viral hemorrhagic septicemia (VHS) and the fungus *Ichthyophonus hoferi* probably contributed most to the population decline (Meyers 1994, Marty et al. 1996, 1998). After rebounding from the 1993 decline, the PWS herring population collapsed again in the winter of 1998-99. Viral hemorrhagic septicemia and *Ichthyophonus hoferi* were found in many herring sampled in 1998 and 1999, respectively, and appear to have once again contributed to their decline (pers. comm. Steve Moffitt, PWS Area Research Project Leader, ADF&G-Cordova).

Herring are an important component of the marine ecosystem providing a trophic pathway for energy flowing from secondary producers to apex predators. Throughout their life, herring are prey to birds (Logerwell and Hargreaves 1997), marine mammals (Iverson et al. 1997), invertebrates (e.g. hydromedusae: Wespestad and Moksness 1989), other fish (Tanasichuk et al. 1991), and humans (Fischer et al. 1997). Understanding the role herring occupy in the food web of marine ecosystems is relevant to sustaining viable populations of herring and the species that prey on them (Schweigert 1997). The ability to define the stock of origin for herring sampled during ecosystem level investigations (e.g., Gulf Ecosystem Monitoring [GEM]) would dramatically improve our understanding of the distribution and ecology of this organism. Researchers would be better able to evaluate cause and effect relationships associated with the population dynamics of NWGA herring stocks and thereby improve the management and recovery of herring, as well as other marine species that feed on them.

Many diverse techniques have been investigated to facilitate discriminating between fish populations including: nuclear and mtDNA analysis (Seeb 1995), enzyme electrophoresis (Schweigert and Withler 1990), parasite markers (Moles et al. 1990), scale pattern (Rowell 1981, Ross and Packard 1990, Barros and Holst 1995), mass marking of otoliths using temperature manipulation (Joyce et al. 1996) and fluorescent markers (Beckman et al 1990), and meristic and morphometric characteristics (Schweigert 1990). While many of these techniques have proven successful for certain applications, each has its own set of limitations that may reduce its effectiveness for specific stock identification situations. For instance, DNA analysis and enzyme electrophoresis are often able to discriminate stocks on a broad geographic scale, however, these techniques can falter when even a small amount of genetic drift occurs between closely distributed populations.

We propose to conduct a pilot study of two promising techniques for herring stock identification. Herring from Prince William Sound, Kamishak Bay, Kodiak Island, Togiak, and Sitka Sound will

be collected. Otoliths and heart tissue will be extracted from each specimen to facilitate elemental analysis (EA) and fatty acid analysis (FAA), respectively. To minimize sample sizes (i.e., costs) for this pilot study, we propose to focus our investigation on age-4 and age-5, pre-spawning female herring. If these procedures prove capable of identifying significant differences between similar cohorts from different stocks, further investigation would be warranted to evaluate the temporal, spatial, and structural (i.e., sex, age, gonad maturity) variability associated with each stock's unique biomarkers. Our principal objective is to determine which of these two stock identification tools is most robust.

NEED FOR THE PROJECT

A. Statement of Problem

Herring populations in PWS and Kamishak Bay are depressed. To better understand factors affecting the dynamics of these populations, and therefore effect their recoveries through potential improvements in management, we propose to evaluate two tools that may facilitate determining the scale at which discrete stocks exist within PWS and the greater NWGA. Herring researchers have long pondered the degree to which herring return to natal areas to spawn and the scale at which population structure exists within large geographic areas (Hourston 1982, Wheeler and Winters 1984, Hay and McCarter 1997, McQuinn 1997). Answers to these fundamental questions are directly relevant to the manner in which herring are assessed and managed. One of the underlying principles of sustainable fisheries management is the ability to monitor the dynamics (environmental, biological, and human induced) of individual populations (Mundy 1996). The inability to accurately apportion the catch from mixed stock fisheries, for example, is a common problem that undermines fishery managers' abilities to manage populations discretely.

Many diverse techniques have been investigated to discriminate between fish populations including: nuclear and mtDNA analysis (Seeb 1995), enzyme electrophoresis (Schweigert and Withler 1990), parasite markers (Moles et al. 1990), scale pattern analysis (Rowell 1981, Ross and Packard 1990, Barros and Holst 1995), otoliths thermal marking (Joyce et al. 1996), fluorescent markers (Beckman et al 1990), and meristic and morphometric characteristics (Schweigert 1990). While many of these techniques have proven successful for specific applications, each has its own set of limitations that may reduce its effectiveness in certain situations. For instance, DNA analysis and enzyme electrophoresis are often able to discriminate stocks on a broad geographic scale, however, these techniques can falter when even a small amount of genetic drift occurs between closely distributed populations.

This pilot study proposes to evaluate the potential for elemental analysis (EA), and fatty acid analysis (FAA) to discriminate NWGA herring stocks residing within and between PWS, Kodiak Island, and Kamishak Bay. Our principal objective will be to determine which of these two stock identification tools is most robust. The stock identification technique developed through this project could eventually be applied to identify the stock of origin for juvenile and adult herring collections made during long term monitoring (e.g., GEM) and also to apportion mixed stock harvests during commercial fisheries (e.g., Shelikof Strait food/bait fishery). Finding discernable differences between Kodiak and Kamishak herring is of particular interest to managers of these

respective stocks (Otis and Bechtol 1997, Otis et al. 1998). Herring harvested from northwest Kodiak Island (e.g., Shuyak, Afognak, and Raspberry Is.) during the Shelikof Strait fall food/bait fishery are presumed to include both Kodiak and Kamishak stocks (Johnson et al. 1987). The Department's Kamishak Bay District Herring Management Plan addresses this presumed mixed-stock fishery through allocation of the Kamishak Bay harvestable surplus (5 AAC 27.465). The success of this pilot project may result in the ability of managers to more accurately allocate the harvest of herring taken during the Shelikof fall food/bait fishery.

Fatty acid compositions of fish lipids have been investigated for decades (Ackman et al. 1963). Much of the early lipid research was directed at determining the commercial value of fish oils (e.g. Ackman 1966) and understanding how fat content relates to various life history functions (e.g. Rajasilta 1992). Because the composition of certain lipids can be closely related to the types of food recently ingested (Navarro et al. 1995, Kirsch et al. 1998), recent investigations have been directed at diet analysis and foraging distribution (e.g. Iverson et al 1997). The composition of phospholipid fatty acids prominent in some body tissues (e.g., heart tissue, gills, eggs) have been shown to have a more stable genetic or environmental basis that makes analysis of these tissues appropriate for stock identification studies. As early as the 1930's it was demonstrated that different stocks of fin whale *Balaenoptera physalus* could be distinguished by the degree of unsaturation of their oils (measured as iodine value: Lund 1934, as cited in Grahl-Nielsen et al. 1993). Recently, fatty acid analysis of eggs has been used to discriminate between American lobster *Homarus americanus* populations (Castell et al. 1995), Baltic cod *Gadus morhua* stocks (Pickova et al. 1997), and even the wild/domestic origin of sturgeon ova (Czesny et al. 2000).

Chemometry of fatty acids from heart tissue has been used to discriminate stocks of striped bass *Morone saxatilis* (Grahl-Nielsen and Mjaavatten 1992), Atlantic herring *Clupea harengus harengus* (Grahl-Nielsen and Ulvund 1990), and Atlantic cod *Gadus morhua* (Joensen et. al. 2000). This technique has also been used to distinguish between closely related species of the genus *Sebastes* from the Faroe Islands (Joensen and Grahl-Nielsen 2000). It is often the fatty acid profile (i.e., unique composition of an array of fatty acid levels; also referred to as a 'signature' by Iverson et al. 1997 and Smith et al. 1998) that distinguishes individual stocks, and not a single distinct fatty acid. Considerable variability can naturally occur in the fatty acid profiles (especially lipid profiles) between individual fish (Viga and Grahl-Nielsen 1990). This variability can be influenced by changes in diet, water temperature, salinity, growth, reproductive cycle, and pollution (Viga and Grahl-Nielsen 1990). The fatty acid profiles of certain tissues (e.g., heart) and specific lipids (e.g., phospholipids) are considered more stable, but still exhibit some variability. Recently published research found significant differences in the fatty acid profiles of heart tissue extracted from representatives of 2 cod stocks that had been reared under identical conditions since hatching (Joensen et. al. 2000). This key study demonstrates the potential for fatty acid compositions to discriminate fish stocks, even when they may occupy similar environments during later stages of their life histories (e.g., Kamishak Bay and Northwest Kodiak stocks).

Trace elemental analysis of otoliths has been used to identify stocks of pink snapper, (Edmonds et al. 1989), orange roughy (Edmonds et al. 1991), yellow-eye mullet (Edmonds et al. 1992), Atlantic cod (Campana and Gagne 1995, Campana et al. 1995), and salmonids (Kalish 1990). Thresher (1999) provides a comprehensive review of the use of otolith elemental composition as stock discriminators and offers some cautionary suggestions for researchers interested in

employing this promising technique. Of particular concern is the potential for non-standardized lab equipment and procedures to contribute to differences in otolith elemental composition reported among published studies (Campana et al. 1997).

Otoliths are acellular, so once accreted, the material is not resorbed or reworked (Campana and Nielson 1985). As a result, otolith microchemistry can be used to identify the environments inhabited by fish during their life (Gunn et al. 1992, Radtke and Shafer 1992, Secor et al. 1992). The use of otoliths as records of environmental exposure is based on the premise that otolith microchemistry reflects differences in water chemistry in the environment (Radtke and Shafer 1992, Campana and Gagne 1995). The trace elemental composition of fish otoliths is determined by the elemental composition of the endolymph (Kalish 1989, 1991). The concentration of various trace elements in the environment and the physiology of the fish largely determine the composition of the endolymph. Physiological processes may be modified by temperature (Kalish 1991), or subtle differences in the genetics of the fish affecting the uptake of various elements and their inclusion in the endolymph (Thresher et al. 1994). Controlled laboratory studies have shown that otolith microchemistry is strongly affected by temperature, salinity and ontogeny (Fowler et al. 1995a, 1995b).

Successful application of trace otolith elemental analysis for stock discrimination is likely dependent on the extent of the differences in water chemistry between the environments inhabited by each stock. But, the need to identify stocks often arises when they are exploited in mixed-stock fisheries in the same environment. Three methods are commonly employed for otolith elemental analysis. Solution-based inductively coupled plasma mass spectrometry (ICPMS) is typically used to measure elemental concentrations in whole otolith samples or portions of whole otoliths (Date 1991). Laser-ablation ICPMS is a technique that can be used to analyze trace elements (ppm) at specific loci (30 μm) on the otolith (Gray 1985, Denoyer et al. 1991). Electron microprobes (EM) also allow analysis of specific loci (5-7 μm), albeit at a reduced resolution in the parts per thousand (ppt) range (pers. comm. K. Severin, UAF Dept. of Geology and Geophysics). Solution-based ICPMS may successfully discriminate stocks that inhabit different environments exhibiting different water chemistries during the majority of their life history (Campana et al. 1995). However, techniques that target specific loci, such as EM and LA-ICPMS, may be more appropriate for identifying stocks that spawn in different environments but later reside in similar environments (Coutant and Chen 1993, pers. comm. K. Severin). In this case, the microchemistry of the otolith accreted during the embryo or larval stage may indicate differences between stocks. It is unknown to what extent herring spawning around Kodiak Island, in Kamishak Bay or PWS may inhabit similar environments throughout their life history. Therefore, the proposed project will examine the efficacy of either EA or LA-ICPMS of the primordium of the otolith for discriminating between herring stocks.

B. Rationale/Link to Restoration (Why should work be done)

Pacific herring is a key species in the marine ecosystem affected by the 1989 Exxon Valdez oil spill. Herring is also a primary forage species for other marine fishes, birds and mammals, and is used extensively by subsistence and commercial fishers.

C. Location

Herring will be collected from Sitka Sound, PWS (Montague and NE PWS), Lower Cook Inlet (Kamishak Bay), Kodiak Island (west side), and Bristol Bay (Togiak) waters.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Lab Study/Not Applicable

PROJECT DESIGN

A. Objectives

To accommodate funding limitations, we restricted our FY01 activities to sample collection and preservation. The bulk of our lab analyses will take place in FY02.

FY01:

1. Collect herring samples from Sitka, PWS, Kodiak, Kamishak, and Togiak; extract lipids for fatty acid analysis to be performed in FY02.

FY02:

1. Determine whether EA or FAA will allow discrimination among Alaska's 3 major herring stocks, and if so;

2. Determine whether EA or FAA can detect finer scale structuring of putative herring stocks inside PWS and elsewhere in the NWGA.

B. Methods

This pilot study has one main objective broken down into two parts: to determine if EA or FAA can distinguish between Pacific herring stocks, and if so, on what scale. To accomplish the first part of this objective we plan to compare the biomarker profiles of herring collected from Alaska's three major stocks- PWS, Sitka Sound and Togiak. Togiak and PWS have already been shown to have disparate genetic profiles (O'Connel et. al. 1998), so they make ideal initial test groups. If EA and FAA are not able to distinguish between these stocks, then they probably have little value as stock discrimination tools for Pacific herring. However, if PWS, Sitka and Togiak samples are distinguishable, we will process our remaining samples to investigate smaller scale population structuring within the NWGA, and PWS specifically.

To minimize the inherent natural variability that may reside within each population, only age-4 and age-5 prespawning female herring will be collected. This will also allow us to minimize our

sample sizes (i.e., cost) for this pilot study while still retaining the ability to look for variability in chemical markers across adjacent year classes. Herring will be collected from the north end of Montague Island (e.g., Zaikof Bay) and the northeast corner of PWS (e.g., Galena Bay), locations believed to represent the focal spawning areas for two putative PWS herring stocks (Pers. Comm., Evelyn Brown, UAF, IMS). We will also collect herring from NWGA spawning aggregations centered on the west side of Kodiak Island (e.g., Paramanof Bay) and in Lower Cook Inlet (Kamishak Bay). Processing samples from these collection sites will allow us to resolve the scale at which EA and FAA techniques are able to discriminate between herring stocks in the NWGA.

Collections will be made where significant numbers of herring spawn in areas judged to be the focal spawning area for each respective stock and will target the first groups of returning fish (Table 1). For each specimen, length, wet weight, sex, and gonad maturity will be determined. When pre-spawning female herring between 190-250 mm SL are encountered, a scale will be removed to determine the age of the fish. If determined to be age-4 or age-5, their heads will be removed, individually labeled, and stored frozen in plastic bags for later laboratory processing of the otoliths. Whole hearts will be removed, transferred to labeled vials, placed in liquid nitrogen, and stored at –70° C until analyzed (Ackman et al. 1969, Grahl-Nielsen and Mjaavatten 1992). The remaining body of the fish will be labeled, bagged, and frozen whole for possible whole body fatty acid analysis. EA and FAA will only be conducted on specimens from the same two adjacent age classes from each area (e.g. age 4 and 5). This approach will control for biomarker variability that may occur across cohorts. To reduce project costs, only 30 samples from each area will be processed (180 total samples). However, 50 additional fish of similar age/sex will be collected in case the sample variance dictates more individuals are needed to facilitate robust statistical comparisons (Johnson and Wichern 1992).

Table 1: Dates, locations, and sample sizes for FY01 collections to evaluate the feasibility of EA and FAA to discriminate between northern Gulf of Alaska herring stocks.

Location	Date	Sample sizes	
		EA	FAA
Sitka Sound	3/10-4/10	30	30
PWS, N. Montague	4/10-4/20	30	30
PWS, NE (e.g., Galena Bay)	4/10-4/30	30	30
LCI, Chenik/Amakdedori	4/20-5/5	30	30
KDK, Paramanof/Foul Bay	4/15-4/30	30	30
Togiak	5/1-5/20	30	30
Totals Samples		180	180

Direct methanolysis of the thawed heart tissue and gas chromatography of the resulting fatty acid methyl esters will follow procedures described by Viga and Grahl-Nielsen (1990) and Grahl-Nielsen and Mjaavatten (1992). Representative peaks (i.e. fatty acid levels) from the resulting chromatograms will be selected and quantified. Multivariate techniques such as principal components analysis (PCA), soft independent modeling of class analogy (SIMCA), linear discriminant analysis (LDA), and classification and regression trees (CART) have typically been

used to compare fatty acid compositions (Grahl-Nielsen and Mjaavatten 1992, Navarro et al 1995, Castell et al. 1995, Smith et al. 1997). However, there remains some debate over which multivariate techniques are most robust for this application (Grahl-Nielsen 1999, Smith et al. 1999).

Otoliths will be removed from heads and processed as described by Fowler et al. (1995a). Left and right sagittal otoliths will be dissected from each specimen using glass probes on a glass surface, insuring that the otolith and dissection equipment do not touch metal. Tissue adhering to the otoliths will be removed with glass probes and the sample washed in Super Q water. Otoliths will be air dried in a positive flow flume hood and weighed to the nearest 0.01 mg. Those used for laser-ablation ICPMS will be mounted on glass slides using thermal plastic cement, then ground and polished in the sagittal plane until the otolith primordium is visible. Polished otoliths will be rinsed in super Q water (deionized, purified through reverse osmosis, and millipore filtered) and stored in paper envelopes for later analysis (Fowler et al. 1995b). Methods described by Fowler et al. (1995a) and Fowler et al. (1995b) will be used for the laser-ablation ICPMS analyses of the primordium of each otolith.

Discriminant function analysis (DFA) and principle component analysis (PCA) will be applied to the calibration samples collected from all areas to determine which analytical technique (EA or FAA) is the best stock discriminator (Johnson and Wichern 1992). Each technique produces a biomarker signature (trace elements or fatty acid profiles) that will be evaluated for the level of discrimination (e.g. number of stocks identified) and the accuracy of discrimination. Each multivariate statistical technique will first be applied to the data sets derived from each analytical technique (EA or FAA), separately. The misclassification probabilities associated with each technique will be compared to evaluate the accuracy of each method. DFA and PCA could then be conducted on the data set derived from all analytical techniques combined. This approach would enable us to determine whether a combination of variables from the two analytical techniques provides greater classification accuracy than any of the individual techniques.

A stepwise discriminant analysis will first be applied to the variables derived from each analytical technique to identify any biomarker signatures associated with herring stocks or age classes. All variables found to be poor discriminators will be discarded. DFA will then be applied to the reduced set of variables. DFA produces a probability density function (pdf) for each group identified. If DFA can not discriminate between stocks it will combine all stocks into one pdf. The number of unique stocks identified will indicate the level of discrimination achieved. If DFA can discriminate between stocks, misclassification probabilities (accuracies) will be determined by the number of specimens that incorrectly fall outside the pdf for their respective stock in the calibration sample. Groups may be pooled if misclassification is high. This will reduce detail but increase overall accuracy.

PCA will be used to express the biomarker signatures as a set of principal component variables. Skree plots will be used to determine how many principal components are needed to accurately describe the variation in the biomarker signatures. To reveal relationships that exist within the signatures a varimax rotation of the principle components will be completed and the components will be graphed against each other. If PCA appears to distinguish among stocks, additional PCAs will be conducted for each individual stock and perhaps age-classes within stocks. Cross-validation analysis will be used to determine the number of principal components that best

describe the data (Wold 1978). Varimax rotation plots will be used to evaluate misclassification (accuracies).

C. Cooperating Agencies, Contracts, and other Agency Assistance

This project is jointly proposed by the Alaska Department of Fish and Game (ADF&G) and the National Marine Fisheries Service (NMFS), Auke Bay Lab. ADF&G will collect all the necessary samples and Auke Bay Lab will perform the fatty acid analysis of soft tissues. If this project is funded, the department will draft specifications for EA and solicit bids from at least three qualified vendors. This process will follow standard State of Alaska bidding and contract award procedures. The successful bidder will be offered a co-authorship option if publishable findings result from the analyses.

SCHEDULE

A. Measurable Project Tasks for FY01

Feb-Mar:	Contract laboratory for elemental analysis of otoliths.
Apr-May:	Collect otolith and heart samples from spring spawning herring from Sitka Sound, PWS, Kodiak, Kamishak, and Togiak.
Jun-Sep:	Extract lipids from soft tissue, store samples until they can be processed in FY02.

B. Measurable Project Tasks for FY02

Oct-Jan:	Perform fatty acid and elemental analyses of soft tissue and otoliths, respectively.
Feb-Mar:	Analyze results, write project final report.
April:	Submit project draft final report

C. Project Milestones and Endpoints

Sep 2001	Complete FY01 objective 1
Jan 2002	Complete FY02 objectives 1 and 2
April 2002	Complete project draft final report.

C. Completion Date

This project will be completed in FY02. A draft final report will be submitted by April 15, 2002.

PUBLICATIONS AND REPORTS

A draft project final report will be submitted by April 15, 2002. Selected results from the project may be published in referred journals in FY02 or 03 as appropriate.

PROFESSIONAL CONFERENCES

Travel funds have been requested to present selected project results at one professional conference in FY02, as appropriate (e.g. Lowell Wakefield Symposium or AFS Meeting).

NORMAL AGENCY MANAGEMENT

The ability to distinguish between and manage stocks discretely is a principal component of sustainable fisheries management. However, this principle cannot be implemented effectively in many cases due to inherent difficulties in distinguishing discrete stocks using methods commonly available to fishery managers. New advances in fisheries stock identification are necessary to fill these gaps. The techniques we propose to evaluate may have broad application towards better understanding the structuring of many marine mammal and fish populations, including those not managed by the proposing agencies. Successfully applying these techniques as stock discriminators could also illuminate pathways for more effective long term monitoring through GEM.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project proposes to develop stock discrimination tools that may help resolve questions concerning the scale at which discrete herring stocks exist in PWS and the greater Gulf of Alaska. Information gained by this project could help put the results of other EVOS projects into context and illuminate new pathways for long term monitoring under GEM.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

None

PRINCIPAL INVESTIGATORS

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Education: Master of Science, Fisheries Science, University of Arizona, 1994. Bachelor of Science, Environmental Science, University of New Hampshire, 1988.

Professional Experience: April 1996-present: Asst. Area Research Biologist for Lower Cook Inlet, Alaska Department of Fish and Game, DCF, Homer, AK. Supervised by William R. Bechtol. Responsible for assessment and forecasting of Kamishak Bay herring stock, direct salmon and herring catch and escapement sampling programs, forecast Lower Cook Inlet salmon returns. April 1994-March 1996: Fishery Technician, Kenai Fishery Resources Office, U.S. Fish and Wildlife Service, Kenai, AK. Supervised by Gary Sonnevil. Project leader for Andreafsky River (Yukon) adult salmon enumeration project: constructed and deployed resistance board/floating weir to count adult salmon; project leader for Kenai River rainbow trout radio-telemetry project: surgically implanted radio transmitters and tracked fish using mobile receivers and remote data loggers. June 1991-March 1994: Graduate Research Asst., Univ. of Arizona, Dept. of Renewable Natural Resources, Tucson, AZ. Supervised by Dr. O. Eugene Maughan. Designed and implemented field studies to assess the composition, abundance, and distribution of fishes in streams tributary to the Colorado River in Grand Canyon. Designed and implemented field study to inventory aquatic habitat available to stream fishes in Grand Canyon. August 1987-June 1991 (intermittent): Fisheries technician, Kenai Fishery Resources Office, U.S. Fish and Wildlife Service, Kenai, AK. Supervised by Gary Sonnevil. Project Leader or team member on various field projects including: assessing adult salmon returns using weirs (Uganik R, Kodiak); developing new approaches to aging dolly varden and lake trout otoliths; enumerating emergent salmon fry (Tustumena Lake); evaluating angler effort (Kenai River); investigating run-timing and migration rates of chinook salmon (Kuskokwim River); and inventorying salmon spawning habitat (Ayakulik R., Kodiak).

Selected Publications:

Weiss, S.J., E.O. Otis, and O.E. Maughan. 1998. Spawning ecology of flannelmouth sucker *Catostomus latipinnis* (Catostomidae) in two small tributaries of the lower Colorado River. Environmental Biology of Fishes 52:419-433.

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Otis, E.O., W.R. Bechtol, and W.A. Bucher. 1998. Abundance, age, sex, and size statistics for sockeye salmon in Lower Cook Inlet,1995. Alaska Department of Fish and Game Regional Information Report No. 2A98-07.

Otis, E.O. 2000. Forecast of the Kamishak herring stock in 2000. Alaska Department of Fish and Game Regional Information Report No. 2A00-14.

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Education:
Currently enrolled as PhD candidate at University of Alaska
Master of Science, Fisheries Biology, University of Alaska, Fairbanks. 1987.
Bachelor of Science, Ecology Ethology and Evolution, University of Illinois, Champaign. 1979.

Principal Findings involving chemometric techniques:

1. Oil weathers by first-order loss-rate kinetics (Short and Heintz 1997).
2. Most toxic PAHs spilled by *Exxon Valdez* persisted in spawning habitats for at least six years after the spill (Murphy et al. 1999).
3. Marine derived fatty acids provided by returning salmon are an important source of nutrition to fish residing in the natal streams (Wipfli et al. in press).

Current Research:

1. Evaluation of the potential use of fatty acid and lipid class analysis for discriminating diet and diet quality in marine species.
2. Use of lipid class and fatty acid analysis for discriminating populations of northern fur seals.
3. Characterization of the quality of salmon rearing habitats by evaluation of the lipid class and fatty acid composition of overwintering parr.

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Murphy, M. L., R. A. Heintz, J. W. Short, M. L. Larsen, and S. D. Rice. (1999). Trans Am Fish Soc. 128:909-918.

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Campana, S.E., J.A. Gagne, J.W. McLaren. 1995. Elemental fingerprinting of fish otoliths using ID-ICPMS. Mar. Ecol. Prog. Ser. 122: 115-120.

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the electron microprobe, proton-induced X-ray emission, and laser ablation inductively coupled plasma mass spectrometry. Can. J. Fish. Aquat. Sci. 54:2068-2079.

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2002 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 200'. eptember 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	PROPOSED FY 2002 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
				$19.9				$27.4
Personnel	$0.0	$31.9						
Travel	$0.0	$0.5						
Contractual	$0.0	$9.0						
Commodities	$0.0	$0.5						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$41.9				Estimated FY 2003		
General Administration	$0.0	$5.4						
Project Total	$0.0	$47.3				$0.0		
Full-time Equivalents (FTE)	0.0	0.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0				$0.0		

Comments:

FY02

Prepared:

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Lead Agency: ADFG

FORM 2A
MULTI-TRUSTEE
AGENCY SUMMARY

2002 EXXON VALDEZ TRU: COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$8.5
Travel		$0.5
Contractual		$9.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$18.0
General Administration		$1.9
Project Total	$0.0	$19.9
Full-time Equivalents (FTE)		0.2
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 2003		
			$0.0		

Dollar amounts are shown in thousands of dollars.

Comments:

FY02

Prepared:

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Lead Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2002 EXXON VALDEZ TRU: COUNCIL PROJECT BUDGET

October 1, 2001 --ptember 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
						0.0
To be hired	Fishery Biologist II	16A	1.0	4.0		4.0
	Final Reporting					0.0
						0.0
Joe Cashen	FWT II (otolith preperation for EA)	9J	1.3	3.6		4.5
FWT II, ADF&G Otolith Lab						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.3	7.6	0.0	
					Personnel Total	$8.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
RT Homer - Anch., Attend EVOS workshop or other professional meeting	200.0	1	3	95.0	0.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.5

FY02

Prepared:

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Lead Agency: ADFG

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed FY 2002
Description	
Contract for elemental analysis of 180 otoliths @ $50 apiece	9.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$9.0

Commodities Costs:	Proposed FY 2002
Description	
Commodities Total	$0.0

FY02

Prepared:

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Lead Agency: ADFG

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002
			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
Personal computers	2	ADFG

FY02

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Lead Agency: ADFG

FORM 3B
Equipment
DETAIL

Prepared:

2002 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 200' ptember 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$23.4
Travel		$0.0
Contractual		$0.0
Commodities		$0.5
Equipment		$0.0
Subtotal	$0.0	$23.9
General Administration		$3.5
Project Total	$0.0	$27.4
Full-time Equivalents (FTE)		0.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 2003		
			$0.0		

Dollar amounts are shown in thousands of dollars.

Comments:

FY02

Prepared:

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Agency: NMFS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2002 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 200'. September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
Ron Heintz	Fishery Research Biologist	GS/12/	1.9	7700.0		14.6
	Data analysis and report writing					0.0
Larry Holland	Chemist	GS/12	1.3	7030.0		8.8
	Fatty acid analysis					0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.2	14730.0	0.0	
					Personnel Total	$23.4

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
					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

FY02

Prepared:

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Agency: NMFS

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FY 2002
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FY 2002
Solvents, gasses	0.3
Glassware	0.2
Commodities Total	$0.5

FY02

Prepared:

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Agency: NMFS

FORM 3B
Contractual & Commodities
DETAIL

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2002
			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:	Number	Inventory
Description	of Units	Agency
GC/MS	1	NMFS
HPLC	1	NMFS
computers, analytical software	2	NMFS

FY02

Project Number: 02538
Project Title: Evaluation of two methods to discriminate Pacific herring (Clupea pallasi) stocks along the northern Gulf of Alaska
Agency: NMFS

FORM 3B
Equipment
DETAIL

Prepared:

Evaluation of Oil Remaining in the Intertidal from the Exxon Valdez Oil Spill

Project Number:	02543
Restoration Category:	Research and Monitoring
Proposer:	Jeffrey W. Short and Mandy Lindeberg NMFS, Auke Bay Laboratory ABL Program Manager: Dr. Stan Rice
Lead Trustee Agency:	NOAA
Cooperating Agencies:	
Alaska Sea Life Center:	No
Duration:	2nd year of a 2 year project
FY02	92 K (closeout)
Geographic Area:	Prince William Sound, Gulf of Alaska
Injured Resource/Service:	Intertidal communities, Sediments

ABSTRACT

This project will assess the amount of oil remaining from the *Exxon Valdez* oil spill on shorelines within Prince William Sound in FY01. A stratified random sample of shoreline will be intensively sampled or surface and subsurface oil to estimate length of oiled shoreline, area and volume of oiled sediment, and volume of oil. Approximately 8 km will be sampled by digging about 8,000 pits to discover and quantify subsurface oil. In FY02, Phase III of this project which will be devoted to data and chemical analysis, preparation of a final report, and journal publications. No fieldwork is proposed for FY02.

INTRODUCTION

Oil from the March 1989 *Exxon Valdez* oil spill (EVOS) has been surprisingly persistent on some beaches. At the end of the 1992 cleanup season, natural processes were expected to disperse most of the oil remaining on shorelines. However, relatively unweathered oil remains today at a number of locations that were heavily oiled initially, and protected from dispersion by storm-generated waves. The extent of the remaining oil is unknown, and this uncertainty engenders public and scientific concerns about the effects the oil may continue to have on humans and on fauna that may become exposed to the oil either directly or indirectly. This project was initiated in 2001 with extensive field work to address these concerns by providing a quantitative estimate of the amount of shoreline (length, area, sediment and volume) that remains contaminated. This estimate will inform any assessment of the significance of the amount of oil remaining, and be the basis for further management (e.g., do nothing, restrict access or harvest; etc.). For FY02, this project will complete chemical and data analyses, and provide a final report.

Estimating the oil remaining on beaches affected by the EVOS in a cost-effective manner presents a considerable challenge. Previous attempts to address this problem have mainly relied on Shoreline Contamination Assessment Teams (SCAT), consisting of field teams performing comprehensive foot-surveys of impacted beaches. Although this approach may be useful for directing cleanup efforts immediately after a spill, it is less appropriate for producing a quantitative estimate of remaining oil contamination, especially long after a spill when most remaining oil is obscured from casual view. Instead, a stratified random/adaptive sampling design will be used to focus sampling effort in areas where oil most likely persists, while allocating some effort to discovering oil in areas where persistence is uncertain. This approach will guarantee a credible minimum estimate of remaining oiled area, and will provide a confidence interval for the most likely amount remaining throughout the affected region. This information is needed to predict oil persistence into the future and to determine associated risks to vulnerable biota.

This project will focus on oil remaining on beaches inside Prince William Sound (PWS). At this time, areas outside of PWS are not part of the proposed assessment. Previous Trustee-funded projects have examined oil persistence along the Kenai-Alaska Peninsula shoreline in 1999 (Project 99495) and in the vicinity of Kodiak Island in 1995 (Project 95027).

In FY01, Phases I and II were initiated. Phase I is development of the sampling design to be applied to the study area. Phase I was funded, and the study design used for Phase II is the product. Design alternatives were developed during summer 2000 and presented at a workshop in November 2000 for consideration by peer-reviewers, trustee agency representatives, and other stakeholders. Phase II is execution of the adopted sampling design inside Prince William Sound during spring/summer 2001. Permitting is in progress, and the vessel and labor contracts are completed. Phase II of the project enters the field on May 7, 2001, and will have 80-100 charter days and 6 field personnel deployed. This detailed project description presents the specific objectives, sampling design, and methodology for Phase III in FY02.

NEED FOR THE PROJECT

A. Statement of Problem

Although the persistence of relatively unweathered oil is clearly established on some beaches 10 years after the EVOS, the cumulative extent of remaining oiled beach is controversial. One estimate places the area of beach that remains contaminated by oil at less than 450 m^2 (Page 1999), but the basis for this claim has not been presented. Other studies suggest more extensive contamination (Brodersen et al. 1999; Hayes and Michel 1999; Irvine et al. 1999). These latter studies have often found relatively unweathered oil in the upper intertidal zone of beaches that are armored by boulders and beneath mussel beds that were initially heavily oiled (Babcock et al. 1998; Carls et al. 2000).

The extent of oil remaining on these beaches defines the lack of recovery for these sediments. The remaining oil may also impede recovery of injured species still exposed to it. This exposure includes direct contact with water contaminated by the remaining oil, or indirect contact through ingestion of prey contaminated by the oil. The fact that the remaining oil is often so unweathered indicates the oil is still a potent source of toxic polycyclic aromatic hydrocarbons (PAH), which elicit manifold adverse effects on biota exposed to them. These species may include black oystercatchers, clams, intertidal communities, mussels, Pacific herring, pink salmon, sea otters, subtidal communities, and harlequin ducks. In addition, subsistence uses, passive uses, recreation, and tourism may also be impaired because of speculation that the area remains contaminated.

B. Rationale

The plausibility of oil-exposure linkages connecting fauna at higher trophic levels with oiled habitat, as well as the propriety of additional restoration options, depend on an assessment of the amount of oiled habitat remaining in the spill area. Conversely, without this assessment, the public will continue to wonder how much of the spill area remains contaminated, and may make inappropriate decisions regarding resource use based on misperceptions about the extent of remaining oil. Also, scientists evaluating biological linkages to oil exposure will be less able to assess geographic correlation, compromising those studies.

Assessment of the extent of remaining oil should be done now to maximize benefits that may derive from the expected reduction in uncertainty regarding the extent of this oil.

C. Location

This project will be undertaken in PWS during 2001. Communities directly affected by this project include Cordova, Chenega, Tatitlek, Valdez, and Whittier. Benefits of the project will accrue especially to participants in subsistence and commercial fishing, scientists studying resource recovery in the region, and more generally to the public at large.

COMMUNITY INVOLVEMENT

Community involvement has been a critical part of this project from public feedback meetings to local labor needs in Prince William Sound. In FY02, results of this project will be summarized as a map depicting locations and extent of remaining oil discovered, together with a report summarizing the statistical estimate of the amount of oiled shoreline remaining. These materials will be accompanied by a press release announcing these findings to the media for general distribution. Public presentations will be given in Anchorage, Cordova, and Valdez to facilitate public review and commentary on the findings.

PROJECT DESIGN

A. Objectives

This project has four objectives:

1. Determine the amount of shoreline (length, surface area, sediment volume, and oil volume) that remains contaminated with oil in the *Exxon Valdez* oil spill area;

2. Determine the trend in the recovery of oiled shoreline in terms of oiled surface area and sediment volume;

3. Determine the trend in the recovery of subtidal sediments in terms of oil concentrations remaining at locations sampled in 1991; and

4. Verify the source of oil as the *Exxon Valdez* oil spill by "fingerprinting" and characterize the weathering state of the oil remaining in each of the strata sampled.

B. Methods

1. Phase I

The goal of phase I was to produce a final sampling design to be implemented in the field the following spring. A set of design alternatives was developed by Auke Bay Laboratory staff and presented at a workshop on November 2, 2000. Refinements to the design were selected at the end of the workshop.

2. Phase II

Phase II consists of implementing the main sampling efforts of this project to determine the amount and recovery of contaminated shorelines and subtidal sediments in Prince William

Sound. This requires an extensive field season during the summer of 2001 to survey the necessary shoreline. The methods for sampling design, power analysis, sampling effort, and recovery trends have been listed in detail in last years proposal (project 01543).

3. Phase III

Phase III will be carried out during FY01 and will primarily consist of updating the GIS oiled shoreline database, conducting chemical analyses, and completing estimates of contaminated shoreline and trend analyses.

GIS Mapping

Data currently available in the EVOS GIS database (ADNR 1992) are not detailed enough to allow for stratification by shore type prior to sampling. Detailed information on shore type will be taken at each sampling unit so that relationships between oil retention and shore type can be examined. Maps will be generated depicting the survey areas.

Estimate of Contaminated Shoreline in Prince William Sound

We will estimate the surface area and volume of contaminated shoreline based on a random sample of oiled shoreline identified in previous surveys from 1989 to 1993. We define three sampling strata: 1) shoreline having heavy impact in 1990, 1991, or 1993 (ADNR 1992; Gibeaut and Piper 1998a); 2) shoreline with medium impact in 1990, 1991, or 1993; and 3) shoreline with heavy impact in 1989 but only light impact or less in later years.

For analysis, data may be stratified by shoreline type if doing so increases precision of the estimates of total oil. Shoreline type is based on the Environmental Sensitivity Index (ESI) and classifies shoreline locations according to geomorphology and exposure. Heavily impacted locations in 1990 were primarily of five shoreline types: 1) exposed rocky shores; 2) exposed wavecut platforms; 3) mixed sand and gravel beaches; 4) gravel, cobble, boulder beaches; and 5) sheltered rocky shores.

Recovery Trends

The trend in recovery of oiled shoreline will be measured in two ways. First, we will resurvey at least 10 randomly selected sites from the 45 sites that were used in the 1993 shoreline assessment (Gibeaut and Piper 1998a,b). These sites have oiling and cleanup data from 1989 through 1993. At these sites, we will duplicate the sampling procedures of Gibeaut and Piper (1998a, b), as well as conduct the adaptive sampling design to compare results of the two designs.

A second means of determining recovery trend will be to resurvey some of the stations with permanent transects established in 1989 by NOAA and ADEC and resurveyed in 1993 by Gibeaut and Piper (1998a). These stations include high-energy boulder and cobble beaches; moderate-energy boulder, cobble, and pebble beaches; and sheltered set-aside stations. This type of survey entails measuring the profile along a line oriented perpendicular to the shoreline trend

and visually estimating sediment and oiling conditions (Gibeaut and Piper 1998a). Resurveying 15 of these stations will provide quantitative data on erosional and depositional processes related to degradation and dispersal of oil.

Recovery trend of subtidal sediments will be evaluated by resampling 5 locations at 7 decending depths (0-100 m) for a total of 35 samples. These samples will be analyzed by GCMS and the data evaluated by the hydrocarbon source recognition methods developed by Short and Heintz (1997). Comparison of results with the 1991 data will permit assessment of oil persistence at these locations.

Oil Amount in Intertidal sediments

Approximately 150 samples of oiled sediment from pits will be taken for gravimetric analysis to determine oil weight and to calibrate visual estimates of weighting categories. Oil in the collected material is extracted twice with dichloromethane, and the dichloromethane of the combined filtered aliquots is removed by distillation and re-used. The weight of the remaining residue is taken as the amount of oil present within the original sample.

The mean and variance of amount of oil recovered from each category of oil estimated visually by hydrocarbon vapor detection, or by UV-fluorescence will establish the basis for estimating the amount of oil present in each of the approximately 8,000 test pits dug during Phase II of this project, which in turn will establish the basis for extrapolation of results to un-sampled beaches in PWS.

Oil Presence in subtidal sediments

Each of the 35 samples of subtidal sediments collected from the 1991 transects re-sampled during Phase II in 2001 will be analyzed for the same suite of alkane and PAH analytes as were analyzed during the 1991 studies (O'Clair et al. 1996), using the same methods (summarized in Short et al. 1996). These analytes include 24 normal alkanes plus pristane and phytane, and 44 polycyclic aromatic compounds (PACs) ranging from naphthalene through indenoperylene, and including the alkylated isomers of naphthalene, fluorene, dibenzothiophene, phenanthrene, fluoranthene/pyrene, and chrysene. Results from these samples will be compared with corresponding results from the 1991 studies to evaluate trends in hydrocarbon concentrations in these subtidal sediments. These results will also be evaluated using a Baysian statistical approach developed under EVOS Trustee Project 00598 to estimate the proportions of hydrocarbons from Exxon Valdez oil and from natural sources to these sediments.

Oil Source: Fingerprinting

To determine condition of remaining oil and whether it still matches *Exxon Valdez* oil, 24 sediment samples with visible subsurface oil from pits at different sampling sites will be analyzed by GC-MS (summarized in Short et al. 1996) to determine whether PAH composition matches weathered *Exxon Valdez* oil. A weathering index (Short and Heintz 1997) will be determined for each sample.

C. Contracts and Other Agency Assistance

None

SCHEDULE

A. Measurable Project Tasks for FY02 (October 1, 2000 – September 30, 2002)

FY02:	*Closeout year*
Oct 1 – April 15:	Enter FY01 data into a GIS database, analyze FY01 gravimetric and fingerprinting GC-MS samples.
Jan. 14-23:	Attend 2002 Trustee Council Annual Workshop.
April15 – Sep 30:	Produce map depicting sampled locations and present to locals in Prince William Sound.
April15 – Sep 30:	Submit final report and transform for journal publications.

B. Project Milestones and Endpoints

The project has evolved from the development of the sampling design (Phase I), the collection of data from the summer survey crew (Phase II), and now the analysis of samples and synthesis of data will be compiled into a final report (Phase III).

C. Completion Date

September 30, 2002

PUBLICATIONS AND REPORTS

We anticipate that three research papers will be submitted to peer-reviewed scientific journals in FY02. Probable titles of these papers will be "*Amount of oil contamination in Prince William Sound 11 years after the Exxon Valdez oil spill*," "*Trend of recovery of subsurface oil after the Exxon Valdez oil spill*," and "*Identification and weathered condition of remaining Exxon Valdez oil 11 years after the spill.*"

PROFESSIONAL CONFERENCES

None Planned for FY02.

NORMAL AGENCY MANAGEMENT

If the oil spill had not occurred, neither NOAA nor the cooperating agencies would be conducting this project.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will be coordinated through participation of the cooperating agencies. Formal coordination commenced at the November workshop in Anchorage. All of the previous Trustee-funded studies on oil persistence in the spill region have been performed under the auspices of these agencies, and it is presumed that local knowledge is the only significant source of additional information relevant to this project outside these agencies.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

None

PROPOSED PRINCIPAL INVESTIGATOR

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Phone: (907) 789-6065
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e-mail: jeff.short@noaa.gov

PRINCIPAL INVESTIGATORS

Jeffrey W. Short

Education: M.S. (Physical Chemistry)

Relevant Experience:
1989- Present: Established and managed the hydrocarbon analysis facility at ABL to analyze hydrocarbon samples generated by the *Exxon Valdez* NRDA effort (about 20% of these samples were analyzed at ABL).

1989 - 1992: Principal Investigator, Exxon Valdez project Air/Water #3: Determination of petroleum hydrocarbons in seawater by direct chemical analysis and through the use of caged mussels deployed along the path of the oil spill.

1991 - 1996: Principal Investigator, Exxon Valdez project Subtidal #8: Development of computer-based statistical methods for global examination of sediment and mussel hydrocarbon data produced for the Exxon Valdez NRDA effort for systematic bias, and for identification of probable sources of hydrocarbons.

1996 - present: Principal Investigator, Restoration Project 290, Database Management.

OTHER KEY PERSONNEL

1. Patricia Harris, Zoologist, Auke Bay Laboratory, will assist in supervising field sampling, data analysis, and coordinate interactions with local communities.

2. Mandy Lindeberg, Fisheries Biologist, Auke Bay Laboratory, will assist in supervising field sampling, data analysis, and writing.

3. Jerome Pella, the senior biometrician at the Auke Bay Laboratory, will consult on sampling design and data analysis.

LITERATURE CITED

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Brodersen, C.C., J.W. Short, L. Holland, M.G. Carls, J. Pella, M. Larsen, and S.D.Rice. 1999. Evaluation of oil removal from beaches 8 years after the *Exxon Valdez* oil spill. Proc. 22nd Arctic and Marine Oil Spill Program, Environment Canada, Calgary, June 1999, pp. 325-336.

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Gibeaut, J. C., and E. Piper. 1998a. 1993 shoreline oiling assessment of the *Exxon Valdez* oil spill. *Exxon Valdez* oil spill restoration project 93038 final report.

Gibeaut, J. C., and E. Piper. 1998b. 1993 shoreline oiling assessment of the *Exxon Valdez* oil spill. *Exxon Valdez* oil spill restoration project 93038 data report, Volumes 1-6.

Hayes, M. O., and J. Michel. 1999. Factors determining the long-term persistence of *Exxon Valdez* oil in gravel beaches. Mar. Pollut. Bull. 38:92-101.

Irvine, G. V., D. H. Mann, and J. W. Short. 1999. Multi-year persistence of oil-mousse on high energy beaches distant from the Exxon Valdez spill origin. Mar. Pollut. Bull. 38:572-584.

O'Clair, C. E., J. W. Short, and S. D. Rice. 1996. Contamination of intertidal and subtidal sediments by oil from the Exxon Valdez in Prince William Sound. Am. Fish. Soc. Symp. 18:61-93.

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Short, J. W., T. J. Jackson, M. L. Larsen, and T. L. Wade. 1996. Analytical methods used for the analysis of hydrocarbons in crude oil, tissues, sediments, and seawater collected for the Natural Resources Damage Assessment of the Exxon Valdez oil spill. Am. Fish. Soc. Symp. 18:140-148.

Short, J. W., and R. A. Heintz. 1997. Identification of *Exxon Valdez* oil in sediments and tissues from Prince William Sound and the northwestern Gulf of Alaska based on a PAH weathering model. Environmental Science & Technology 31:2375-2384.

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Thompson, S. K., and G. A. F. Seber. 1996. Adaptive sampling. John Wiley & sons, Inc. New York.

FY 02 *EXXON VALDEZ* TRUS COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel	$89.1	$71.3
Travel	$30.0	$3.7
Contractual	$284.9	$17.9
Commodities	$9.0	$8.3
Equipment	$10.0	$0.0
Subtotal	$423.0	$101.2
General Administration	$31.6	$11.9
Project Total	$454.6	$113.1
Full-time Equivalents (FTE)	1.0	1.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
Estimated FY 2003					
$0.0					

Dollar amounts are shown in thousands of dollars.

Comments:

Phase I of this project (planning workshop) was completed in Nov. 2001 **Phase II** included the detailed costs of field sampling, labor, and vessel charters in FY01. This is the **Phase III** budget for FY02 which includes data and chemical analyses, and completion of a final report .

NOAA Contribution: Jeff Short 2mo@ 20.6 K, Jeep Rice 1 mo @13K for a total NOAA contribution of 30 K

FY02

Prepared:4/13/01

Project Number: 02543 Phase III
Project Title: Evaluation of Oil in the Intertidal from the EVOS
Agency: NOAA- Auke Bay Laboratory

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 02 *EXXON VALDEZ* TRUS COUNCIL PROJECT BUDGET

October 1, 2001 September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
Jeff Short	Research Chemist	GS/14	0.5	10.6		5.3
Mandy Lindeberg	Fisheries Research Biologist	GS/11	6.0	6.0		36.0
Josie Lunasin	chemist	GS/9	2.0	6.0		12.0
Larry Holland	chemist	GS/11	1.0	7.4		7.4
Jacek Maselko	Programmer (GIS database)	GS/9	2.0	5.3		10.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		11.5	35.3	0.0	
					Personnel Total	$71.3

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
					0.0
Junuea/Anchorage Trustee Annual Workshop	0.4	2	2	0.2	1.2
					0.0
Juneau/Cordova	0.4	2	4	0.2	1.6
Air Charter $300/hr	0.3	3			0.9
Final Results outreach to Chenega, Valdez, Tatitlek					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.7

FY02

Prepared:4/13/01

Project Number: 02543
Project Title: Evaluation of Oil in the Intertidal from the EVOS
Agency: NOAA- Auke Bay Laboratory

FORM 3B
Personnel
& Travel
DETAIL

FY 02 *EXXON VALDEZ* TRUS COUNCIL PROJECT BUDGET

October 1, 2001 September 30, 2002

Contractual Costs:		Proposed FY 2002
Description		
Temporary labor (NOAA) chem lab support		12.9
Contract labor technical support		5.0
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$17.9

Commodities Costs:		Proposed FY 2002
Description		
150 Gravimetric Samples		
Chemicals		2.3
lab supplies		2.0
60 samples for GC/MS Analysis		
chemicals		2.0
lab supplies		2.0
	Commodities Total	$8.3

FY02

Prepared:4/13/01

Project Number: 02543
Project Title: Evaluation of Oil in the Intertidal from the EVOS
Agency: NOAA - Auke Bay Laboratory

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2002
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency
Computer Equipment		NMFS
HPLC		NMFS
GC/MS		NMFS

FY02

Project Number: 02543
Project Title: Evaluation of Oil in the Intertidal from the EVOS
Agency: NOAA - Auke Bay Laboratory

FORM 3B
Equipment
DETAIL

Prepared:4/13/01

Assessing harbor seals: Methods to identify metabolic responses to environmental change

Project Number:	02546
Restoration Category:	Research
Proposer:	Dr. Michael Castellini, University of Alaska Fairbanks
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	None
Alaska SeaLife Center:	No
Duration:	1st year, 1 year project
Cost FY02:	$47.1
Cost FY03:	None
Geographic Area:	Laboratory analysis, Fairbanks
Injured Resource:	Harbor seals

ABSTRACT

This package is a relatively small pre-GEM proposal to provide final design and sensitivity testing for what we believe to be an extremely powerful sampling scheme and software approach to monitoring population wide health patterns in harbor seals. Much like the concept of genetic fingerprinting, this method uses a novel blood chemistry fingerprinting technique that can easily separate sub-populations of animals based on a suite of 20-30 blood chemistry values. We have termed this method "Metabolic Identity" and we intend to use it as the core of a long running GEM proposal. This FY02 EVOS proposal it to conduct the pre-deployment testing of the method and to test its strength and robustness.

INTRODUCTION

This package is a relatively small pre-GEM proposal to provide final design and sensitivity testing for what we believe to be an extremely powerful sampling scheme and software approach to monitoring population wide health patterns in harbor seals. In fact, the method could be used for any population of animals, but is confined in this proposal to EVOS-GEM related issues with marine mammals.

In work supported by the Rasmuson Fisheries Fellowship, one of our PhD students (Steve Trumble) has developed a statistical test that allows us to assign a "Metabolic Identity" to whole groups of seals (Trumble and Castellini, 2001). Much like the concept of genetic fingerprinting, his method uses a novel blood chemistry fingerprinting technique that can easily separate sub-populations of animals based on a suite of 20-30 blood chemistry values. We believe this Metabolic Identity may be in some sense more powerful than genetic identity because it provides a picture of how animals have responded to their environment through metabolic translation of their genetic codes. That is, while the genetic code describes the full range of potential adaptations, which responses are actually utilized better describe how the animal has responded to its environment.

We have begun planning a major GEM package for submission next year on harbor seals, to monitor how they respond to temporal and geographical variances in their environment using Metabolic Identity as the backbone of our sampling paradigm. However, in the meantime, we need to conduct the final sensitivity tests and parameter limits of the Metabolic Identity method to essentially BETA test this process.

This work would be an expansion of the PhD thesis for Mr. Trumble beyond what is supported by his Rasmuson Fellowship and into an area that we believe has great potential for EVOS related studies. The grant does not need field or travel time, has very little laboratory work and focuses on refining the Metabolic Identity package. Our purpose is to test the analysis now, so that when we submit our GEM package for field work with harbor seals next year, the method will be formalized, robust and ready to apply. This will allow our GEM work to begin immediately without having to spend time developing and testing methods.

NEED FOR THE PROJECT

A. Statement of the problem

Assessing population level health assessment of any species must incorporate methods that can identify animals outside of normal population parameters. This is distinct from the health of an individual animal within that group, which is a diagnostic and clinical approach. Our laboratory has been working on developing such population methods for marine mammals using values that can be obtained from blood chemistry and morphometrics. Our approach has been to examine animals from healthy and compromised populations (eg, Eastern and Western Steller sea lions), from populations that have been exposed to some perturbation (eg, harbor seals and EVOS) and from pristine, healthy populations (eg, Antarctic species). We have produced a number of

reports, papers and PhD theses that show the time line of our theory development (Castellini et al., 1993; Rea et al., 1998). Up until last year, we were able to show how individual chemistries may be used to distinguish populations (Zenteno et al., 1997), but had only a very preliminary view of how to apply our methods to whole groups of animals using many blood variables. Through past EVOS support, we produced a PhD thesis (Fadely et al., 1998) that suggested a possible method for grouping variables and defining outliers, but that method was not the goal of the thesis and was not pursued any further through subsequent EVOS funding.

While working on a Rasmuson Fisheries PhD graduate fellowship, Steve Trumble took our original outlier concept and developed a method to assign a single statistical identity to whole groups of animals using upwards of 20 different blood chemistry values. This essentially provides a metabolic fingerprint of a population. We have already used it to easily distinguish harbor seal pups from around Kodiak, vs those in Prince William Sound and from California. (Trumble and Castellini, 2001). This method will be extremely powerful in the GEM paradigm because we should be able to track harbor seals through time and space and quantify their metabolic response to the environment.

Everyone is familiar with the concept of genetic identity and that this identity is fixed. If someone is sampled today, his or her genetic pattern will be exactly the same as a sample taken 30 years from now. What about the translation of that identity into the metabolic status of that individual? Genes turn on an off and proteins are expressed depending on a host of environmental and internal metabolic demands. How those genes are expressed is translated into the metabolic identity of the animal. We have used our Metabolic Identity method to differentiate groups of harbor seal pups with a geographic model, but not a temporal model. If one were to sample the same group of harbor seals over 10 years, would their metabolic identity change? We believe that while some patterns are genetically fixed, some respond to environmental and internal cues.

B. Rationale

The actual GEM proposal will address the field issues of harbor seal adaptation to change and we will propose a relatively simple geographical and temporal sampling scheme at that time. However, in the meantime, the Metabolic Identity method needs to be finalized and packaged so that it is as easy to use and robust as possible when GEM initiates.

C. Location

There is no field work or travel associated with this project. It will be carried out solely at the University of Alaska in Fairbanks.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

In our past EVOS work, we were involved in significant community interactions with the Alaska Native Harbor Seal Commission and traveled extensively to work in the field with Native hunters or to attend TEK meetings. We expect that our GEM work will once again involve these types of interactions. However, the testing of the Metabolic Identity model will not *per se* involve any

field or collection methods that would lend itself to community interactions. However, we hope that this method would become widely used and distributed.

PROJECT DESIGN

A. Objectives

This short, one-year project has a single goal with several easily defined objectives:

Goal:

Derive the mathematical and statistical limits of the Metabolic Identity method in order to prepare it for GEM utilization.

Objectives:

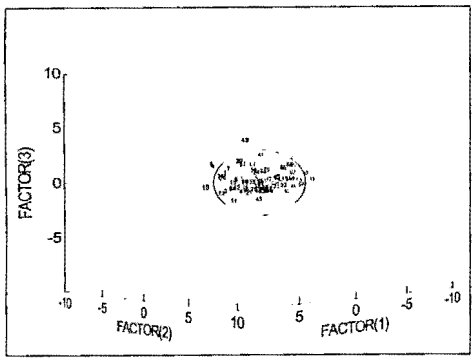
1. Add and test new parameters that we suspect respond to dietary shifts.
2. Determine how many variables are minimally necessary to provide a statistically significant and powerful differentiation of populations.
3. Refine the front end of the software package to make it easily transportable and user-friendly

These objectives are defined to enhance the biological background for the Identity model (Objective 1), the mathematical strength (Objective 2) and user enhancement (Objective 3).

B. Methods

The Metabolic Identity Method:

We have applied our method to test harbor seal pups from Alaska waters. In this study, our approach was to use informal multivariate statistical methods to assess outliers in blood chemistry on two geographically distinct populations of harbor seal pups in Alaska. To detect outliers, we employed a technique that involves the singular value decomposition of 25 blood chemistry parameters. In essence, standardized blood parameters from individual animals were used to produce a set of coordinates in a q dimensional space from an $n \times p$ matrix. The outliers were identified as being outside a 95% confidence interval in a 3-dimensional array using a quasi-continuous sequence of rotations of the data cloud (Figs. 1-2).



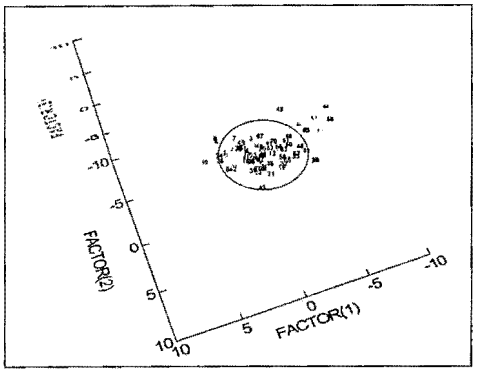


Fig. 1. (LEFT) PWS and Tugidak Is. harbor seal pup outliers. The outliers were identified as being outside a 95% confidence interval in a 3-Dimensional array using a quasi-continuous sequence of rotations of the data cloud.

Fig. 2. PWS (RIGHT) and Tugidak Is. harbor seal pup outliers. Rotations of the data cloud reveals additional outliers

For outliers detected within a population, we used a Pearson correlation dissimilarity cluster analysis to determine what blood parameters were responsible for an animals "outlier" status (Fig. 3)

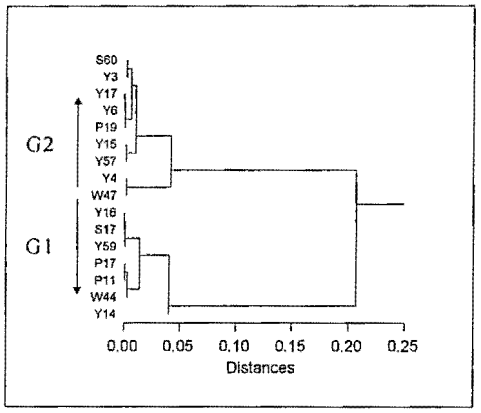


Fig 3. Subgroups identified from individual outlier pups using cluster analysis. Note: Pups are identified by corresponding letter and number. Depending on year captured (P=1997, W=1998, S=1999, Y=2000 for pups in PWS; T=1997, U=1998, G=1999, X=2000 for Tugidak pups)

Pups were singly plotted against values minimum and maximum plasma chemistry values (minus outliers) obtained from each population, data standardized and graphically displayed as a cluster analysis (Fig. 4). From the method of using blood parameters to detect outliers on a 3D output, we took another step and used discriminate analysis to determine if populations were parallel in these parameters.

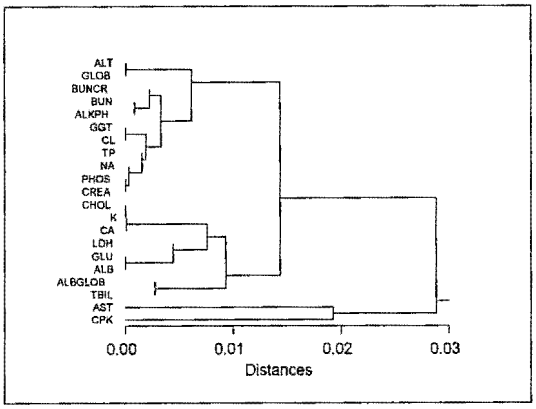


Fig 4. Cluster analysis of blood chemistry parameters from an individual harbor seal pup. Note: Arrows point to chemistries responsible for outlier status in pup. PWS (above) and Tugidak Is. (below).

Using this multi variate Discriminate Analysis technique we have been able to separate these harbor seal pups based on standard blood chemistry panels. We determined the relative importance of each blood variable with respect to separation among groups of harbor seal pups. For instance, from this study we concluded that Na and Cl were the blood variables most responsible for separation among groups accounting for approximately 50% of the relative importance of all blood variables. That is, from these two variables alone, we can correctly classify any seal captured from these areas with 50% confidence. Interestingly, Na and Cl were not affected in captive harbor seal feeding trials (EVOS support at the ASLC). However, ten variables (Na, Cl, P, Albumin, ALT, Creatinine, protein, globulin, cholesterol, and K) are needed to confidently classify populations at the 90% level. From previous captive studies we have determined that 4 of these blood chemistry variables respond to changes in diet (ALT, creatinine, and protein, globulin). While we are aware that some blood variables alter with dietary changes we believe that these "Metabolic Identities" are relatively fixed because of the dependence among organ systems and the relatively few variables that are affected by a change in diet (to date we have isolated 6 out of 23 blood chemistry parameters that are affected by changes diet). However, assuming that blood variables not affected by diet are genetically fixed any shifts in the position of the population centroid using the Discriminate Analysis technique would therefore be attributed to some environmental perturbation (i.e. change in food quality). This would offer an effective assessment of population wide perturbations during long-term monitoring studies.

We have conducted a preliminary power analysis to determine the theoretical sensitivity curve of how many variables are necessary to run this program as shown in Figure 5 below.

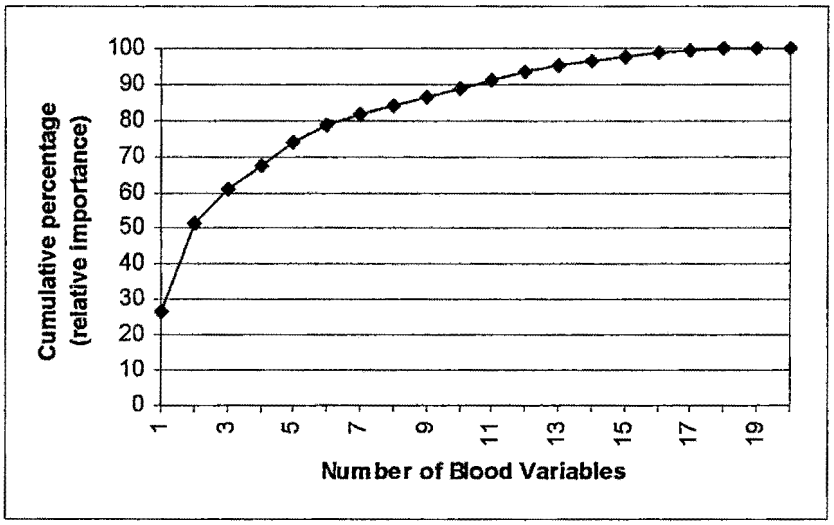
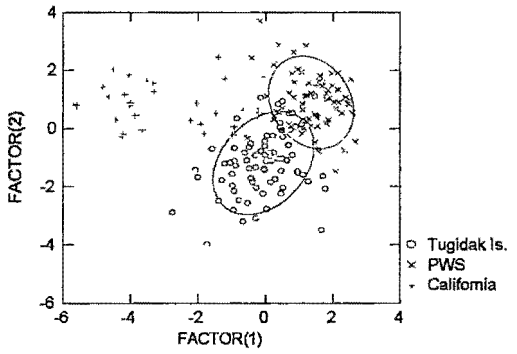


Figure 5. Plot of sensitivity of Metabolic Identity to number of variables.

In the final analysis, a plot of the groupings of harbor seals using this method is shown in Figure 6. In this case, harbor seals pups from PWS, Kodiak and California are clearly distinguished.



Objective 1.
Add and test new parameters that we suspect respond to dietary shifts.

As noted above, in other studies (EVOS funded harbor seal feeding trials at the ASLC) we have identified about 6 blood chemistry variables that clearly respond to dietary shifts. We suspect from work published on harbor seals at other locations (Thompson et al., 1997), that there may be other hematological and chemical variables that are also sensitive to diet. We have not included hematological values in the Identity testing to date, although future models will include these variables. Our preliminary analysis shown in Figure 5 above suggests that approximately 15-20

15-20 parameters can provide a very high level of confidence in correctly identifying populations of animals.. Clearly, the selection of WHICH 20 variables are chosen can influence whether that classification tends towards fixed, dietary influenced or environmentally influenced results. During the course of the year, we will run a suite of sensitivity tests to determine how many variables of each kind tend to influence the results. For example, what would happen if 18 variables are chosen, 6 of which are theoretically fixed, 6 of which respond to diet and 6 of which respond to contaminants?

It is vital to note that these types of tests are critical to the effective application of this method to a potential GEM package and that this testing is NOT part of the current PhD work for Mr. Trumble. Mr. Trumble has essentially finished his work on this method as far as his academic requirements demand. This proposed EVOS package would allow us the time and the ability to expand it and prepare it for GEM.

In summary, for this objective, we will determine how classification and grouping of specific blood chemistry, hematological and morphological variables impacts the statistical "distance" among populations of seals so that we assess the animals response to certain environmental conditions We still have a few blood samples left in our archives that should be analyzed and added to the database on harbor seals for this project. Therefore, we are requesting enough analytical time to process at most 100 more samples. No new samples will be collected for this objective and there is no field time component.

Objective 2:
Determine how many variables are minimally necessary to provide a statistically significant and powerful differentiation of populations.

As shown above in Figure 5, our preliminary analysis shows that high degree of statistical certainty can be achieved using 15-20 blood chemistry variables. While objective 1 is meant to explore which variables should be used, this objective asks how many should be used? We will determine the minimal number of variables necessary to run the Identity package with resulting statistical and power analysis limitations. In addition, how many variables can be run before you reach the point of diminishing returns? We have reason to believe that this package could be run with hundreds of variables. However, is the field and laboratory effort necessary to run such a large sample set necessary? Perhaps, if one was interested solely in nutrition markers, the test could be set up with 15-20 known markers that respond to diet. On the other hand, perhaps it would take more markers for those that respond to contaminants. This level of testing if what we are proposing in this EVOS package.

Objective 3:
Refine the front end of the software package to make it easily transportable and user-friendly

All of the software used for Metabolic Identity is commercially available. Our laboratory has written none of the software. However, there are multiple steps involved in manipulating the packages (primarily SYSTAT, ACCESS, EXCEL and SIGMAPLOT) that would not be intuitive

at this point to anyone beside Mr. Trumble. In order for others to effectively use Metabolic Identity in their research (both inside and outside our laboratory...new students, postdoctoral fellows, etc), we need to produce a Users manual and perhaps a CD based tutorial for distribution. It is critical to understand that we do not have a mathematical algorithm that no one else could understand or test. The software behind Metabolic Identity is readily available and the process is relatively straightforward. In order for the scientific community to test and verify our method however, we need to make the exact method available. This section of the proposal would be to produce such a manual, troubleshoot the teaching of the method and produce a set of sample solutions so that others could use the process.

Conclusion:
We will be submitting a package for GEM next year that will deal with monitoring the health and nutritional status of harbor seals. In that proposal, we intend to use the concept of Metabolic Identity as the core concept around which our sampling scheme will be built. We intend to ask the question of how time and space impact the adaptation of harbor seals to environmental changes. This current EVOS proposal is to conduct the final testing and applicability of Metabolic Identity to such a program. By defining its strengths and weaknesses now, we will be able to focus our GEM proposal on the study design and field effort associated with running a long term project instead of using time to develop the models and tests.

C. Cooperating Agencies, Contracts and Other Agency Assistance

None

SCHEDULE

A. Measurable project tasks for FY02 (October 1, 2001 - September 30, 2002)

October - December:	Sensitivity Analysis Software upgrades
January-March:	Biological enhancement Addition of further variables
April-June:	Software enhancement User interface upgrades GEM proposal submission
July-September:	Final product testing Preparation for GEM rollout

B. Project Milestones and Endpoints

The three objectives will be met in the Quarterly project tasks as noted above. The milestones will be the completion of the additional variables, the final testing of archived samples and the ultimate production of the user-friendly version of the Identity package

C. Completion Date

This is a 1 year project and will be completed by September 2002, in time for the initiation of GEM.

PUBLICATIONS AND REPORTS

We expect a publication on the Identity method and its applications to marine mammals in late 2001 or early 2002. We have not yet identified a journal.

PROFESSIONAL CONFERENCES

None are requested in this project.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

There is no planned coordination with other EVOS related project in this proposal, although we expect the method may be used by other EVOS and GEM teams.

PROPOSED PRINCIPAL INVESTIGATOR

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907 474 7204 fax
mikec@ims.uaf.edu

PRINCIPAL INVESTIGATOR

Dr. Michael Castellini, Professor of Marine Biology at the University of Alaska Fairbanks, will be the primary investigator for this project. Dr. Castellini has worked in the field of marine mammal physiology and metabolism for over 25 years. He has held several past EVOS projects on harbor seals and was the Science Director for the Alaska SeaLife Center for four year.

OTHER KEY PERSONNEL

Mr. Steve Trumble will be the primary graduate student on this project. Steve created the concept of how to characterize populations of marine mammals using this Metabolic Identity concept and understands the analysis better than anyone else. He has worked on harbor seal biology for over 10 years and was resident at the Alaska SeaLife Center for 2.5 years where he worked on EVOS related projects.

J.M. Castellini is a Research Associate in the laboratory and is in charge of QA/QC issues, computer upgrades and project day to day management. She has worked in the field of marine mammal biochemistry since 1986.

LITERATURE CITED

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Fadely, B.S., J.M. Castellini and M.A. Castellini. Recovery of harbor seals from EVOS: Condition and Health Status, *Exxon Valdez* Oil Spill Restoration Project Final Report (97001), Alaska Department of Fish and Game, Anchorage, AK. 1998.

Rea, L.D., M.A. Castellini, B.S. Fadely and T.R. Loughlin. Health status of young Alaska Steller sea lion pups as indicated by blood chemistry and hematology. Comparative Biochemistry and Physiology. 120 A: 617-623. 1998.

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Zenteno-Savin, T., M.A. Castellini, L.D. Rea and B.S. Fadely. Plasma haptoglobin levels in threatened Alaskan pinniped populations. Journal Wildlife Diseases. 33(1):64-71. 1997.

2002 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$0.0
Travel		$0.0
Contractual		$47.1
Commodities		$0.0
Equipment		$0.0
Subtotal		$47.1
General Administration		$3.3
Project Total		$50.4
Full-time Equivalents (FTE)		0.6
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
Estimated FY 2003					

Dollar amounts are shown in thousands of dollars.

Comments:

FY02

Prepared: April 2001

Project Number: 02 546
Project Title: Assessing Harbor Seals: Methods to Identify Metabolic Responses to Environmental Change
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2002 *EXXON VALDEZ* TRUS COUNCIL PROJECT BUDGET
October 1, 200. September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$29.1
Travel		$0.7
Contractual		$3.5
Commodities		$2.0
Equipment		$2.3
Subtotal		$37.6
Indirect		$9.5
Project Total		$47.1
Full-time Equivalents (FTE)		0.6
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
Estimated FY 2003					

Dollar amounts are shown in thousands of dollars.

Comments:

The indirect rate is 25% TDC, as negotiated by the Exxon Valdez Oil Spill Trustee Council with the University of Alaska.

FY02

Prepared: April 2001

Project Number: 02 546
Project Title: Assessing Harbor Seals: Methods to Identify Metabolic Responses to Environmental Change
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

2002 *EXXON VALDEZ* TRUS :OUNCIL PROJECT BUDGET
October 1, 200' ptember 30, 2002

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2002
	Michael A. Castellini	Professor	1.0	7.5		7.5
	J.M. Castellini	Res. Associate	3.0	4.1		12.3
	PhD Student	PhD Student	3.0	3.1		9.3
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	7.0	14.7	0.0	
					Personnel Total	$29.1

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2002
	Catellini 1 R/T Fairbanks-Anchorage	0.3	1	2	0.2	0.7
	(attend Trustee Council workshop)					0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$0.7

FY02

Prepared: April 2001

Project Number: 02546
Project Title: Assessing Harbor Seals: Methods to Identify Metabolic Responses to Environmental Change
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

2002 *EXXON VALDEZ* TRUS COUNCIL PROJECT BUDGET
October 1, 200[illegible] September 30, 2002

Contractual Costs:	Proposed FY 2002
Description	
Blood Analysis	3.5
Contractual Total	$3.5

Commodities Costs:	Proposed FY 2002
Description	
Lab Expendables	1.0
Software	1.0
Commodities Total	$2.0

FY02

Prepared: April 2001

Project Number: 02546
Project Title: Assessing Harbor Seals: Methods to Identify Metabolic Responses to Environmental Change
Name: University of Alaska Fairbanks

FORM 4B
Contractual & Commodities
DETAIL

2002 *EXXON VALDEZ* TRUS COUNCIL PROJECT BUDGET
October 1, 200. September 30, 2002

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2002
Computer	1	2.3	2.3
			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**		$2.3

Existing Equipment Usage:	Number	
Description	of Units	

FY02

Prepared: April 2001

Project Number: 02546
Project Title: Assessing Harbor Seals: Methods to Identify Metabolic Responses to Environmental Change
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Alaska Resources Library & Information Services (ARLIS)

Project Number: 02550

Restoration Category: Public Information, Science Management and Administration

Proposer: Restoration Office

Lead Trustee Agency: All Trustee Agencies

Alaska SeaLife Center: No

Duration: Ongoing

Cost FY 02: $140,300

Cost FY 03: TBD

Geographic Area: All

Injured Resource/Service: All

ABSTRACT

Project 02550 represents the Trustee Council's contribution to Alaska Resources Library and Information Services (ARLIS). ARLIS serves as a central access point for information generated through the Trustee Council restoration process and the transition phase of the GEM program. In addition, ARLIS acts as the public repository for reports and other materials generated from and related to the cleanup, damage assessment and restoration efforts following the *Exxon Valdez* oil spill (EVOS).

INTRODUCTION

The Trustee Council has contributed budgetary support for ARLIS since the library was established in 1997. ARLIS is providing services that were previously provided through the Oil Spill Public Information Center (OSPIC). With the exception of Fiscal Year 1994, this activity has historically been funded under the Public Information, Science Management and Administration budget (Project 1100).

In Fiscal Year 2002, the Trustee Council will continue to support one librarian at ARLIS. In addition, the Council continues to contribute funding to support the building lease, subscriptions, and other expenses. Council funding in Fiscal Year 2003 and beyond will be assessed on an annual basis.

NEED FOR THE PROJECT

Over the years, a vast array of material has been produced as a result of the restoration program. ARLIS provides guidance to the principal investigators regarding preparation of the reports, distributes the reports to individuals and libraries as appropriate, and acts as a repository of all reports and publications generated as a result of the restoration process. ARLIS also supplies the principal investigators with research materials and reference service pertinent to their restoration projects.

ARLIS provides universal access to Alaska natural and cultural resources information. The ARLIS collection contains 150,000 books, including agency publications, technical reports, and masters and doctoral theses, 700 journals, maps and atlases, legal reference materials, federal and state documents, public review documents, administrative records, videotapes, audiotapes, slides, photographs, electronic databases, environmental education kits, and a circulating collection of furs, skulls, and mounted birds. These materials are cataloged in a global bibliographic database making most circulating items accessible to users around the world. The library catalog is available for searching at the ARLIS website at www.arlis.org.

The ARLIS staff provides reference service, literature searches, and document delivery to Restoration Office staff working on Project 02535 and creating documents and databases for the GEM program.

Since it was established in October 1997, ARLIS annually receives 21,000 visitors, responds to 15,000 requests for information, performs over 11,000 interlibrary loans and circulates 14,000 books. Approximately 15% of the use of the library is directly related to the *Exxon Valdez* oil spill and the Trustee Council's restoration program. In addition, 15% of the materials borrowed by other libraries from ARLIS are EVOS materials.

A. Statement of the Problem

The Trustee Council's policies, as specified in the Restoration Plan and the GEM program, include a strong commitment to public information. ARLIS ensures that findings and results of restoration efforts are available to the public, scientists, and agency staff to help understand the status of injured resources and services and to plan for future restoration, research and monitoring.

B. Rationale/Link to Restoration

Project 02550 provides essential support to implement the restoration program as directed by the Trustee Council and guided by the *Restoration Plan* and during the transition to the GEM program.

C. Location

ARLIS is located at 3150 C Street, Anchorage, Alaska.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Project 02550 supports various aspects of community involvement. This includes public information efforts to assist the general public and spill community residents to learn about the restoration program. ARLIS provides research support to those principal investigators conducting research in the areas of subsistence and traditional ecological knowledge.

PROJECT DESIGN

A. Objectives

The fundamental objective for ARLIS is to provide research materials to governmental agencies, the general public and spill community residents.

Specific objectives for FY 01 include:

1. Provide access to local, state, national, and international users of restoration program information.

B. Methods

ARLIS provides access to information through participation in library networks and a global bibliographic database. Through cooperative collection development efforts, appropriate books, technical reports, journals, gray literature, videotapes, maps, and other materials are acquired and cataloged. A web accessible library catalog, through a partnership with the University of Alaska Anchorage Consortium Library and the Anchorage Municipal Libraries, provides worldwide access to ARLIS materials through interlibrary loan services. Some full text publications are available through web links in the catalog record. Reference service is provided on-site and off-site via phone, mail, fax and email. The library provides in-house access to journal indexes to the general public and desktop access to agency users. Additional indexes are available through a partnership with the UAA Consortium Library.

C. Cooperating Agencies, Contracts and Other Agency Assistance

ARLIS is a partnership of eight natural and cultural resource libraries and information centers including:

U.S. Fish and Wildlife Service Library
Alaska State Department of Fish and Game Habitat Library
U.S. Bureau of Land Management Library
U.S. Minerals Management Service Library
U.S. National Park Service Library
U.S. Geological Survey Library
Arctic Environmental Information and Data Center Library
Exxon Valdez Oil Spill Public Information Center

The University of Alaska Anchorage is also a partner, although its library collection is not a part of ARLIS.

ARLIS shares a library catalog with the Anchorage Municipal Libraries and the University of Alaska Anchorage Consortium Library. The holdings of all partner libraries can be searched from the ARLIS web site by anyone with Internet access.

SCHEDULE

The Trustee Council operates on the Federal Fiscal Year (October 1 - September 30).

A. Measurable Project Tasks for FY 02 (October 1, 2001 - September 30, 2002)

On-going tasks throughout the fiscal year:

1. Review and approve format of final and annual reports, maintain a list of completed reports, and distribute reports to appropriate libraries. Catalog reports in a global bibliographic database for access throughout the world.
2. Maintain for public review the public record copy of the Trustee Council official record.
3. Maintain for public access a file of peer reviewed journal articles and conference papers resulting from Trustee Council funded research.
4. Provide reference service for oil spill related topics and other information needs to the Trustee Council, Restoration Office staff, science review staff, principal investigators, media, students and faculty, spill area residents, and the general public.
5. Acquire and catalog publications generated by the Trustee Council and other oil spill and restoration related materials deemed appropriate for the collection and necessary to the restoration program.

B. Milestones and Endpoints

1. Provide monthly reports to the Restoration Office on the status of the report format review and distribution process.
2. Provide quarterly reports and an annual summary of library usage statistics and

staff projects.

C. Completion Date

Council funding in Fiscal Year 2003 and beyond will be assessed each year.

PUBLICATIONS AND REPORTS

Not applicable to this project.

NORMAL AGENCY MANAGEMENT

Funding in Project 02550 is for the sole purpose of supporting restoration program activities and may not be used for other purposes.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Unless otherwise specified by the Restoration Office, each project funded by the Trustee Council is required to submit an annual report and a final report. As the public repository, all reports are cataloged and housed at ARLIS.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

In October 1997, the Oil Spill Public Information Center (OSPIC) was consolidated with seven other state and federal agency libraries to create ARLIS. Planning for the consolidation was done by library staff, with the guidance of a Management Advisory Group consisting of participating agency heads, through the U.S. Department of Interior, under the auspices of the Reinventing Government program. Although ARLIS was established as a cost saving measure in response to federal and state budget cuts, the resulting library provides a vastly more comprehensive collection of Alaska resource information in a single location, served by highly qualified staff specializing in resource related information.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

Carrie Holba holds a masters degree in Library and Information Science. In February 1991, she joined the staff of the Oil Spill Public Information Center, serving as public services librarian and then as director since 1992. Since OSPIC was consolidated with ARLIS in October 1997, Ms. Holba has served as reference service coordinator and a member of the ARLIS library management team, and continues to specialize in EVOS related reference service.

FY 02 *EXXON VALDEZ* TRU[redacted] COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	PROPOSED FY 2002 TRUSTEE AGENCIES TOTALS ADEC	ADF&G	ADNR	USFS	DOI	NOAA
				$89.2			$51.1	
Personnel	$75.6	$77.6						
Travel	$0.0	$0.0						
Contractual	$39.4	$47.8						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$115.0	$125.4	Estimated					
General Administration	$14.1	$14.9	FY 2003					
Project Total	$129.1	$140.3	TBD					
Full-time Equivalents (FTE)	1.0	1.0						
			Dollar amounts are shown in thousands of dollars.					
Other Resources	$0.0	$0.0	$0.0					

Comments:

This budget is for the Trustee Council contribution to funding for the Alaska Resources Library and Information Services (ARLIS). With the exception of Fiscal Year 1994, this activity has historically been funded under the Public Information, Science Management and Administration budget (Project 1100). Funding as a project began in Fiscal Year 2001, as Project 01550.

FY02

Prepared:

Project Number: 02550
Project Title: Public Information, Science Management and Administration - ARLIS
Lead Agency: Multiple

FORM 2A
MULTI-TRUSTEE AGENCY SUMMARY

Budget Category:	Authorized FY 2001	Proposed FY 2002

FY 02 *EXXON VALDEZ* TRU[redacted] COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Personnel	$75.6	$77.6
Travel		$0.0
Contractual		$0.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$75.6	$77.6
General Administration	$11.3	$11.6
Project Total	$86.9	$89.2
Full-time Equivalents (FTE)	1.0	1.0

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2003					
TBD					

Dollar amounts are shown in thousands of dollars.

Other Resources

Comments:

FY02

Prepared:

Project Number: 02550
Project Title: Public Information, Science Management and Adminstration - ARLIS
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
Holba	Librarian III	19J	12.0	6.5		77.6

						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal	[redacted]	12.0	6.5	0.0	[redacted]
					Personnel Total	$77.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
					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

FY02

Prepared:

Project Number: 02550
Project Title: Public Information, Science Management and Administration - ARLIS
Agency: Alaska Department of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FY 2002

When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 2002
Description	
Commodities Total	$0.0

FY02

Prepared:

Project Number: 0233[illegible]
Project Title: Public Information, Science Management and Administration - ARLIS
Agency: Alaska Department of Fish and Game

FORM 3B
Contractual & Commodities
DETAIL

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2002
Description			
			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

FY02

Prepared:

Project Number: 02550
Project Title: Public Information, Science Management and Administration - ARLIS
Agency: Alaska Department of Fish and Game

FORM 3B
Equipment
DETAIL

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$0.0
Travel		$0.0
Contractual	$39.4	$47.8
Commodities		$0.0
Equipment		$0.0
Subtotal	$39.4	$47.8
General Administration	$2.8	$3.3

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2003			

FY 02 *EXXON VALDEZ* TRU[illegible] COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Project Total	$42.2	$51.1	TBD					
Full-time Equivalents (FTE)	0.0	0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY02

Prepared:

Project Number: 02550
Project Title: Public Information, Science Management and Administration - ARLIS
Agency: Department of Interior

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0

						0.0
						0.0
		Subtotal		0.0	0.0	0.0	
						Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
					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

FY02

Prepared:

Project Number: 02550
Project Title: Public Information, Science Management and Administration - ARLIS
Agency: Department of Interior

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FY 2002
Budget lease (contribution to ARLIS)	23.9
Subscriptions, acquisitions, other expenses (contribution to ARLIS)	23.9

When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$47.8

Commodities Costs:	Proposed
Description	FY 2002
Commodities Total	$0.0

FY02

Prepared:

Project Number: 02550
Project Title: Public Information, Science Management and Administration - ARLIS
Agency: Department of Interior

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2002
			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

FY 02 *EXXON VALDEZ* TRU[illegible]E COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY02

Prepared:

Project Number: 02550
Project Title: Public Information, Science Management and Administration - ARLIS
Agency: Department of Interior

FORM 3B
Equipment
DETAIL

Exchange between Prince William Sound and the Gulf of Alaska. Submitted Under the Broad Agency Announcement.

Project Number:	02552-BAA
Restoration Category:	Research
Proposer:	Prince William Sound Science Center
Sponsoring Agency:	NOAA
Duration:	Three years
Cost FY 00:	($106.9 K)
Cost FY 01:	($ 98.8 K)
Cost FY 02:	$ 95.8 K
Cost FY 03:	$0 K
Cost FY 04:	$0 K
Geographic Area:	Prince William Sound
Injured Resource/Service:	pink salmon, Pacific herring

ABSTRACT

One of the least understood physical processes that influence the biological components of PWS is the exchange between the northern Gulf of Alaska (GOA) and Prince William Sound (PWS). The main objective of this proposal is to document the interannual variability in water mass exchange between PWS and the adjacent northern GOA at Hinchinbrook Entrance, and to identify mechanisms governing this exchange. Support is requested for continued deployment of an upward looking ADCP mooring in Hinchinbrook Entrance to create time series of velocities spanning three years. The mooring will be equipped with a CTD to create a time series of deep temperature (T) and salinity (S). To identify the dominant factors that govern PWS/GOA exchange, the mooring velocity and deep T/S time series will be combined with meteorological and physical data collected under other research programs in progress in PWS and the GOA.

INTRODUCTION

The Sound Ecosystem Assessment (SEA), funded by the EVOS Trustee Council from 1994 to 1999, was aimed at understanding physical and biological factors affecting pink salmon and Pacific herring survival on an ecosystem level. As part of the SEA study, an upward-looking acoustic Doppler current profiler (ADCP) mooring was deployed in Hinchinbrook Entrance from June through September 1995 and from September 1996 through May 1997. Time series of horizontal and vertical velocities were created for these two periods. The data were low-pass filtered (40 hour) to remove the tidal component.

At Hinchinbrook Entrance, the summer and early fall months of 1995 (June through September) were characterized by outflow above about 150m and inflow below (Vaughan et al., 1999). Easterly offshore winds caused surface Ekman layer inflow, accompanied by deeper outflow. Except for the Ekman inflow, which reached speeds greater than 80 cm/sec, the magnitude of the flow seldom exceeded 20 cm/sec. In late September, at the very end of the 1995 time series, the pattern seemed to reverse to one of inflow above about 150m and outflow below.

The fall and early winter months (September 1996 through January 1997) at Hinchinbrook Entrance were characterized by inflow above 150m and weak outflow below. The magnitude of the inflow often exceeded 60cm/sec. The change to the opposite baroclinic structure in September could be a regular seasonal event, or indicate different conditions in 1995 and 1996. Late winter and spring months (January through May 1997) were characterized by more barotropic inflows and outflows (Vaughan et al., 1998). Speeds during this time were the weakest observed, typically less than 20cm/sec. The mechanisms responsible for the observed variability have not been identified. Offshore wind forcing or flows through the deep trench southeast of Montague Island may influence the vertical structure at Hinchinbrook Entrance.

Along channel transports through Hinchinbrook Entrance were calculated from the 1995 and 1996-1997 time series for layers above and below 150m, and compared to transports from 1978 (Niebauer et al., 1994). Trends in the monthly mean transports were similar above and below 150m for both time periods. In the upper layer, maximum inflows occurred in October and December, although the magnitudes in 1978 (0.3 Sv) were slightly greater than in 1996 (0.2 Sv). Above 150m, weaker outflows occurred in summer 1995 and in summer 1978. Below 150m, weak inflow occurred in summer 1995 and in summer 1978.

In December 1999, the ADCP mooring was redeployed in Hinchinbrook Entrance under EVOS project 00552. The mooring was retrieved in July 2000, but the ADCP failed to record any data. The problem (a bad chip in the ADCP deck box) was identified and corrected, and the mooring was redeployed in September 2000. A series of in-water tests were performed prior to deployment to insure the instrument was functioning properly. The mooring is scheduled for retrieval in May 2001, and for redeployment in September 2001. This proposal is for continued support of the Hinchinbrook mooring deployment.

This project will interface with other projects underway in PWS. GLOBEC Northeast Pacific (NEP) monitoring surveys in the northern GOA are scheduled to continue in FY00 through FY04. Process studies in the northern GOA are scheduled for FY01 and FY03. A GLOBEC survey line of particular interest is the trench on the southeastern side of Montague Island, which runs from the western side of Middleton Island to Hinchinbrook Entrance, and is almost certainly the conduit of any dense water entering PWS.

Anther project underway in PWS is the development of a near real-time nowcast/forecast (N/F) system, co-sponsored by the Oil Spill Recovery Institute (OSRI), the Alyeska Ship Escort and Response Vessel System (SERVS), and the PWS Region Citizens Advisory Council (PWS RCAC). The main objective of this project is to develop a prototype N/F circulation model that will be capable of calculating current velocity vector fields, particle trajectories, and the evolution of passive drifter concentrations. Current data are collected using a downward looking ADCP towed from one of the Alyeska SERVS vessels. East-west and north-south transects through central PWS, and repeated transects at Hinchinbrook Entrance (to eliminate the tidal contribution), were conducted in 1999 and 2000. Funding has been secured to continue measurements in 2001.

NEED FOR THE PROJECT

A. Statement of the Problem

Mechanisms governing exchange between the northern GOA and PWS are not well understood. It is not clear quantitatively what controls the amount of throughflow at Hinchinbrook Entrance, or how the throughflow affects the circulation in PWS. In particular, it is not known what causes the baroclinic structure in summer and early fall, the apparent reversal of this structure in September, and the transition to a barotropic structure in winter. The Hinchinbrook Entrance velocity data collected during the SEA program revealed significant spatial (horizontal and vertical) and seasonal variability of the throughflow. Documenting the interannual variability of the currents at Hinchinbrook Entrance and identifying the mechanisms that govern the exchange will require a time series of velocity at all depths that spans several years.

B. Rationale/Link to Restoration

Juvenile fish in PWS rely on zooplankton as their food source. Exchange at Hinchinbrook Entrance could either seed PWS with zooplankton or flush zooplankton out, thereby regulating the amount of available food and possibly the number of copepods diapausing in PWS in winter. Exchange at Hinchinbrook Entrance may influence the central Sound circulation, and possibly the transport of juvenile fish from one nearshore region to another.

C. Location

This project has been designed for Prince William Sound. All communities that utilized the marine resources of Prince William Sound will benefit from this research.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Bids will be solicited from the private sector for oceanographic charters in FY01. This project will contribute information to local newsletters and newspaper articles. Results will be published in peer reviewed scientific journals. Results will be posted on a PWSSC web page, and will be accessible to the public.

PROJECT DESIGN

A. Objectives

The main objective of this proposal is to document the interannual variability in water mass exchange between PWS and the northern GOA at Hinchinbrook Entrance, and to identify mechanisms governing this exchange. Funding is requested for continued deployment of an upward looking ADCP mooring in Hinchinbrook Entrance in FY02. In addition to the ADCP velocity time series, time series of deep temperature (T) and salinity (S) will be collected by a CTD mounted on the mooring.

B. Methods

An upward-looking ADCP mooring (RDI 150 kHz broadband) will be deployed in the fall of each year (e.g., September) and retrieved in the spring or summer (e.g., May). The approximate mooring location will be latitude 60 17.0', longitude 146 51.0', which is in the deepest part of Hinchinbrook Entrance at the northern end of the Montague Island trench. As configured, the ADCP will measure horizontal and vertical velocities from a few meters above the transducer faces to within roughly 45m of the surface in 8m bin depths. To maximize deployment time while still capturing the tidal cycle, the sampling interval will be 2 hours.

The data will be processed using standard RDI software and analyzed using software developed under SEA. The horizontal velocities will be translated into along-channel and cross-channel components, and 40 hour low-pass filtered to remove the tidal components. Transports will be calculated from the along-channel low-pass filtered velocities above and below 150m (as well as other depth intervals) and compared to previous years' values. Power spectra for each component will also be calculated at several depths and compared to previous years.

In addition to the velocity data, T/S data will be collected by a SeaBird 16 CTD mounted on the mooring. The instrument has been equipped with a new pressure housing enabling

it to function at the mooring depth. The data will be processed using standard SeaBird software. Density will be calculated from T and S.

The velocity and T/S data will be stored on the PWSSC network computers. Analyzed data products will be available via a PWSSC web site. Raw data will be available to other EVOS investigators after publication.

With a 2 hour sampling interval, continuous data collection is limited by battery power to approximately 9 months. The second deployment took place in September 2000. In FY01, retrieval is scheduled for May 2001, and redeployment for September 2001. In FY02, the final retrieval is scheduled for May 2002.

It is unfortunate that this collection strategy does not include measurements in the summer months. Previous summer observations at Hinchinbrook Entrance have revealed many interesting features. September and May were chosen for several reasons. With a maximum 9 month deployment time, a single mooring will miss 3 months of the year. Since severe weather often precludes shipboard work in the late fall through early spring, the summer months were chosen to miss. In the summer, the mooring time series will be supplemented by velocity measurements using a towed shipboard instrument as described below. Conditions in both September and May are usually mild enough to allow mooring work. Also, this time period covers the late fall and early winter when volume transports at Hinchinbrook Entrance are maximum. Efforts are underway to secure funding for a second mooring, so that year-round measurements will be possible.

Target cruise dates for years 2001 and 2002 are:

May 2001	(retrieval)
September 2001	(deployment)
May 2002	(retrieval)

FY01 included two mooring cruises (May 2001 and September 2001). FY02 will include one mooring cruise (May 2002) unless continued funding makes additional deployments possible. A vessel with a crane, A-frame, or other equipment suitable for mooring deployments will be required.

To identify the dominant factors that govern PWS/GOA exchange, the mooring velocity and deep T/S time series will be combined with additional data types collected under other programs. The time series obtained from the mooring will be supplemented by the velocity transects made with a downward-looking towed ADCP (funded under the OSRI N/F project). The repeated transects will capture the spatial variability of the Hinchinbrook Entrance flow patterns. T/S measurements on the SERVS cruises will be obtained using expendable CTDs (XCTDs). Conditions in the GOA, particularly in the trench southeast of Montague Island, will be documented by the GLOBEC group at the Institute of Marine Science (IMS) at the University of Alaska Fairbanks (UAF). Meteorological data are available from the NOAA NDBC stations, particularly the Seal Rocks and Mid-Sound buoys, and from the FAA station located on Middleton Island.

The numerical circulation model developed by the OSRI N/F modeling group at the University of Miami (UM) Rosenstiel School of Marine and Atmospheric Science (RSMAS) will be used in conjunction with the observations to identify mechanisms governing PWS/GOA exchange.

The mooring velocity time series coupled with the repeated ADCP transects over multiple years will show whether the baroclinic inflow/outflow structure that dominated the flow in summer 1995 and in fall through early winter 1996 (including the apparent September reversal and the 150m separation depth), as well as the transition from a baroclinic to barotropic structure in January 1997, is typical or anomalous. The mooring velocity time series coupled with time series of wind from the meteorological buoys will allow further investigation of surface Ekman layer inflow.

The T/S time series will signal the movement of any new deep water mass into or out of PWS. T/S observations from the GLOBEC cruises should reveal the source of deep water flowing into PWS, or the southern extent of deep water flowing out of PWS. Time series of GOA wind speed and direction (from the Middleton Island station) should indicate if large scale atmospheric forcing in the Gulf is responsible for the inflow/outflow patterns and transitions at Hinchinbrook Entrance, and for the variability in transports above and below 150m.

C. Cooperating Agencies, Contracts and Other Agency Assistance

Cooperating agencies will be OSRI, PWS RCAC, and Alyeska SERVS.

SCHEDULE

A. Measurable Project Tasks

FY01:

April 15, 2001:	FY00 Annual Report due
May 2001:	Mooring retrieval
September 2001:	Mooring deployment

FY02:

January 2002:	EVOS Workshop - Anchorage
April 15, 2002:	FY01 Annual Report due
May 2002:	Mooring retrieval

FY03:

April 15, 2003:	FY02 Final Report due

B. Project Milestones and Endpoints

Milestones of each year will be the successful deployment and retrieval of the mooring. The endpoint of each fiscal year will be marked by the Annual Report due date (April 15 of 2001, 2002 and 2003).

C. Completion Date

All project objectives will be completed in FY02 except for submission of the final report. The completion data of this project is September 30, 2003.

PUBLICATIONS AND REPORTS

The following manuscripts are in review and are expected to be published in FY01:

Physical Variability in Prince William Sound during the SEA Study (1994 - 1998), Fisheries Oceanography, March 2001. (This manuscript was previously entitled Physical Processes Influencing the Pelagic Ecosystem of Prince William Sound).

Seasonal Hydrography and Tidal Currents of Bays and Fjords in Prince William Sound, Alaska, March 2001.

PROFESSIONAL CONFERENCES

Travel is requested to attend the EVOS Workshop in Anchorage. Travel is also requested to present results at the American Geophysical Union (AGU) Ocean Sciences Meeting in February 2002.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will be coordinated with the efforts Dr. T. Weingartner and Dr. D. Musgrave, both of IMS/UAF (GLOBEC), and with Dr. C. Mooers and Dr. I. Bang, both with UM/RSMAS (OSRI N/F). This project will cooperate with other EVOS sponsored programs to provide the most efficient means for investigating biological and environmental factors common to all projects.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

Shari L. Vaughan, Ph.D.
Physical Oceanographer, Prince William Sound Science Center
(P.I. of SEA Physical Oceanography project 320-M)

Education:
B.S., University of Miami, May 1981, Physics (major)/Mathmatics (minor)
M.S., University of Miami, May 1986, Physics
Ph.D., University of Miami, Rosenstiel School of Marine and Atmospheric Science (RSMAS), May 1993, Meteorology and Physical Oceanography (MPO), Kevin D. Leaman, advisor

Professional Experience (since 1986):
1986 - 1993: Research Assistant, University of Miami, RSMAS, MPO, Miami, Florida
1993 - 1995: Postdoctoral Associate, University of Miami, Cooperative Institute for Marine and Atmospheric Studies, a cooperative institute between RSMAS and NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML), Miami, Florida, Robert L. Molinari, supervisor
Sept. 1995 - present: Physical Oceanographer, Prince William Sound Science Center, Cordova, Alaska

Recent Refereed Journals:
Vaughan, S. L. and K. D. Leaman, 1995: The Role of Small-Scale Cells in the Mediterranean Convection Process. J. Phys. Oceanogr., 25 (10), 2423-2436.

Vaughan, S. L. and R. L. Molinari, 1997: Temperature and Salinity Variability in the Deep Western Boundary Current. J. Phys. Oceanogr., 27 (5), 749-761.

Vaughan, S. L., C. N. K. Mooers, and S. M. Gay III, 2001: Physical Variability in Prince William Sound during the SEA Study (1994-1998). J. Fish. Oceanogr. (submitted).

Gay III, S. M. and S. L. Vaughan, 2001: Seasonal Hydrography and Tidal Currents of Bays and Fjords in Prince William Sound, Alaska. J. Fish. Oceanogr. (submitted).

OTHER KEY PERSONNEL

Shelton M. Gay: cruise staging, instrument calibration and maintenance, data acquisition and analysis, contribute to journal publications.

LITERATURE CITED

Niebauer, H.J., T.C. Royer, and T.J. Weingartner, 1994: Circulation of Prince William Sound, Alaska. J. Geophys. Res., 99, C7, pp 14,113-14,126.

Vaughan, S.L., S.M. Gay, L.B. Tuttle, and K.E. Osgood, 1998: SEA: Observational Oceanography in Prince William Sound. Exxon Valdez Oil Spill Restoration Project Annual Report (Restoration Project 97320-M), Prince William Sound Science Center, Cordova, Alaska.

Vaughan, S.L., C.N.K. Mooers, J. Wang, S.M. Gay, and L.B. Tuttle, 1999: Physical Processes Influencing the Pelagic Ecosystem of Prince William Sound. Exxon Valdez Oil Spill Restoration Project Annual Report (Restoration Project 98320-M), Prince William Sound Science Center, Cordova, Alaska.

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 199_ _ptember 30, 2000

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$0.0
Travel		$0.0
Contractual		$95.8
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$95.8
General Administration		$6.7
Project Total	$0.0	$102.5
Full-time Equivalents (FTE)		0.6

LONG RANGE FUNDING REQUIREMENTS

Dollar amounts are shown in thousands of dollars.

Other Resources								

Comments:

FY02

Prepared:

Project Number: 02552-BAA
Project Title: Exchange between PWS and the Gulf of Alaska
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Budget Category:	Authorized FY 2001	Proposed FY 2002

Personnel		$55.1						
Travel		$6.1						
Contractual		$11.8						
Commodities		$2.2						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$75.2						
Indirect (27.43%)		$20.6						
Project Total	$0.0	$95.8						
Full-time Equivalents (FTE)		0.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY02

Prepared:

Project Number: 552
Project Title: Exchange between PWS and the Gulf of Alaska
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2002
	Shari Vaughan	Physical Oceanographer (PI)	3.8	8300.0		31,540.0
	Shelton Gay	Physical Oceanographer	3.8	6200.0		23,560.0

						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		7.6	14500.0	0.0	
					Personnel Total	$55.1

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2002
	EVOS Workshop - Anchorage - January 2002	220.0	1	3	145.0	655.0
	1 r/t Cordova-Fairbanks	460.0	1	3	145.0	895.0
	1 r/t Cordova-Miami	960.0	1		0.0	960.0
	1 r/t Miami-Cordova	960.0	1	4	145.0	1,540.0
	AGU Ocean Sciences Mtg. - Honolulu - Feb. 11-15, 2002	980.0	1	6	171.0	2,006.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$6.1

FY02

Prepared:

Project Number: 552
Project Title: Exchange between PWS and the Gulf of Alaska
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FY 2002
Vessel Charter (1cruise, 2 days each @ $3000 per day)	6,000.0
Equipment calibration/repair	1,000.0
Network costs and maintenance ($100/computer-month)	1,600.0
Professional servies - mooring technician ($2000 per cruise)	2,000.0

Phone, fax, copying	600.0
Mail, freight, shipping	600.0
Contractual Total	$11.8

Commodities Costs:	Proposed
Description	FY 2002
Office supplies	600.0
Computer supplies	600.0
Marine supplies	1,000.0
Commodities Total	$2.2

FY02

Prepared:

Project Number: 552
Project Title: Exchange between PWS and the Gulf of Alaska
Name: Prince William Sound Science Center

FORM 4B
Contractual & Commodities DETAIL

New Equipment Purchases:			
Description	Number of Units	Unit Price	Proposed FY 2002
			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	

FY02

Prepared:

Project Number: 552
Project Title: Exchange between PWS and the Gulf of Alaska
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Project Title: Mapping the Physics and Physical Processes of Marine Habitats: The First Step in a Spatially Nested Monitoring Program

RECEIVED
APR 13 2000
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Project Number:	02556
Restoration Category:	Research and Monitoring
Proposer:	Kachemak Bay Research Reserve
Lead Trustee Agency:	ADFG
Duration:	1st year, 1 year project
Cost FY02:	$50,000
Geographic Area:	Kachemak Bay/Lower Cook Inlet
Injured Resource/Service:	Subtidal and intertidal communities, sediments, mussels, clams, archeological resources

ABSTRACT

Groups, individuals, and programs as diverse as natural resource agencies, local governments, researchers, conservation advocates in Cook Inlet and Kachemak Bay, and the EVOS/GEM can benefit from a comprehensive, high resolution database of shoreline and nearshore habitats, and from information on the physical changes seen through time. At present, no such detailed database or monitoring program exists within the Gulf of Alaska. We propose to use a method adopted along the U.S. west coast to gathering such habitat information in a cost-effective yet detailed manner. The method relies on a nested hierarchical nearshore classification based on the physics of the environment to select replicate shore sites for monitoring algal and invertebrate diversity.

INTRODUCTION

The overall purpose of our proposal is to develop a statistically rigorous monitoring program in Kachemak Bay and lower Cook Inlet to address the needs of resource managers, researchers, conservation groups, local governments, and oil spill prevention/restoration organizations. This proposal seeks funding to build a spatially comprehensive database of the geomorphology and physical attributes of subtidal and intertidal habitats for the greater Kachemak Bay/Lower Cook Inlet area. We regard this as the foundation for developing a monitoring program to detect changes in nearshore communities resulting from shifts in watershed and marine processes. The NOAA Environmental Sensitivity Index (ESI) maps, developed for oil spill response planning, do not contain the data necessary for resolving small spatial scale features of the shoreline needed in ecological studies where biophysical linkages often occur at scales of less than one meter.

This project is linked to FY02 EVOS proposal #02565. While this project can be conducted independently, the cumulative value of these projects being undertaken simultaneously is great.

NEED FOR THE PROJECT

A Statement of Problem

The ecology of the nearshore benthos (from intertidal to 10 m depth) has been studied in detail at many coastal locations in the U.S. However, the processes that couple the intertidal regions with those in the nearshore ocean are poorly understood. For example, it is not apparent if production in some intertidal communities is regulated by the delivery of nutrients from the coastal ocean or by drainage from nearby rivers and estuaries (Menge et al., 1997). Such "edge" communities at the transition between one regime and another have rarely been studied as an integrated system. However, it is clear that there is strong physical and biological coupling between the nearshore and the intertidal (Schoch and Dethier, 1996). Prediction of how these communities will change over time or space is still a significant challenge. Map data of dominant habitats and species, as well as statistics about abundance, are important to our understanding of how these systems interact and function and have many applications in resource management as well as basic research. Such understanding is especially critical as we try to make predictions about impacts of large-scale environmental phenomena, from coastal eutrophication, to oil spills, to shifts in weather patterns and wind driven processes (ENSO and global climate change).

The planet is experiencing an unprecedented loss and impoverishment of its biological wealth as measured by species extinctions and degradation of its ecological systems (Schoch, 1998). Benthic organisms within the marine nearshore ecosystem are sensitive to environmental gradients and may serve as indicators of changes occurring in the coastal ocean. These benthic communities often include organisms with life spans ranging from days to seasons or years, and they frequently occur in large numbers, thus providing an attractive baseline for statistical analyses. For these reasons, and logistical accessibility, detecting change in nearshore biological communities is a key component of experimental ecological research and applied monitoring programs. But quantifying the distribution, abundance, and diversity of nearshore organisms over large spatial scales is

problematic for scientists and resource managers. Monitoring biological communities for a response to natural or anthropogenic perturbations encounters two fundamental problems. The first is the large temporal and spatial variability of organism abundances in natural ecosystems, which masks our ability to statistically separate an actual change caused by a perturbation from natural cycles. Second, extrapolating or generalizing the results of localized studies to broad areas is fraught with problems; yet biological sampling is too labor-intensive to attempt everywhere (Underwood & Petraitis 1993). One solution in the marine realm involves systematic quantification and minimization of physical gradients among sample sites.

B. Rationale/Link to Restoration

A method developed in Alaska by the principal investigator partitions complex shorelines into physically homogeneous segments. Groups of physically similar segments can then be aggregated into groups of replicates that allow more rigorous monitoring of the marine environment. This method has been successfully applied to shorelines in Kenai Fjords, Lake Clark (Schoch and Chen, 1995; Schoch, 1996), Katmai (Schoch 1994), and Glacier Bay National Parks: http://www.nps.gov/glba/learn/preserve/projects/coastal/. The database is now in use by the Olympic Coast National Marine Sanctuary (Schoch 1999) for the basis of a marine reserve network design, resource agencies in Puget Sound (Schoch and Dethier, 1998) for ecological modeling, and by the Partnership for Interdisciplinary Studies of the Coastal Ocean (PISCO: www.piscoweb.org) along the western U.S. (Schoch et al., 2000a, 2000b) for monitoring and comparing biodiversity at nested spatial scales. Monitoring across replicates increases the statistical power of ecological data by minimizing the variability of the biological community caused by physical forces. This method is proposed for implementation in Kachemak Bay as a first step in monitoring the changes in marine and estuarine physical and biological diversity. The method can be applied anywhere as the foundation for a statistically sound, scientifically defensible monitoring program.

With respect to the link to restoration effort, this project is proposed under the strategy "Ecosystem Synthesis/GEM Transition." This project is best linked to New Projects: Innovative Tools and Strategies for Improving Monitoring." ADFG encourages the Trustees to fund this project this year because it will answer key resource questions and lay the foundation for the development of an intertidal component of the GEM program. Moreover, the proposed research and monitoring effort will help leverage NOAA funds to establish and maintain a long-term oceanographic monitoring program in the Kachemak Bay/Lower Cook Inlet area.

Kachemak Bay is a NOAA National Estuarine Research Reserve (NERR). The NERR system has 26 sites throughout the United States that are dedicated to research and education of the marine/terrestrial interface of estuarine ecosystems. These reserves are a partnership between individual states and NOAA, so that each reserve is allocated approximately 70% of their funding for basic operations from the federal government. The remaining 30% of the funding must come from non-federal sources.

The NERR site in Kachemak Bay, called the Kachemak Bay Research Reserve (KBRR), is well situated to begin studies on coastal ecosystem dynamics. Kachemak Bay is located at the interface

between land and ocean waters and thus near the juncture of major oceanographic and land-based processes. The interaction of these forces is the major focus of the research being conducted by KBRR. The KBRR is developing models to understand the variability of factors driving primary productivity in the bay and specifically, the linkages and interactions of water delivered from the offshore ocean and surrounding watersheds. Watershed influences on the intertidal and other habitats in the Bay range from freshwater input, transport of nutrients, sediments and contaminants to topographic influences on winds and precipitation amounts and rates. Changes in watershed vegetation cover due to urbanization, spruce bark beetle infestation, logging and forest fires will alter transport dynamics and nutrient cycling, and thus the habitat quality and structure of biological communities in the intertidal and other habitats. Oceanographic processes, working from the other end of the ocean-bay-shore continuum, influence nutrient transport, life history dispersal mechanisms of plants, invertebrates and fishes, sediments and contaminants. The NERR system has a research mandate to develop a national time series of water chemistry from which natural variability and long-term changes can be measured over different spatial scales. As part of this system, the KBRR has a program to continuously measure seasonal oceanographic water characteristics including nutrients, phytoplankton, temperature and salinity at two stations in the Bay (Homer and Seldovia) as part of the national System Wide Monitoring Program (SWMP). These sensor arrays measure water temperature, conductance, salinity, pH, turbidity, dissolved oxygen, depth, PAR, and fluorescence on a continuous basis.

If successful, this proposal (along with proposals #02565 and #02569) will provide the KBRR with the required matching funds to receive additional support from NOAA to: (1) maintain and operate the exisiting monitoring program (e.g., pay for staff time to operate and maintain the oceanographic sensors); (2) expand the instrument array by adding two additional stations in Halibut Cove and Bear Cove; and (3) operate and maintain the more comprehensive monitoring program. Without these funds, the KBRR will mostly likely not be able to meet the required 30% non-federal match requirement and will have to decline the NERR operation funds that would be used to develop and run this monitoring program.

C. Location

This project will take place in Kachemak Bay: the north shore from Anchor Point to the Fox River, then the south shore from Fox River to Nanwalek. The project will benefit all the resource management agencies in the Bay, oil spill advisory councils, conservation agencies, and local governments (see attached letters of support). The communities include City of Homer and greater Homer area, Anchor Point, Seldovia, Port Graham, Nanweluk, and small unorganized communities on the south shore or Kachemak Bay (Halibut Cove, Jakalof Bay, Bear Cove). The benefits of this project will have broader application if these tools, technologies, and monitoring approaches are applied to other areas affected by the spill.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

The KBRR is an integrated research and education program. A goal of KBRR education program is to provide for community involvement and conduct educational programs that will interpret and instruct the public on research projects conducted in the region. While this project does not have

an explicit community involvement/data gathering component in this FY02 proposal, the KBRR will interpret research results by the following means:

- The KBRR web page;
- The KBRR interactive research and education programs;
- Conferences, workshops, and presentations on our programs to the community and schools;
- Display information on research projects at KBRR facilities and/or with partner organizations such as the Pratt Museum
- The results of this project, the GIS database, may have application with developing school monitoring programs.

The Olympic Coast National Marine Sanctuary is already employing a similar database developed by Dr. Schoch as an integral component for their teacher education program. The Sanctuary educators on the West Coast wish to link Olympic Coast Washington teachers and students with teachers, communities and students in Kachemak Bay, Alaska, with hopes to also link with other west coast Sanctuaries in California using this same model and protocol. This proposed research project will play an important role in laying the foundation for future public education and citizen monitoring efforts.

PROJECT DESIGN

A. Objectives

The objective of this proposal is to augment the long-term NOAA programs in ocean physics and chemistry in Kachemak Bay by adding an ecological component to address issues identified in the GEM Science Plan and by National Academy of Sciences reviewers. We propose to use subtidal and intertidal monitoring protocols developed by PISCO in Washington, Oregon, and California in Kachemak Bay. To that end, we envision being the ecological endpoint to a series of monitoring sites that now stretch from Mexico to Canada. By establishing water column, subtidal, and intertidal monitoring programs, using standardized protocols of the NERRS and PISCO, we will be able to make meaningful comparisons of data across multiple spatial scales to address issues of change locally and globally. The first step in the monitoring program is to inventory and map the benthic habitats in Kachemak Bay. In terms of identifying characteristic habitat types, rare habitats, and habitat diversity, these data will be required in order to determine the best locations for monitoring sites and to establish an ecological context to the habitats chosen for monitoring. Monitoring marine habitats relies largely on understanding where the larval sources are in relation to the populations and communities being monitored. Other issues include how and where larvae move at different times of the year, what habitats are used by which organisms at what periods of their life cycles, etc. The sources and movements of larvae in the Bay are not the

focus of this proposal, but it is necessary for reviewers to understand that these components of the ecosystem are not being overlooked.

We propose to map the nearshore habitats in Kachemak Bay and quantify the *physical attributes* that force spatial variation in diversity of fish, invertebrate, and algal populations among the various habitat types in the Bay.

B. Methods

The approach for minimizing biological variability (thus increasing statistical power to detect change) is to adopt a highly stratified sampling design based on the physics of the nearshore environment. We will use the protocols developed by PISCO to segment complex biogeochemical shoreline gradients using a combination of qualitative and quantitative partitioning criteria. Previous studies have often failed to develop quantitative links between specific intertidal assemblages and physical attributes of habitats, thus making it impossible to "scale up" in either time or space from limited *in situ* sampling (Menge et al., 1997). The proposed shoreline partitioning model addresses the needs of coastal ecologists seeking to make comparisons among spatially independent beach sites. This model relies on quantification of physical features known to have direct and indirect ecological responses, and uses these as criteria for partitioning complex shorelines into a spatially nested series of homogeneous segments. For example, at small spatial scales the quantified geophysical parameters include sediment grain size, wave energy, substrate dynamics, and sediment chemistry. At large spatial scales water chemistry attributes such as salinity, chlorophyll and nutrient concentrations are used. These nested segments can be used to study between-segment and within-segment variability, which in turn will support studies of the biotic and abiotic processes that control variability. This segment approach allows large areas of shoreline to be classified based on relatively limited *in situ* sampling. The results of previous research by the principal investigator in Alaska (Lake Clark, Kenai Fjords, Katmai and Glacier Bay National Parks) have shown this to be a robust approach, despite the enormous complexity of these regions (Schoch & Dethier 1996). An additional use of this database has recently been developed through an Olympic Coast National Marine Sanctuary initiative to establish a marine reserve network on the outer Washington coast.

The proposed study site will include all of Kachemak Bay and the smaller fjords and inlets along the more remote south shore. Homogeneous alongshore segments (10-100 meters in length) will be delineated and the physical component of the habitat characterized by up to ten geophysical parameters within each of three intertidal zones. These partitions include three intertidal polygons nested within each alongshore segment. Alongshore segments are grouped within oceanic cells to control for variations in salinity, temperature, nutrients and wave energy. These physical data provide the foundation to support comparisons and experimental studies of epibiota and infaunal abundances.

Methods Summary

1. At no cost to the project, use the existing and expanded system of ocean sensors at Homer and Seldovia, measuring salinity, temperature, D.O., pH, PAR, fluorescence and

turbidity to identify the spatial and temporal variability of ocean and estuarine water along and across the axis the Bay;

2. At no cost to the project, partner with the Cook Inlet Regional Citizens Advisory Council to obtain low altitude oblique aerial videography of the coastal zone in Kachemak Bay, at extreme low tides, for large scale (100-1,000 m) partitioning of the shoreline based on shore geomorphology, geophysical and biological characteristics of the nearshore, and characteristics of the upland watershed (Howes et al. 1994, Zacharias et al 1999);

3. Use *existing* NOAA high altitude vertical aerial photography and field measurements to map and partition the shoreline into geophysically homogeneous segments (10-100 m), quantifying the geophysical attributes known to force biological community structure in the nearshore marine system;

4. Build a GIS database of physical habitat features for intertidal and subtidal lands in Kachemak Bay and analyze the statistical distribution of characteristic habitat types.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Not applicable: all funds requested in this proposal will be used by ADFG/KBRR staff.

SCHEDULE

A Measurable Project Tasks

We intend to begin the fieldwork as soon as we are notified of a successful proposal. We anticipate 3 months of full-time field data collection, 2 months of data entry and analysis, and another 4 months of data analysis and GIS database development.

December 31, 2001:	complete fieldwork and begin data entry
February 28, 2002	complete data entry and begin GIS development
May 31, 2002	complete draft GIS database before summer field season
September 30, 2002	complete draft report
April 1, 2003	submit final report

B. Project Milestones and Endpoints

The project milestones are to complete a map the nearshore habitats in Kachemak Bay and quantify the physical attributes that force spatial variation in diversity of fish, invertebrate, and algal populations among characteristic habitat types in the Bay, will be met by the end of the funding period.

C. Completion Date

The work will be completed at the end of the funding cycle. The final report will be prepared by April 1, 2003. No funding is requested to complete this report.

PUBLICATIONS AND REPORTS

The product of this work is regarded as the foundation for further monitoring of the biological components of the ecosystem. The research and scientific value of this data is relevant to the monitoring of the biological components of the system; however, the management value will be realized immediately. As such, we do not expect to publish this data in a scientific journal until the biological data has also been collected and analyzed.

PROFESSIONAL CONFERENCES

The principal investigator is professionally obligated to present the results of Kachemak Bay research projects at the annual NERRS Research Conference (travel funded by NOAA), and the annual PISCO Conference (travel funded by PISCO). The PI seeks funding to attend the 2002 American Geophysical Union (AGU)/American Society of Limnology and Oceanography (ASLO) Conference.

NORMAL AGENCY MANAGEMENT

This project is not required by statute or regulation regardless of whether or not the spill had occurred. The proposed work has not been conducted by either ADFG or KBRR in the past without funds from the Trustees Council.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

We are coordinating this project with ADFG Commercial and Sport Fish Division projects in Kachemak Bay focusing on clam bed research, with the Cook Inlet RCAC to map beaches for oil spill response planning, with The Nature Conservancy to map important conservation areas, and with the City of Homer to map high use beaches for potential land use zoning (see attached letters of support).

The work proposed here will support the biological component of the study described in the accompanying Proposal (#02565): Bottom-up or Top Down: What Forces the Variability of Subtidal and Intertidal Fishes, Invertebrates and Algal Communities in Kachemak Bay?

Furthermore, we are building on the NOAA System Wide Monitoring Program by using the oceanographic time series data being collected in the Bay to identify and monitor the variability of major estuarine spatial and temporal divisions. The data collected will become a part of the PISCO database archived at the National Center for Ecological Analysis and Synthesis (NCEAS)

in Santa Barbara, CA.

We are partnering with the Cook Inlet Regional Citizens Advisory Council to map the shores of Kachemak Bay and parts of western Cook Inlet using an innovative technique of aerial mapping developed in British Columbia and Washington.

In summary, the KBRR has put forth a substantial effort to obtain funds from non-Council sources. KBRR proposals for EVOS Trustee funds will make it possible to secure additional NOAA funds to maintain and expand the Reserve system-wide monitoring program, which will be great benefit to the GEM program.

PROPOSED PRINCIPAL INVESTIGATOR

Dr. G. Carl Schoch
Kachemak Bay Research Reserve
2181 Kachemak Drive
Homer, AK 99603
907-235-4799
907-235-4794
carl_schoch@fishgame.state.ak.us
(or: cschoch@bcc.orst.edu)

PRINCIPAL INVESTIGATOR

Dr. Schoch is the Science Coordinator for the Kachemak Bay Research Reserve in Homer, Alaska (a NOAA National Estuarine Research Reserve). He has a dual Ph.D. in Biological Oceanography and Geological Oceanography from the College of Oceanic and Atmospheric Sciences at Oregon State University (1999) and continues to work with his post-doc advisors (Lubchenco and Menge) as a Senior Fellow for the Partnership for Interdisciplinary Studies of the Coastal Ocean (PISCO) studying marine ecosystem dynamics. His research interests are in the physical and biological linkages between marine nearshore and continental shelf ecosystems, specifically how physical processes such as currents, wave energy, sediment dynamics, and nutrient fluxes structure intertidal and subtidal communities. His current research projects include studying larval distributions and forces affecting recruitment, monitoring the variability of primary productivity as a function of ocean climate, and investigating kelp bed community dynamics. He serves as the science advisor for the Olympic Coast National Marine Sanctuary Advisory Council, and is the chair of their Research Advisory Committee. He also serves as the technical advisor to the Sanctuary Marine Conservation Working Group, consulting on the design and development of a marine reserve network on the outer coast of Washington. He also consults to the Washington Department of Natural Resources on intertidal habitat modeling in Puget Sound and Georgia Straits.

OTHER KEY PERSONNEL

The grant, if funded, will provide support for a Research Analyst, and a Research Assistant to assist with data entry and analysis. The NERRS Graduate Research Fellowship Program will provide 2 graduate students to assist Dr. Schoch with the fieldwork at no cost to the project.

LITERATURE CITED

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International Headquarters
Arlington, Virginia

March 23, 2001

Dr. Phil Mundy
EVOS/GEM
645 G Street
Anchorage, AK 99603

Dear Phil:

I am writing this letter in support of the Kachemak Bay Research Reserve's proposal to the Gulf Ecosystem Monitoring Program titled *Mapping Marine Habitats at Nested Spatial Scales: A Monitoring Framework for Coastal and Marine Habitats.*

This project is critical to understanding status and dynamics or nearshore and intertidal communities and their relationship to broader ecosystem dynamics in the Gulf of Alaska. Most of the commercially important marine species, forage fish, marine mammals, seabirds, eagles, and other species damaged by the Exxon Valdez spill rely on these nearshore areas for at least a component of their life history. These are also the same environments that are likely to suffer impacts from overuse, shoreline development, future oil spills, and overharvest. A clear understanding of natural community dynamics and change under a variety of human and natural stresses is critical to a sustainable relationship between people and the environment. These two really come together in Kachemak Bay, with its renowned marine resources, economy dependent on those resources, and burgeoning human population.

At the same time, the proposed work establishes a methodology that allows research from one location to be better extrapolated to other locations in a more rigorous and quantitative fashion. Both the methodology and data developed in this study can have applicability to greater area impacted by the spill.

Dr. Schoch's proposal fits well with the Conservancy's interests in monitoring key elements of biodiversity in Kachemak Bay to gauge the effectiveness of conservation efforts and/or the need to allocate conservation resources in ways that are most effective. We have sought funding through internal sources for this work, and will continue to seek ways to support work that helps meet out goals of improving understanding of biodiversity and its conservation in this diverse and productive estuary.

In summary, The Nature Conservancy supports the work proposed by Dr. Schoch and I urge you to give this proposal full consideration in your funding decisions.

Sincerely,

Randall H. Hagenstein
Associate State Director

CAC

"The mission of the Council is to represent the citizens of Cook Inlet in promoting environmentally safe marine transportation and oil facility operations in Cook Inlet."

9 April 2001

Molly McCammon
Exxon Valdez Oil Spill Trustee Council
645 G. Street, Suite 401
Anchorage, AK 99501-3451

Dear Ms. McCammon,

This letter is a recommendation by the Cook Inlet Regional Citizens Advisory Council (RCAC) to the *Exxon Valdez* Oil Spill Trustee Council to fund the proposal "Mapping Marine Habitats at Nested Spatial Scales: A Monitoring Framework for Coastal and Marine Habitats" as part of their 2002 Fiscal Year Plan. This proposal was submitted by Dr. Carl Schoch of the Kachemak Bay Research Reserve with the goal of developing a nested habitat database for the intertidal and subtidal shorelands in Kachemak Bay and Lake Clark National Park in Cook Inlet.

Dr. Schoch has identified a relatively low-cost, high-resolution method of quantifying shoreline habitats along Alaskan coastlines, which have typically been difficult and expensive to map. The Cook Inlet RCAC has a multi-fold interest in a successful pilot program such as that proposed. We have previously identified a need for more detailed information on shoreline habitats in Cook Inlet as part of our environmental monitoring program. We noted a lack of this type of information while trying to identify potential sampling sites for our recent intertidal contaminant monitoring study. The database produced for Washington state, in which Dr. Schoch played a key role, provides more detailed information and more habitat categories than do the existing databases for Alaskan shorelines. We would like to see a similar program that could provide agencies and researchers with information that is currently unavailable for much of Alaska. A pilot program conducted in Kachemak Bay and Lake Clark National Park will provide a complete set of nested spatial scales to demonstrate the value of such a database as well as help to fulfill immediate data needs of local resource managers and researchers.

The Cook Inlet RCAC also believes that the shoreline information and low altitude, oblique angle digital imagery provided by the aerial portion of this program can provide invaluable information at an Incident Command Center during oil spills or drills. Many of the shorelines at risk from spilled oil along tanker transportation routes in Alaska occur in remote areas with little detailed shoreline information available at-hand. Having detailed imagery that shows the exact shoreline types, access, and upland habitat can provide on-scene coordinators with invaluable information for decision-making in the initial critical hours after a spill. By linking these data to the more detailed (nested) data obtained by Dr. Schoch, the

resulting database would also be invaluable for SCAT team planning and for site selections during the NRDA process.

The Cook Inlet RCAC has committed a significant portion of our FY 2001 Environmental Monitoring Committee's funds to conduct the shoreline aerial imagery portion of the proposed study. We believe that these images and data, in coordination with Dr. Schoch's on-the-ground data collections, will produce an invaluable database that will fulfill the needs of multiple users and we strongly urge your support of his proposed program. If you have any questions regarding our recommendation, please contact our Science Research Coordinator, Susan Saupe, at (907) 283-7222.

Sincerely,

Susan M. Saupe, Acting E.D.

Mr. James E. Carter, Sr.
Executive Director, Cook Inlet RCAC

cc: Dr. Carl Schoch, KBRR

STATE OF ALASKA

TONY KNOWLES, GOVERNOR

DEPARTMENT OF FISH AND GAME

DIVISION OF SPORT FISH

Homer Office
3298 Douglas Place
HOMER, AK 99603-8027
PHONE: (907) 235-8191
FAX: (907) 235-2448

March 29, 2001

Dr. Phil Mundy
EVOS/GEM
645 G Street
Anchorage, AK

Dear Phil,

I am writing in support of a project proposal entitled "Mapping Marine Habitats at Nested Spatial Scales: A Monitoring Framework for Coastal and Marine Habitats" submitted to your committee by Dr. Carl Schoch. Carl's proposal seeks to conduct much needed characterization of Kachemak Bay habitat and its utilization by marine organisms. The focus of Carl's study would compliment current assessment programs conducted by the Alaska Department of Fish and Game (ADF&G) by providing better understanding the factors that influence the distribution and abundance of marine species in Kachemak Bay. Basic comprehensive information about shoreline and nearshore habitat types in Kachemak Bay is unavailable due to the department focus on assessment of the adult phase of commercially and recreationally important species for management of fisheries. Understanding of physical and environmental processes that influence species distribution and abundance in Kachemak Bay is essential but woefully lacking.

While some habitat characterization is done in conjunction with the department clam assessment program, the progress towards characterization of large areas of the bay is slow and piecemeal. Little to no department effort is likely to be focused on areas of Kachemak Bay without significant commercial and recreational fishing effort. Accomplishment of this task in a timely manner would greatly augment the ability of the department to respond to demands placed on Kachemak Bay resources by harvesting and development. Characterization of the shoreline habitat would include the identification of hardshell clam habitat. This would allow stratification of sample locations and an associated improvement in the precision and accuracy of hardshell clam abundance estimates. An estimate of total clam habitat would provide the basis for estimating the potential yield of clams and the impacts of removals by harvest. Identification of suitable nearshore habitats for rearing or spawning of species is almost completely unknown. Knowledge of such areas would allow better protection of important habitats from development impacts. Dr. Schoch proposes essential baseline mapping work that should have been conducted years ago! Completion of this work will have significant positive impacts on future research and management of marine resources in Kachemak Bay. I urge you to approve funding for this project.

Sincerely,

Nicky Szarzi
Lower Cook Inlet Area Biologist

FY 02 *EXXON VALDEZ* TI EE COUNCIL PROJECT BUDGET
October 1, 20.. September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$33.8						
Travel		$0.4						
Contractual		$6.0						
Commodities		$4.3						
Equipment		$0.0						
Subtotal	$0.0	$44.5	Estimated FY 2003					
General Administration		$5.5						
Project Total	$0.0	$50.0						
Full-time Equivalents (FTE)		0.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: The KBRR went through a substantial effort to obtain funds and establish partnerships with other organizations to support the proposed research and monitoring effort. These efforts include:

NOAA/KBRR Support: The proposed EVOS projects (including proposals #02565 and #02569) will meet the required non-federal match for approximately $274K in NOAA operations funds. Federal funds will be used to operate and expand the Reserve monitoring program. These NOAA funds will support, in part, two research staff, the purchase of ocean sensors and a CTD, Reserve research and support facilities and equipment. Without this match, the KBRR will need to decline all or part of these funds, and likely will not be able to implement and maintain the long-term monitoring program.

Cook Inlet RCAC - The Cook Inlet RCAC will provide $30,000 for an aerial video survey of the bay to map geomorphogical processes

NERRS Graduate Research Fellows - KBRR is funding 2 graduate students ($34,000) who will assist with the summer field work and incorporate the data into their dissertation work.

FY02

Prepared: 4/12/01

Project Number: 02556
Project Title: Mapping the Physics and Physical Processes of Marine Habitats: the First Step in a Spatially Nested Monitoring Program
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 02 *EXXON VALDEZ* T EE COUNCIL PROJECT BUDGET

October 1, 20.. September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
Recruitment in Progress	Research Analyst III	18A	3.0	5.0		15.0
(Hire in Progress)	Research Assistant (FB-I)	14A	4.7	4.0		18.8
						0.0
Dr. G. Carl Schoch	Research Coordinator	min. of 4 months at 5K/mo.				no charge
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		7.7	9.0	0.0	
					Personnel Total	$33.8

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
Dr. G. Carl Schoch to present at PISCO annual conference, and the NERR					0.0
annual conference	no charge				no charge
					0.0
Dr. G. Carl Schoch to the annual EVOS workshop Conference	0.2	1	1	0.2	0.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.4

FY02

Prepared: 4/12/01

Project Number: 02556
Project Title: Mapping the Physics and Physical Processes of Marine Habitats: the First Step in a Spatially Nested Monitoring Program
Agency: ADFG

FORM 3B
Personnel
& Travel
DETAIL

FY 02 *EXXON VALDEZ* T[illegible]EE COUNCIL PROJECT BUDGET
October 1, 2C[illegible]. September 30, 2002

Contractual Costs:			Proposed
Description			FY 2002
Fuel for Skiff			6.0
When a non-trustee organization is used, the form 4A is required.		**Contractual Total**	$6.0

Commodities Costs:			Proposed
Description			FY 2002
Misc Supplies and Operating Expenses for Boat			1.5
Software upgrades	1	2.0	2.0
Surveyors rod	1	0.3	0.3
Surveyors level	1	0.4	0.4
Surveyors tape	1	0.1	0.1
		Commodities Total	$4.3

FY02

Prepared: 4/12/01

Project Number: 02556
Project Title: Mapping the Physics and Physical Processes of Marine Habitats: the First Step in a Spatially Nested Monitoring Program
Agency: ADFG

FORM 3B
Contractual & Commodities
DETAIL

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2002
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency
Research Skiff	1	
KBRR headquarters and research facilities	2	
KBRR Computers	3	

FY02

Project Number: 02556
Project Title: Mapping the Physics and Physical Processes of Marine Habitats: the First Step in a Spatially Nested Monitoring Program
Agency: ADFG

FORM 3B
Equipment
DETAIL

Prepared: 4/12/01

Harbor Seal Recovery: Application of New Technologies for Monitoring Health

Project Number:	**02558**
Restoration Category:	Research
Proposer:	Shannon Atkinson, Ph.D., University of Alaska Fairbanks, School of Fisheries and Ocean Science, Institute of Marine Science
Lead Trustee Agency:	ADFG
Alaska SeaLife Center:	YES
Duration:	2nd of a 3-year project
Cost FY 02:	$124,751
Cost FY 03:	closeout approx. $80,000
Geographic Area:	Alaska SeaLife Center, Gulf of Alaska
Injured Resource/Service:	Harbor seals

ABSTRACT

This study continues investigating the potential for new technologies to assess and monitor endocrine and immune systems as diagnostic measures of harbor seal health. Analysis of thyroxine (T_4), triiodothyronine (T_3), and cortisol (primary metabolic and gluconeogenic hormones), and measurement of immunoglobulins (IgG, IgM and IgA) and the body burden of organochlorine contaminants assesses both permanently captive seals as well as seals that are brought into the Alaska SeaLife Center (ASLC) for rehabilitation. Once the profiles of healthy seals and those 'failing to thrive' in their natural environment are assessed, these techniques will be evaluated for routine monitoring of free-ranging seals in an effort to restore this species.

INTRODUCTION

The potential exists for several environmental factors to impact the biology of harbor seals (*Phoca vitulina*), resulting in poor survival, recruitment and reproductive rates. While the leading hypothesis is that changes in the availability of high quality prey have reduced the carrying capacity of the Gulf of Alaska, a contributing factor to poor survival and reproduction may include exposure to organochlorine contaminants (OCs), with associated endocrine and immune system impairment (Addision, 1989; De Swart *et al.*, 1994, 1996; Ross *et al.*, 1995; Reijnders, 1986). OCs and their by-products are bioaccumulated, biomagnified and transferred through lactation from mother to pup (Beckmen *et al.*, 1999; Gallenberg and Vodicnik, 1989; Vreel *et al.*, 1996; Wagemann and Muir, 1984). These contaminants and by-products may continually affect a population of animals even though no major polluting event has occurred. The adverse effects on the physiology of the animal may be subtle or subclinical, or may manifest themselves with symptoms such as, 'failure to thrive' or 'failure to reproduce'. The systems that typically respond to environmental changes, including contamination of suitable prey, are the endocrine and immune systems. This proposed study will develop technologies to examine these two systems to be used to monitor the health of individuals and the well being of subpopulations.

The endocrine system is a complex system that integrates the environment in which an animal lives, with the physiology of that animal. As seasons, nutrition and other environmental parameters change, the neuroendocrine system is the first to work toward ensuring that the body can adapt to the changes. Many compounds in the environment are known to interfere with the endocrine systems of mammals and are often referred to as 'endocrine disrupting compounds' (EDCs). The most commonly known EDCs are the organochlorines, including polychlorinated biphenyls (PCBs), DDT and it's metabolites, as well as the phthalates. Some EDCs are known to bind with estrogen receptors (Katzenellenbogen, 1995), either mimicking or blocking the effects of estrogens. Extreme examples of the effects of OCs on reproductive function are the neoplastic occlusions of the uterus resulting in infertility and the development of hermaphroditic offspring (Helle *et al.*, 1976; Baker, 1989; Reijnders, 1998). PCBs can also compete for binding sites on the transport proteins for the thyroid hormones, resulting in hypothyroid conditions that can affect early development or later reproductive performance (Brouwer, 1989). The results from these endocrine disruptions can be varied and also include suppression of the immune system (De Swart *et al.*, 1996; Ross *et al.*, 1995). Atkinson and Oki (2001) used thyroxine and cortisol concentrations along with several morphometric measurements to assess the well being of yearling Hawaiian monk seals that appeared to be malnourished. Their results suggest that a suite of measurements, including these hormones, provides a good indication of the physiology of a seal and its ability to adapt to suboptimal environments.

The immune system of marine vertebrates is a rapidly advancing area of interest, both in the basic components of the immune system as well as the development of immunodiagnostic reagents. Baseline information on the immune system of pinniped species is critical to any future field assessment of immunocompetence. The lack of baseline information on the immune system of the harbor seal population in Europe hindered assessment of the role of pollution-induced immunosuppression in the phocid distemper virus outbreak of 1988 (Dietz *et al.*, 1989a; Vos and Luster, 1989). Studies of levels of immunoglobulins and of isotypes of those immunoglobulins have been reported for a few species of pinnipeds. Cavagnolo and Vedros (1979) evaluated IgG, IgM and IgA levels in sera and colostrums of adult and immature northern fur seals (*Callorhinus ursinus*), finding low immunoglobulin levels in the sera of pups during the

first four months of life. Baker (1984) found similar results for overall gamma globulin levels in grey seal (*Halichoreus grypus*) pups. Carter *et al.* (1990) measured specific immunoglobulin isotype levels in sera and colostrums of the grey seal. Ross *et al.* (1993) evaluated IgG levels in the harbor seal, and also evaluated lymphocyte function in this species by measuring responsiveness to a T-cell mitogen. A number of reports have appeared describing ELISA's or other immunoassays measuring pinniped antibody levels against canine distemper virus (e.g. Dietz, *et al.*, 1989b; Carter, *et al.*, 1990; Bengston, *et al.*, 1991; King, *et al.*, 1993). It is of note that some of the latter studies utilized antibodies specific for canine immunoglobulins to measure pinniped immunoglobulins, with which they cross-react. In assays such as the ELISA's mentioned above that require the use of anti-immunoglobulin indicator antibodies it is generally preferable to utilize species-specific antisera when available, but such antisera are not readily available for most species of pinnipeds.

This project will utilize our ability to montior several hormones and immunoglobulins, and relate their function to the body burden of contaminants and the overall health of individual seals. We propose to provide critical reagents and methodologies necessary for the assessment of several aspects of immunocompetence levels in the harbor seal, and to establish baseline data on these levels for the duration of the project in selected populations of harbor seals. The project will also result in the production of species-specific antisera for use in assays of immunoglobulin class specific antibody levels in the harbor seal population against pathogens, toxins, or other antigens of potential health importance. This project will also determine critical baseline concentrations of the thyroid hormones and cortisol of captive seals, housed in a stable environment with regular and balanced diets, to compare with free-ranging seals. In doing so, we can assess whether the seals in the Gulf of Alaska are being exposed to endocrine disrupting and/or immunosuppressive agents at level that are impacting their ability to survive, grow and reproduce. If contaminants are affecting the physiology of harbor seals, then we need to incorporate this into the working hypothesis under which this species is being managed. In addition, assessing the effects of environmental contaminants should be incorporated into any long-term plans for monitoring harbor seals. Monitoring endocrine and immune levels can also be used as indicators upon which parameters needed to model the population dynamics of harbor seals can be developed. This will become increasingly important if this species continues its population decline in the Gulf of Alaska.

During the first year of the funding, we have been developing the techniques to quantify harbor seal immunoglobulins. The cell lines for this technique are being developed through the production of monoclonal antibodies at the University of Southern Mississippi. Hormonal assays for the thyroid hormones and coritsol have been validated in my laboratory at ASLC. Blood samples for the circadian pattern of thyroid hormones and cortisol have been collected and the assays completed. The data are currently being statistically analyzed. The permit modification to collect blubber samples from the permanently captive seals and ASLC has been submitted and reviewed. We anticipate collecting the first blubber samples this spring.

NEED FOR PROJECT

A. Statement of Problem

Harbor seals were one of the resources that were injured by the 1989 *Exxon Valdez* oil spill (EVOS). To date this species is listed as 'not recovering'. Several studies have focused on the general health and metabolism of these seals as it relates to their diet, body condition and habitat (Projects 001, 341, 371, and 441). The proposed study will compliment these investigations as it will utilize new techniques to enhance our understanding of the health and physiology of the species and incorporate the possible affects of environmental organochlorine contaminants. If the techniques can be combined to develop a concise indicator of a given animal's health, then these techniques should be incorporated into the routine assessment and monitoring of harbor seals in the Gulf of Alaska.

B. Rationale/Link to Restoration

In order to recover any species whose population has experienced a major decline, it is necessary to fully understand the biology of the species. A few species of marine mammals have failed to recover with the enactment of the Marine Mammal Protection Act (e.g. Hawaiian monk seals and Steller sea lions). Other species have declined precipitously since the Marine Mammal Protection Act, with some subpopulations more affected than others (e.g. Alaskan harbor seals). The problems that these species face are multifaceted and complex. Many times a combination of factors will synergize to produce a devastating effect (such as the 1988 harbor seal epizootic in the North Sea), while either factor alone may not have had clinical effects. In understanding what the Alaskan harbor seals are experiencing, it is essential to know the degree to which they are being subjected to immunosuppressive or endocrine disrupting agents. Restoration of the species can only be successfully accomplished if the species is thoroughly understood. With this knowledge we can begin to predict the devastating effects of environmental changes and model the long-term population dynamics. In addition to predicting the impact of a given environment, we can also begin to manipulate animals and their environments to assist in their recovery.

The information gained from this study will enable us to assess two groups of animals, those that live in a stable, consistent environment (captivity), with those that experience the natural environment (rehab seals). Seals brought in for rehabilitation are generally young animals that are failing to thrive in their environment. They may not be able to naturally survive the weaning process due to a variety of factors, including immuno-incompetance or inadequate maternal investment (ie, poor milk quality or shorten lactation period). Through morphometric measurements, assessment of immune and endocrine function, and measurement of body contaminant levels, we can evaluate the degree to which these animals are adapting to a changing environment. Once these techniques have been perfected at the ASLC, we plan to test their application to a long-term field monitoring program. The ability of harbor seals to adapt to a changing environment is essential to the recovery of this species. Knowing what the animals are dealing with and their ability to adapt will enable resource managers to predict the recovery or mitigate the future decline of this species.

C. Location

Years 1 and 2 of this project will be undertaken at the ASLC using harbor seals that are currently resident and permitted for research under the Marine Mammal Protection Act for research. It will also utilize animals that will be brought in for rehabilitation under the terms of an existing letter of authorization, and through our collaboration with the Alaska Native Harbor Seal Commission. Year 3 of this work is proposed to closeout the project, including the publication of results that

have been obtained in years 1 and 2, as well as the analysis of a few free-ranging seals in Prince William Sound and areas near South Central Alaska.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

This project will involve a growing collaboration with the Alaska Native Harbor Seal Commission. In addition to the native communities, we propose working with coastal fishing communities to increase the awareness of the plight of this species. In working with community facilitators, we will request that nearby communities inform us of harbor seals needing rehabilitation, including orphaned pups. These animals provide a wealth of information as they have incorporated any environmental constraints into their physiology. As coastal communities come into contact with these animals more often than we know about, we propose working with these communities to increase our sample sizes. Through the development of brochures and speaking with local community groups, we will collaborate to ensure that seals requiring rehabilitation are brought to ASLC. Partnerships with the Civil Air Patrol and US Coast Guard will be sought to provide transportation of seals to ASLC from neighboring communities. During the rehabilitation process, these animals will be monitored for biochemical changes that indicate their ability to adapt.

This project will also coordinate with the existing volunteer and intern programs at ASLC to make opportunities available for spill-area residents who would like to spend time volunteering at ASLC. To a large extent this will increase our awareness of traditional and local knowledge of harbor seals as well as incorporate local expertise into the project. This project is budgeted for one graduate student and one research associate who will receive training to increase their level of expertise in marine mammal physiology as well as provide the necessary time to ensure that our community involvement is successful.

PROJECT DESIGN

A. Objectives

The overall goal of this project is to develop and test new methods of monitoring the physiology of harbor seals. In doing so the project has the following five objectives:

1. Determine seasonal and circadian patterns of total and free triiodothyronine (T_3), thyroxine (T_4), and cortisol in healthy captive harbor seals (Yr 1).
2. Develop new antibodies specific to harbor seal immunoglobulin classes IgG, IgM and IgA (Yr 1).
3. Determine seasonal patterns of IgG, IgM, and IgA, in healthy captive harbor seals (Yrs 1 and 2).
4. Determine endocrine and immunoglobulin profiles and measure organochlorine concentrations for rehabilitation seals periodically throughout the rehabilitation process (Yrs 1 and 2).
5. Assess the suite of measurements as overall indicators of health in free-ranging seals (Yr 3).

B. Methods

Objective 1. Seven harbor seals (3 males, 4 females) housed at the ASLC will have monthly blood samples collected to assay for total and free T_4, T_3, and cortisol. In addition, circadian patterns of these hormones will be assessed from the seven seals during the seasonal extremes of the summer and winter solstices, with samples collected at 2 to 3 hourly intervals over a 24 hour period. Blood and blubber samples will be collected quarterly over the two years for organochlorine analysis.

The analyses for these hormones have previously been validated for other pinniped species (Atkinson and Oki, 2001) and recently for harbor seals. Concentrations of cortisol will be measured in unextracted plasma using a single-antibody radioimmunoassay (Atkinson and Oki, 2001; Atkinson and Adams, 1988). The plasma will be heated at 60°C for 30 minutes to denature cortisol-binding proteins before assaying directly. Samples will be analyzed in batches to reduce inter-assay variation. Concentrations of total and free T_4 and T_3 will be measured in unextracted plasma using solid phase radioimmunoassays (Diagnostic Products Corporation, Los Angeles, CA) that are specific to either total or free, T_4 or T_3 (Atkinson and Oki, 2001). The standard curves of each assay will be log-logit transformed, enabling extrapolation of sample concentration (Robard, 1974). A profile of the variation in total and free T_4 and T_3 will be generated and statistically analyzed.

Objective 2. The prerequisite for development of heavy chain specific antisera for the major immunoglobulin classes of the harbor seal is the production of purified preparations of each of these immunoglobulin classes. These purified immunoglobulin classes will be obtained from pooled sera from captive animals at ASLC and will be used as the source of the immunoglobulins to be purified. The first step toward purification of individual immunoglobulin isotypes (IgG, IgM, and IgA) from serum will be to remove non-immunoglobulin proteins, leaving a mixture of all immunoglobulin isotypes present. Serum samples will be centrifuged (five minutes at 10,000 rpm) to remove any large particulate matter present. The supernatant will then be filtered through a 0.45 μm and then a 0.2 μm filter to further remove any remaining particulates and/or aggregates. The next step involves separating serum proteins in the filtrate based on molecular weight. The serum will be placed in a Millipore UltraFree®-15 centrifugal filter device with a molecular weight cutoff of 100,000 daltons. During a thirty minute centrifugation step (2000 x g) proteins less than 100,000 daltons pass through the filter, while those greater than 100,000 daltons are retained above the filter. Since the immunoglobulin isotypes being studied have molecular weights greater than 100,000 daltons, they will be retained in the fluid retained in the UltraFree®-15, and can be removed and kept available for use in further purification steps. This filtration technique has proven more satisfactory than techniques involving differential precipitation of serum proteins in saturated ammonium sulfate.

Aliquots of such partially purified and concentrated samples will then be applied to one of the types of chromatography columns for purification of a particular immunoglobulin isotype. Antiserum will be produced monoclonally against the precipitated immunoglobulins to permit preliminary analysis of the IgG, IgM, and IgA immunoglobulins in harbor seal serum. Grabar-Williams immunoelectrophoresis will be used in initial examination of harbor seal whole and precipitated serum for immunoglobulins.

In order to obtain immunogens suitable for production of heavy chain specific antisera for immunoglobulins of the harbor seal, purified immunoglobulins will first be enzymatically partially digested with papain to obtain the equivalent of Fab and Fc fragments for each isotype.

Use of whole heavy chains as the immunogen produces antisera, which include antibodies against the variable region of the heavy chain, which may cross-react with immunoglobulins of various isotypes. The Fc fragment contains only heavy chain constant regions and is more likely to induce isotype specific antisera if used as the immunogen. Purified "Fc" fragments of each isotype will be reduced with 2-mercaptoethanol and alkylated with iodoacetamide to break the disulfide bonds between the linked heavy chains. Chromatography using a Sephacryl S-400HR column will then be used to separate the heavy chain fragments from the other peptides which may be present (e.g. the J-chain of IgA or IgM). Once the purity of heavy chain preparations has been determined, they will be used to produce isotype-specific antisera that can be used to determine specific IgG, IgM, and IgA levels within a sample. Mice will be used to produce these antisera. The animals will be immunized by standard approved protocols. The titer and specificity of the antisera will be determined by (1) standard indirect ELISA (wells coated with purified harbor seal immunoglobulin heavy chain), followed by the anti-heavy chain antibody being tested, followed by enzyme-labeled anti-rabbit immunoglobulin, and finally by the indicator substrate) and (2) immunoelectrophoresis (IEP) methods including Grabar-Williams, Rocket IEP, Crossed IEP, and Tandem Crossed IEP. The antisera will be partially purified by use of the Millipore UltraFree®-15 centrifugal filter device followed by purification by Protein G Sepharose^{R} affinity chromatography to obtain the IgG fraction of this monoclonal antisera. The purified antisera will be labeled with biotin or an enzyme (e.g. alkaline phosphatase or horseradish peroxidase) using standard labeling linkers (Pierce). The resulting antisera will be analyzed for specificity by several methods, including application of the antisera to Western blots of whole heavy chain preparations obtained by reduction/alkylation of the respective whole immunoglobulin isotype preparations.

Once the antisera for each immunoglobulin's heavy chain isotype has been made, it will be possible to regularly monitor immunoglobulin levels as an indicator of immune status of a population of harbor seals. It will also be possible to determine the level of each isotype present in, for example, samples obtained during a vaccination trial, at particular points in time of interest to a veterinarian or researcher (e.g. during pregnancy, drug therapy, maturation stage, etc.).

Objective 3. An ELISA protocol similar to that described by Suer *et al.* (1988) has been used to evaluate serum antibody levels in several species of marine mammals against several antigens (e.g. Patterson *et al.*, 1994). A "sandwich" ELISA protocol will be employed in an effort to determine general immunoglobulin levels in these samples. In the sandwich ELISA, a plastic solid phase matrix (polystyrene microwells) is coated with unlabeled antibodies against the antigen in question, i.e. in this case against on of the heavy chain isotypes (gamma, alpha, or mu for IgG, IgA, and IgM respectively) of immunoglobulins from the harbor seal (prepared via completion of Objective 2 above). The sandwich ELISA conducted in this manner will allow quantification of general immunoglobulin levels in samples by comparison with a standard curve generated using preparations made with known concentrations of immunoglobulins purified from the harbor seal.

Blood samples are being collected on a monthly basis from the permanently captive seals at ASLC. Aliquots of each sample (and aliquots of other samples of harbor seal sera which become available) will be quantified for isotype levels using the ELISA described above in completion of Objective 2.

Objective 4. Using the previously described techniques, we will measure total and free T_3, T_4, cortisol, and IgG, IgM and IgA in harbor seals that are brought in for rehabilitation. ASLC has the ability to hold 10 seals for rehabilitation. An assessment of the level of contamination by organochlorines will also be performed from either blood or blubber samples. As these measurements will be diagnostic, the frequency of sampling will be based on the overall condition of the seals and not all of these animals will have the same numbers of samples collected. It is envisioned that samples will be collected upon entrance and before release of all seals. In addition, samples may be collected periodically to assess any effects of different milk formuli that are fed to very young seals as well as upon weaning when the diet and digestive efficiency of the animals is maturing.

Seals admitted for rehabilitation at the SeaLife Center are held in quarantine and placed in individual holding tanks. Currently, health data such as blood chemistry and morphometrics are collected every 10 days from each harbor seal admitted for rehabilitation. Blood chemistry and hematology values are used in conjunction with body composition to detect significant changes in health status that might alter water balance, cause anemia, or compromise basic metabolic status (Castellini et al., 2000, 1993). Blood urea, nitrogen (BUN) ketone bodies, and free fatty acids, as well as hematocrit, hemoglobin, and erythrocyte sedimentation rate are measured.

Assimilation efficiencies will be determined for harbor seals prior to and during the weaning process, as well as once the animals are on a stable fish diet. Meal size and feeding frequency will be kept constant during the experimental period. Food digestibility in these seals will be determined using manganese (Mn^{++}) as an inassimilable dietary marker. Concentrations of Mn^{++} from sub-samples of the food items fed to individual seals during the acclimation and collection periods will be analyzed using atomic absorption spectrophotometry (Fadely et al. 1990). Feces will be collected during the course of the feeding trail to determine the clearance rate of food items and fecal Mn^{++} concentrations. Differences in the Mn^{++} concentrations between diet and feces will be used to calculate AE. In addition, diet and fecal samples will be freeze-dried and analyzed for energy (cal/g), nitrogen, total lipid, and ash as reported in Keiver et al (1984). To quantify the passage of digesta (mean retention time) and fecal Mn^{++} concentrations, carmine red will be used as a marker to estimate emptying time of the stomach (Ashwell-Erikson and Elsner 1981).

Objective 5. The methodology of this objective will be developed over the first 1 to 2 years of the project. The feasibility of sampling as well as the necessities of sample processing will continually be evaluated with the goal of developing techniques that are feasible for field collections. While the primary goal of Year 3 will be to publish the data collected it Years 1 and 2, it is hoped that Year 3 can include a small number of samples collected from free-ranging seals. The sites of collection, numbers of animals and the permits to cover the sampling of wild seals will be negotiated with other researchers who may be collecting samples concurrently. Discussions will also be held with the Alaska Native Harbor Seal Commission to assist with the planning of the field testing.

C. Cooperating Agencies, Contracts and Other Agency Assistance

This project will primarily be based at ASLC, with the National Marine Fisheries Service permits for the captive seals being held by ASLC with Dr. S. Atkinson serving as the Principal Investigator of that permit. Seals needing rehabilitation will be sought with the guidance of the

Alaska Native Harbor Seal Commission. The letter of authorization for these seals is also held by ASLC, with Susan Inglis, Director of Research and Rehabilitation Operations serving as the PI.

The samples collected for endocrine evaluation will be analyzed in the Marine Mammal Endocrinology Lab of Dr. S. Atkinson, housed at ASLC. The samples for immune assessment will be analyzed in Dr. Bobby Middlebrooks' laboratory at the University of Southern Mississippi. A subcontract within this proposal has been negotiated. The samples for contaminant measurements will be analyzed by the Northwest Fisheries Science Center of the National Marine Fisheries Service. The analysis of these samples has been discussed with Dr. Peggy Khran.

SCHEDULE

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

October 2000:	Blood sampling commences on a monthly basis. In addition, single samples will be taken to initiate the hormone validations and immunoglobulin development.
November 2000:	Blood and blubber samples from the captive seals will be sent for contaminant analysis.
December 2000:	Blood samples will be collected to assess circadian pattern of T_3, T_4 and cortisol.
January 2001:	Endocrine assays will be undertaken with batches of samples to assist with quality control.
May-June 2001:	Seals collected for rehabilitation arrive at ASLC.
June 2001:	Circadian sampling will be performed.
June- September:	Endocrine and immunology samples analyzed.
September-October:	Rehabilitation seals released.

Depending on the age and health of these seals, they are typically kept until late summer or fall. Most of the analyses for samples collected in early 2001 will be accomplished by Sept 2001. Samples collected in 2002 will be scheduled to complete during FY 02.

B. Project Milestones and Endpoints for Year 2

1. Establishment of baseline levels of total and free T_3, T_4 and cortisol levels in the serum: Analysis of the circadian hormone concentrations from captive animals will be completed during Year 2, with a comparison of winter and summer seasons. Monthly blood samples from two years will enable us to assess the variation in values from the samples collected from healthy animals in a stable environment. The rehabilitation seals from two years will also have samples collected enabling an analysis of seals that are failing to thrive in the natural environment.

2. Development of species-specific antisera against immunoglobulins of the harbor seal: An important outcome of Year 1 is the production of antisera against immunoglobulin isotypes of the harbor seal. These antisera will be available for quantifying

immunoglobulins in Year 2. The immunoglobulins will be analyzed for seasonal variation, allowing the question of the variability in immune status throughout the year to be addressed for permanently captive seals in a stable environment.

3. The quantification of organochlorines in captive and rehabilitated harbor seals will provide a baseline as to what kinds of body burdens we can expect. A comparison between blood and blubber concentrations will allow the assessment of the best type of sample to be collected from field studies. This will be done in Year 2.

C. Completion Date

The anticipated completion date of the captive portion of this project is October 2003. At this point we will hope to be able to recommend that some form of these techniques be applied to a field monitoring program. If this is accomplished the feasibility of field sampling could be determined by October 2004.

PUBLICATION AND REPORTS

It is anticipated that all of the work conducted under this proposal be published in peer-reviewed international journals. Potential journals include, General and Comparative Endocrinology, Comparative Biochemistry and Physiology, Marine Mammal Science, and Journal of Developmental and Comparative Immunology. In addition, any student projects will be presented in thesis or dissertation format as well as submitted for journal publication. The presentation of work at conferences and workshops will be encouraged. Such conferences may include, Society for Marine Mammalogy, International Association of Aquatic Animal Medicine, or any EVOS workshops.

PROFESSIONAL CONFERENCES

The PI will request travel for the graduate student, Ms. Danielle Goodrode to attend the Biennial Conference of the Biology of Marine Mammals in Vancouver, Canada in FY02. This conference attracts international researchers, some of whom specialize in harbor seals. It is anticipated that Ms. Goodrode will have enough data to submit and abstract of our work in time for the call for abstracts.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The PI of this proposal also serves as the Science Director of the ASLC. Through this avenue, the PI holds regular discussions on the projects that are currently taking place at ASLC, and is already collaborating on the technical aspects of this study. This project will be using the same animals as have been used for projects 341, 371, and 441, and it is anticipated that the data obtained from FY02 will compliment the data obtained from previous EVOS funded projects. It is also anticipated that if any field samples are scheduled for Year 3, the samples will be collected from a shared field site, integrating existing field projects with our sample collections.

This project will benefit from new equipment that has recently been purchased by UAF and UAF Foundation in an effort to establish an endocrinology laboratory at ASLC. The lab will be regulated under the Nuclear Regulatory Commission License to UAF. It is in this lab that the students and research associate on this project will work.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR (qualifications)

Shannon Atkinson, Ph.D.
University of Alaska Fairbanks,
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Institute of Marine Science,
PO Box 730,
Seward, AK 99664.
Phone 907-224-6346 Fax 907-224-6360
Email shannon_atkinson@alaskasealife.org

The PI of this project has been a professor at UAF for 16 months, with half time duties to serve as the Science Director at ASLC. She has 18 years experience in analyzing body fluids for hormone concentrations. She has established and worked in two other endocrinology laboratories, one at Hawaii Institute of Marine Biology, University of Hawaii, and the other at Murdoch University in Western Australia. The PI also has extensive experience working with a variety of marine mammals, including the endangered Hawaiian monk seal, California harbor seals, northern elephant seals, Risso's, rough-toothed, white sided, and bottlenose dolphins, and, humpback, beluga, and false killer whales. The PI will be responsible for the completion of all project objectives. Her curriculum vita is attached.

OTHER KEY PERSONNEL

Ms. Susan Inglis is the Director of Research and Rehabilitation Operations at ASLC. She has extensive experience in the rehabilitation of seals and birds. She has 15 years experience managing research projects, including numerous species of fish, sea birds and marine mammals. Her organizational and technical skills will be invaluable to this project. Her curriculum vita is attached.

Dr. Bobby Middlebrooks is a Professor at the University of Southern Mississippi. He has an immunology laboratory that focuses on the basic components and functioning of the immune systems of marine vertebrates. He has developed immunodiagnostic assays for pinnipeds and is highly qualified to undertake the immunological aspects of this study. He will be responsible for the developing any specific reagents necessary to assay for immunoglobulins in harbor seals, as well as for performing and analyzing the results from those assays. His curriculum vita is attached.

Salaries have been included for a research associate and a graduate student. The research associate will assist with the overall coordination of the sample collection from the captive seals as well as organize and coordinate sample collections from the rehabilitation seals. The research associate will also work with community facilitators to increase the sample size of rehab seals entering ASLC. This will include collaborations with the Civil Air Patrol or Coast Guard to assist with transport of seals from nearby communities. In addition, the research associate will work in the endocrinology lab at ASLC and help to maintain quality control and assurance standards for the assays performed there.

The graduate student will be responsible for drafting the experimental designs and sampling protocols. They will assist with the sample collections and perform the laboratory work. With assistance from the PI, they will analyze the data and present them in graphical and tabular form. They will be responsible for the first draft of any manuscripts that arise from the work included in their thesis or dissertation.

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2002 *EXXON VALDEZ* TRU COUNCIL PROJECT BUDGET

October 1, 200 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$0.0
Travel		$0.0
Contractual		$124.8
Commodities		$0.0
Equipment		$0.0
Subtotal		$124.8
General Administration		$8.7
Project Total		$133.5
Full-time Equivalents (FTE)		1.4
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2003					

Dollar amounts are shown in thousands of dollars.

Comments:

FY02

Prepared:

Project Number: 02558
Project Title: Harbor Seal Recovery: Application of New Technologies for Monitoring Health
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2002 *EXXON VALDEZ* TRU: COUNCIL PROJECT BUDGET

October 1, 200: - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$51.3						
Travel		$2.0						
Contractual		$45.1						
Commodities		$1.4						
Equipment		$0.0						
Subtotal		$99.8	Estimated FY 2003					
Indirect		$25.0						
Project Total		$124.8	$25.3					
Full-time Equivalents (FTE)		1.4						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

The indirect rate is 25% TDC, as negotiated by the *Exxon Valdez* Oil Spill Trustee Council with the University of Alaska.

Student tuition is included in the Wages - $6,048.

FY02

Prepared:

Project Number: 02558
Project Title: Harbor Seal Recovery: Application of New Technologies for Monitoring Health
Name: Shannon Atkinson

FORM 4A
Non-Trustee
SUMMARY

2002 *EXXON VALDEZ* TRU E COUNCIL PROJECT BUDGET
October 1, 200 . September 30, 2002

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2002
	Atkinson, S.	PI/ Professor	0.5	9.8		4.9
	TBA	Research Associate	4.2	5.4		23.0
	TBA	M.S. Student	12.0	4.0		23.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	16.7	19.2	0.0	
					Personnel Total	$51.3

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2002
	Seward to Vancouver	1000.0	1	6	633.0	1.6
	Seward to Anchorage (car mileage)	125.0		2	121.0	0.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$2.0

FY02

Prepared:

Project Number: 02558
Project Title: Harbor Seal Recovery: Application of New Technologies for Monitoring Health
Name: Shannon Atkinson

FORM 4B
Personnel
& Travel
DETAIL

2002 *EXXON VALDEZ* TRU : COUNCIL PROJECT BUDGET
October 1, 200 - September 30, 2002

Contractual Costs:	Proposed
Description	FY 2002
Hormone analyses (195 samples x 4 hormones @ $13/sample)	10.1
Blood Chemistry and Proximate Analyses (ASLC)	5.0
Dr. Middlebrooks Subcontract	20.0
Contaminant Analysis	10.0
Contractual Total	$45.1

Commodities Costs:	Proposed
Description	FY 2002
Blood Collecting supplies and Regeants	1.4
Commodities Total	$1.4

FY02

Prepared:

Project Number: 02558
Project Title: Harbor Seal Recovery: Application of New Technologies for Monitoring Health
Name: Shannon Atkinson

FORM 4B
Contractual & Commodities DETAIL

2002 *EXXON VALDEZ* TRU : COUNCIL PROJECT BUDGET

October 1, 20.. - September 30, 2002

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2002
			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	
Description	of Units	

FY02

Prepared:

Project Number: 02558
Project Title: Harbor Seal Recovery: Application of New Technologies for Monitoring Health
Name: Shannon Atkinson

FORM 4B
Equipment
DETAIL

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

February 13, 2001

Dr. Shannon Atkinson
Tania Clucas, CRA

RE:	PROJECT DIRECTOR:	MIDDLEBROOKS, B. L.
	TELEPHONE:	(601) 266-4748
	NUMBER OF ADDITIONAL COPIES:	zero (0)

Enclosed please find an original proposal entitled "HARBOR SEAL IMMUNOGLOBIN LEVELS (EVOS STUDY)" which The University of Southern Mississippi wishes to submit to ALASKA SEALIFE CENTER.

After reviewing the proposal, if questions of a technical nature arise, please feel free to contact the above referenced Project Director. Questions relating to budgetary, contractual, or business aspects of the project should be brought to my attention at (601) 266-4119.

I trust that the enclosed proposal is responsive to the interests of ALASKA SEALIFE CENTER. If selected for funding, you can be assured that the project will be conducted in a responsive and timely manner.

I look forward to hearing from you regarding the status of this proposal.

Sincerely,

Pamela F. Miller

Pamela F. Miller, Ph.D.
Director

Enclosures

RESEARCH AND SPONSORED PROGRAMS
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Phone (601) 266-4119 · Fax (601) 266-4312
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Hattiesburg • Long Beach • Ocean Springs • Biloxi • John C. Stennis Space Center

Introduction:

Since the late 1960's and early 1970's the health of marine animals, both in captivity and in the wild, has become a major focal point in research efforts in a number of laboratories throughout the world (Ridgway, 1972). Even with the medical knowledge that currently exists on marine mammals, very little is known about their immune systems (Kennedy-Stroskopf, 1990). Ross, et al. (1993) point out that "pinniped immunology is still in its infancy." Assessment of the health status of individuals in populations of target species provides important information in overall assessment of the species, and may point to steps that might be taken to address health-related impediments to recovery of a species or populations of that species. A case in point (albeit in a non-marine mammal) is the determination of the role of a distemper outbreak in the reduction of the small and only known surviving population of the black footed ferret, which led to the development of a recovery plan based on capture and breeding of surviving animals and attempted re-establishment of several populations (U.S. Fish and Wildlife Service, 1988).

Baseline information on the immune system of target pinniped species is critical to any future field assessment of immunocompetence. The lack of baseline information on the immune system of the harbor seal (*Phoca vitulina*) population in Europe hindered assessment of the role of pollution-induced immunosuppression in the phocid distemper virus outbreak of 1988 (Dietz et al, 1989a; Thomas and Hinsdill, 1978; Vos and Luster, 1989). Studies of levels of immunoglobulins and of isotypes of those immunoglobulins have been reported for a few species of pinnipeds. Cavagnolo and Vedros (1979) evaluated IgG, IgM and IgA levels in serum and colustrum of adult and immature northern fur seals (*Callorhinus ursinus*), finding low immunoglobulin levels in the serum pups during the first four months of life. Baker (1984) found similar results for overall gamma globulin levels in grey seal (*Halichoreus grypus*) pups. Carter et al (1990) measured specific immunoglobulin isotype levels in the serum and colustrum of the grey seal. Ross et al. (1993) evaluated IgG levels in the harbor seal (*Phoca vitulina*), and also evaluated lymphocyte function in this species by measuring responsiveness to a T-cell mitogen. Several reports of neutralizing antibodies against marine caliciviruses in Steller sea lion sera have appeared (Akers, et al., 1974; Barlough, et al., 1987a. 1987b) emphasizing the need for immunological assays to monitor disease/infection exposure in target populations of a species. A number of reports have appeared describing ELISA's or other immunoassays measuring pinniped antibody levels against canine distemper virus (e.g. Dietz, et al., 1989b; Carter, et al., 1990; Bengston, et al., 1991; King, et a;, 1993). It is of note that some of the latter studies utilized antibodies specific for canine immunoglobulins to measure pinniped immunoglobulins, with which they cross-react. In assays such as the ELISA's mentioned above that require the use of anti-immunoglobulin indicator antibodies it is generally preferable to utilize species specific antisera when available, but such antisera are not readily available for most species of pinnipeds.

We propose to provide critical reagents and methodologies necessary for the assessment of several aspects of immunocompetence levels in the harbor seal, and to establish baseline data on these levels for the duration of the project in selected populations of harbor seals. The project will also result in the production of species specific antisera for use in assays of immunoglobulin class specific antibody levels in the harbor seal population against pathogens, toxins, or other antigens of potential health import.

The degree to which an animal is immunocompetent is indicated by how quickly and efficiently its immune system responds to an antigen. Normally upon exposure to an antigen there will be both a T and B-cell mediated response. With regard to the B-cell response, an animal

responds by producing immunoglobulins (antibodies) specific for the infecting antigen. In most mammals, there are five classes or isotypes of immunoglobulins, IgG, IgM, IgA, IgE, and IgD. Of these, IgG, IgM, and IgA are the most prevalent serum immunoglobulins. IgA is also important because of its role as a secretory immunoglobulin, and it is found in secretions such as saliva, milk and colustrum, mucous membrane secretions, etc. The various immunoglobulin classes have identifiably separate but overlapping roles or functions in the immune response, and vary in rate of production and relative concentration in an immune response. Individuals with deficiencies in the production or function of immunoglobulin classes may have health problems directly or indirectly related to these deficiencies; establishment and monitoring of levels can thus be an important indicator of natural or induced humoral immunodeficiencies.

Throughout the course of the project, samples will be taken at least monthly from captive population, from animals in rehab centers, and from captured wild animals as available. Aliquots of these samples either would be used immediately (for use in isolating immunoglobulin isotypes for preparing diagnostic rabbit antisera to be used to quantitate individual isotype levels), or would be cryopreserved pending future assay by ELISA to determine levels of the various isotypes.

Objectives

(1) Antisera will be developed that is specific for the heavy chains of the major immunoglobulin classes IgG, IgM, and IgA of the Harbor seal (*Phoca vitulina*). Alternatively, commercially available cross-reactive antisera (against immunoglobulins of related species) will be identified. These antisera will permit the quantitation and partial immunochemical characterization of these immunoglobulin classes in the Harbor seal.

(2) The antisera against IgG, IgM, and IgA will be used to establish baseline data concerning levels of all of these immunoglobulin classes in serum and of IgA in saliva samples.

Methods

The proposed approach for addressing each of the stated objectives follows:

(1) Antisera will be developed that is specific for the heavy chains of the major immunoglobulin classes IgG, IgM, and IgA of the Harbor seal (*Phoca vitulina*). These antisera will permit the quantitation and partial immunochemical characterization of these immunoglobulin classes in the Harbor seal.

The first prerequisite for development of heavy chair specific antisera specific for the major immunoglobulin classes of the Harbor seal is the production of purified preparations of each of these immunoglobulin classes. These purified immunoglobulin classes will be obtained from pooled sera from captive animals at the Alaska SeaLife Center (ASLC) or other facilities or from wild animals captured specifically for sampling will be used as the source of the immunoglobulins to be purified. Blood samples will be drawn from the animals by qualified project personnel ASLC, who will process the samples and ship them to this laboratory. Sample size will be at least 20ml per month. Additional volumes of serum, including either samples from freshly drawn blood or samples from banked serum aliquots will be obtained if available. The samples will be maintained at -20°C pending use. The first step toward purification of individual immunoglobulin isotypes (IgG, IgM, and IgA) from serum will be an initial purification step to remove non-immunoglobulin proteins

from serum (leaving a mixture of all immunoglobulin isotypes present). Serum samples will be centrifuged (five minutes at 10,000 rpm) to remove any large particulate matter present. The supernatant will then be filtered through a 0.45 μm and then a 0.2 μm filter to further remove any remaining particulates and/or aggregates. The next step involves separating serum proteins in the filtrate based on molecular weight. The serum will be placed in a Millipore UltraFree®-15 centrifugal filter device with a molecular weight cutoff of 100,000 daltons. During a thirty minute centrifugation step (2000 x g) proteins less than 100,000 daltons pass through the filter, while those greater than 100,000 daltons are retained above the filter. Since the immunoglobulin isotypes being studied have molecular weights greater than 100,000 daltons, they will be retained in the fluid retained in the UltraFree®-15, and can be removed and kept available for use in further purification steps. This filtration technique has proven more satisfactory in this laboratory than technuques involving differential precipitation of serum protiens in one-third saturated ammonium sulfate.

Aliquots of such partially purified and concentrated samples will then be applied to one of the types of chromatography columns described below for purification of a particular immunoglobulin isotype. Antiserum will be produced in rabbits against the precipitated immunoglobulins to permit preliminary analysis of the IgG, IgM, and IgA immunoglobulins in Harbor seal serum. Grabar-Williams immunoelectrophoresis will be used in initial examination of Harbor seal whole and precipitated serum for immunoglobulins.

a.) IgG: IgG can be purified by a variety of chromatography techniques, though affinity chromatography is the most commonly used. Affinity columns using matrices such as Protein A and Protein G have been used successfully to purify IgG from a number of species (human, rabbit, cow, horse, goat, guinea pig, sheep, dog, pig, rat, and mouse) (Åkerström et. al, 1985; Nilsson, et. al, 1982; Peng, et. al, 1991). Protein A is a cell surface protein isolated from *Staphylococcus aureus.* Protein G is a bacterial cell wall protein isolated from Group G streptococci. Both proteins bind to the Fc region of IgG (Björck and Kronvall, 1984; Reis et. al, 1984; Reis et. al, 1984), so conjugation of these proteins with a support matrix allows for the formation of an effective affinity column for IgG purification. In this laboratory Protein G Sepharose 4 Fast Flow affinity chromatography columns have proven very effective for purification of IgG from serum of a variety of species of mammals, including several species of cetaceans (Patterson and Middlebrooks, 1998), and more recently the Steller sea lion. It is thus anticipated that Protein G chromatography will be useful for purification of harbor seal IgG. The protein samples purified, dialyzed, and concentrated from the Protein G Sepharose^{R} 4 Fast Flow column will be tested by Grabar-Williams immunoelectrophoresis and polyacrylamide gel electrophoresis to determine purity of the putative IgG and to confirm that the protein has the expected characteristics of IgG. The cross reactivity of antisera against canine immunogloblulins with pinniped immunoglobulins or antisera from other pinnipeds (e.g. our antisera against Steller sea lion immunoglobulins) will be exploited to provide additional confirmation of the identity of the putative IgG. Protein A affinity chromatography of partially purified Steller sea lion immunoglobulins has resulted in the selective purification of IgG and IgM, which could then be further purified by size exclusion chromatography (see below)

b) IgA. IgA has been effectively purified from human serum, tears, and colostrum using and affinity column matrix containing Jacalin (Roque-Barreira and Campos-Neto, 1985; Haun et. al, 1989), an α-D-galactose binding lectin extracted from jack-fruit seeds (*Artocarpus integrifolia).* Jacalin binds to carbohydrate moieties common on IgA from humans. These moieties are common among IgA of many mammalian species, thus an affinity column using Jacalin as the matrix can be used to purify IgA from mammals other than humans. For example, in this laboratory the Pierce jacalin-agarose affinity column (Bunn-Moreno and Campos-Neto, 1981; Rogue-Barreira and

Campos-Neto, 1985) has been used for purification of IgA from cetaceans, mice and rabbits (Patterson and Middlebrooks, 1998). Preliminary results in this laboratory with Steller sea lion immunoglobulins indicates that a protein peak consistent with IgA can obtained using the Jacalin-agarose affinity column. In the proposed study, Jacalin-agarose affinity chromatography will be used to purify sufficient qualities of purified IgA from the harbor seal to permit production of specific antisera. Grabar-Williams immunoelectrophoresis and polyacrylamide gel electrophoresis will be used to determine purity of the putative IgA and to confirm that the protein has the expected characteristics of IgA. The cross reactivity of antisera against canine immunogloblulins with pinniped immunoglobulins or antisera from other pinnipeds (e.g. our antisera against Steller sea lion immunoglobulins) will be exploited to provide additional confirmation of the identity of the putative IgA.

c). There are no reliable standard affinity column techniques for isolation and purification of IgM from serum or other samples. A potential affinity column system exists in the form of column matrices to which is linked mannan binding protein, which has an affinity for IgM from some species. Mannan binding protein is available in linked to several column matrices including Pierce's "Ultra-Link", and a standard agarose matrix, and could be linked to other matrices if desired. Mannan binding protein chromatography will be evaluated for purification of harbor seal IgM. Fortunately, since IgM typically exists as a pentamer in serum, its molecular weight relative to other immunoglobulins makes it a relatively simple matter to purify it. Should mannan-binding protein chromatography prove ineffective, the approach that will be employed is gel filtration on a Sephacryl® S-400HR column (Pharmacia) (Nielsen, 1976; Patterson, 1990). The chromatography fraction falling into the molecular weight category expected of IgM will be purified and subjected to analysis by IEP and SDS-PAGE. In addition, as indicated in b. above, we have preliminary data that suggest that Jacalin-affinity chromatography may be used to partially purify IgM from Steller sea lions, and this approach will also be evaluated for use with the harbor seal.

Preparations of individual immunoglobulin classes or isotypes purified as described above are not suitable for use as immunogens to generate isotype specific antibodies. The immunoglobulins are composed of both heavy chains (which determine the immunoglobulin isotypes, and are isotype specific) and kappa or lambda light chains (which may be associated with immunolobulins regardless of class). Therefore antisera raised against whole immunoglobulin of any isotype will contain antibodies against both the H-chain of that isotype and against both kappa and lambda light chains and can be expected to react with all immunoglobulins of that species. We have in fact observed this expected phenomenon in antisera we have raised against cetacean IgG purified using Protein-G affinity chromatography. In order to produce truly isotype specific antisera, it is necessary to separate the heavy chains from the light chains of each purified immunoglobulin preparation, and to use these purified heavy chains as the immunogen. The purified light chains obtained during this procedure can also be used to raise light chain specific antisera.

Prior to producing antisera, analysis of each of the the purified isotype preparations will be made to confirm that the proteins present have properties consistent with the respective isotypes expected to be in those preparations. Non-reducing polyacrylamide gel electrophoresis will be conducted on each sample to permit comparison of molecular weight standards with the expected molecular weights of each whole immunoglobulin isotype, each isotype's heavy chain, and light chain.

In order to obtain immunogens suitable for production of heavy chain specific antisera for immunoglobulins of the Harbor seal, purified immunoglobulins will first be enzymatically partially digested with papain to obtain the equivalent of Fab and Fc fragments for each isotype. Use of

whole heavy chains as immunogen produces antisera which include antibodies against the variable region of the heavy chain, which may cross-react with immunoglobulins of various isotypes. The Fc fragment contains only heavy chain constant regions and is more likely to induce isotype specific antisera if used as the immunogen. Purified "Fc" fragments of each isotype will be reduced with 2-mercaptoethanol and alkylated with iodoacetamide to break the disulfide bonds between the linked heavy chains. Chromatography using a Sephacryl S-400HR column will then be used to separate the heavy chain fragments from the other peptides which may be present (e.g. the J-chain of IgA or IgM). Once the purity of heavy chain preparations has been determined, they will be used to produce isotype-specific antisera that can be used to determine specific IgG, IgM, and IgA levels within a sample. Rabbits will be used to produce these antisera. The animals will be immunized by standard approved protocols. The titer and specificity of the antisera will be determined by (1) standard indirect ELISA (wells coated with purified Harbor seal immunoglobulin heavy chain), followed by the rabbit anti-heavy chain antibody being tested, followed by enzyme-labeled anti-rabbit immunoglobulin, and finally by the indicator substrate) and (2) immunoelectrophoresis (IEP) methods including Grabar-Williams, Rocket IEP, Crossed IEP , and Tandem Crossed IEP. The antisera will be partially purified by use of theMillipore UltraFree®-15 centrifugal filter device as described previously followed by purification by Protein G Sepharose® affinity chromatography to obtain the IgG fraction of this rabbit antisera. The purified antisera will be labeled with biotin or an enzyme (e.g. alkaline phosphatase or horseradish peroxidase) using standard labeling linkers (Pierce). The resulting antisera will be analyzed for specificity by several methods, including application of the antisera to Western blots of whole heavy chain preparations obtained by reduction/alkylation of the respective whole immunoglobulin isotype preparations.

Once the antisera for each immunoglobulin's heavy chain isotype has been made, it will be possible to regularly monitor immunoglobulin levels as an indicator of general health (immune status) of a population of Harbor seals in conjunction with other such measures and observations. It will also be possible to determine the level of each isotype present in, for example, samples obtained during a vaccination trial, at particular points in time of interest to a veterinarian or researcher (e.g. during pregnancy, drug therapy, maturation stage, etc.).

(2) The antisera against IgG, IgM, and IgA will be used to establish baseline data concerning levels of all of these immunoglobulin classes in serum and of IgA in saliva samples over the course of the project in captive population and wild populations of Harbor seals.

An ELISA protocol similar to that described by Suer et al. (1988) has been used in this laboratory to evaluate serum antibody levels in several species of marine mammals against several antigens (e.g. Patterson et al., 1994). A "sandwich" ELISA protocol will be employed in an effort to determine general immunoglobulin levels in these samples. In the sandwich ELISA, a plastic solid phase matrix (polystyrene microwells) is coated with unlabeled antibodies against the antigen in question, i.e. in this case against on of the heavy chain isotypes (gamma, alpha, or mu for IgG, IgA, and IgM respectively) of immunoglobulins from the Harbor seal (prepared via completion of objective 1 above). The sandwich ELISA conducted in this manner will allow quantitation of general immunoglobulin levels in samples by comparison with a standard curve generated using preparations made with known concentrations of immunoglobulins purified from the Harbor seal.

Details of the sandwich ELISA protocol to be used: In the assay, a plastic solid phase matrix (polystyrene microwells) is coated with a preparation of unlabeled antiserum specific for the

Harbor seal immunoglobulin isotype to be quantitated. Checkerboard (block) titrations are used with a preparation of known concentration of purified Harbor seal immunoglobulin of homologous isotype to determine optimal amounts of the unlabeled antiserum with which to coat wells. To perform an assay to determine levels of the immunoglobulin isotype in a sample of Harbor seal serum (or other sample, including, for example,saliva or milk), wells coated with the predetermined amount of anti-isotype antiserum are filled with test sea lion sera (or alternate samples) and any immunoglobulins of that isotype present are allowed to bind during an incubation period. To another set of wells is added a series of preparations having known concentrations of purified seal immunoglobulin of the relevant isotype. The results of these wells are used to construct a standard curve to permit quantitation of levels of the isotype in question in the "unknown" samples. After washing to remove non-bound substances, biotin-labeled rabbit antibodies (prepared in this laboratory) specific for the relevant sea lion isotype immunoglobulin antibodies, diluted to appropriate strength, are added and allowed to bind to any sea lion immunoglobulins captured by the plate-bound anti-isotype antiserum.. Biotin labeling of indicator antibody is easily accomplished using "kits" specifically designed for that purpose. After washing, alkaline-phosphatase-labeled avidin (available from a number of suppliers) is added and allowed to bind to any biotin label bound to the plate. After a final wash, a chromogenic substrate for the alkaline phosphatase (typically p-nitrophenyl phosphate) is added, and color development is measured by spectrophotometer. The absorbance readings so obtained are used to construct a standard concentration curve (based on the set of standards for the isotype used in the assay). The absorbances obtained for each unknown sample can then be applied to the standard curve to determine the concentration of the isotype in question in the unknown sample. As an alternate to biotin labeling of the anti-isotype antisera, direct labeling with alkaline phosphatase (the indicator enzyme) will also be evaluated. Both biotin labeling and direct enzyme labeling have potential advantages and disadvantages, and it is often necessary to evaluate both to determine the optimum strategy.

Blood samples will be collected on at least a monthly basis by project personnel based at the Alaska SeaLife Center. Aliquots of each sample (and aliquots of other samples of Harbor seal sera which become available) will be provided to this laboratory where they will be frozen and set aside for quantitation of isotype levels using the ELISA described above in completion of objective 2.

Time line

Overall time line is not critical. Since methodologies are already available in this laboratory, purification of immunoglobulins isotypes for use as immunogens and development of antisera are relatively routine procedures, and it is estimated that they can produced in 3-6 months. Should longer time be required it is not a critical matter, since aliquots of monthly samples to be assayed can be stored at -70C or in liquid nitrogen indefinitely before being assayed. Protocols for ELISA assays to be used to measure individual isotype levels in samples have already been developed in this laboratory for other species, and should be readily adaptable to samples from the Harbor seal.

Expected results

1. Development of species-specific antisera against immunoglobulins of the Harbor seal: An important outcome of the proposed project will be the production of such antisera against

immunoglobulin isotypes of the target pinniped species, the Harbor seal (*Phoca vitulina*). These antisera will be available for and of use in future studies involving immunoglobulins of this species. The antisera will also be available for use in ELISA's to measure immune response and immune levels against specific antigens of interest in the Harbor seal population. For example, the antisera can be used in future studies involving use of ELISA's to measure antibody levels against selected viruses, toxins, or bacterial antigens of interest and importance in wild populations of the Harbor seal.

2. Establishment of baseline levels of immunoglobulin isotypes in serum and saliva from Harbor seal: The sandwich ELISA (using the respective anti-isotype antisera as capture antibody) will provide data on general immunoglobulin levels in the species target pinniped species, the Harbor seal (*Phoca vitulina*).

3. Anticipated dissemination of data: Results of the proposed project will be disseminated to the funding agencies and participating facilities via a final report to be prepared at the conclusion of the project. In addition, the results will be presented at one or more professional scientific meetings (e.g. International Association of Aquatic Animal Medicine, Society for Marine Mammalogy). Finally, the results will be presented in one or more papers to be published in appropriate scientific journals (e.g. Marine Mammal Science, Journal of American Veterinary Medical Association, Journal of Developmental and Comparative Immunology).

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EVALUATING THE FEASIBLITY OF DEVELOPING A COMMUNITY-BASED FORAGE FISH SAMPLING PROJECT FOR THE EVOS GEM PROGRAM

Project Number:	02561
Restoration Category:	Monitoring
Proposer:	DOI-FWS
Lead Trustee Agency:	USFWS
Cooperating Agencies:	ADF&G
Duration:	1.5 years (FY 02 - FY 03)
Cost FY 01:	$54.3K
Cost FY 02:	$11.6K
Cost FY 03:	$0.0K
Geographic Area:	Kachemak Bay – lower Cook Inlet, Resurrection Bay, Kodiak Island, and Prince William Sound regions
Injured Resource/Service:	Common murres and other seabirds, and marine mammals injured by the T/V *Exxon Valdez* oil spill

ABSTRACT

This proposed transition project is based on recently completed APEX Projects 95163K, 97163K, 98163K, and 99163K, a successful 5-year pilot study that used stomach contents from sport-caught halibut to sample forage fish populations in Kachemak Bay – lower Cook Inlet. The project is designed to evaluate the feasibility of developing similar community-based studies to help monitor long-term trends in forage fish populations in several regions of the spill area during the upcoming EVOS-sponsored Gulf Ecosystem Monitoring (GEM) program. The project will provide information needed by Trustee Council scientists to help assess and understand the types and levels of community participation that may be available for long-term GEM forage fish monitoring studies. Also, if project results are favorable, the information can be used to begin designing cost-effective, community-based forage fish monitoring studies to track long-term trends in capelin and sand lance stocks in the Kachemak Bay – lower Cook Inlet, Resurrection Bay, Kodiak Island, and Prince William Sound regions for GEM. The project addresses the need to increase public interest and participation in EVOS-sponsored research and monitoring work.

INTRODUCTION

Evaluating the influence of fluctuating prey populations (e.g., forage fish) is critical to understanding the recovery of many species injured by the T/V *Exxon Valdez* oil spill. It is also important to understanding changes in marine bird and mammal populations that may be caused by other phenomena (e.g., changing environmental conditions). However, it is expensive to conduct annual hydroacoustic and trawl surveys to assess forage fish stocks over large regions for long periods of time.

As part of the 1995-1999 Alaska Predator Experiment (APEX), we tested the feasibility and effectiveness of using stomach contents from sport-caught Pacific halibut *(Hippoglossus stenolepis)* to obtain information on capelin *(Mallotus villosus)* and Pacific sand lance *(Ammodytes hexapterus)*, two forage fish important to piscivorous seabirds (Projects 95163K, 97163K, 98163K, and 99163K; see Roseneau and Byrd 1996, 1997, 1998, 1999, 2000). Results from the 5-year study in Kachemak Bay – lower Cook Inlet demonstrated that using these opportunistic predatory fish as sampling tools could supply valuable low-cost information on the relative abundance and spatial and temporal distribution of capelin and sand lance stocks that could be used to monitor long-term changes in prey bases important to seabird and marine mammal populations (see Roseneau and Byrd 2000). The multiyear data showed that capelin and sand lance dominated the fish component of the halibut stomachs every year (82%, 53%, 68%, 87%, and 93% in 1995-1999, respectively), and they also showed that the combined percentages of these two species were lowest in 1996 and 1997, when non-forage fish numbers were highest (22% and 25% in 1996-1997, compared to 6%, 11%, and 5% in 1995 and 1998-1999, respectively). The data also showed that capelin numbers declined throughout the study area from 59% in 1995 to 45% in 1996 and 18% in 1997, and then increased to 43% in 1998 and 54% in 1999, while concurrent changes in sand lance numbers were almost the reverse, increasing from 23% in 1995 to 50% in 1997, and then declining to 44% in 1998 and 39% in 1999.

Also, when the Kachemak Bay – lower Cook halibut stomach data were analyzed in conjunction with 1995-1999 black-legged kittiwake *(Rissa tridactyla)* chick diet data from the Barren Islands (see Project 99163J; Roseneau *et al.* 2000), a significant relationship was found between the numbers of capelin in the halibut stomachs and the weights of these forage fish as percentages of total fish in the chick diets (see Fig. 7 in Roseneau and Byrd 2000; Spearman Rank Correlation, $r = 0.98$, $P < 0.01$). An almost significant relationship was also found between the chick diets and capelin numbers in the smaller Barren Islands subunit of the study area (see Fig. 7 in Roseneau and Byrd 2000; Spearman Rank Correlation, $r = 0.87$, $P = 0.11$). A relationship was also probably present between the numbers of sand lance in the halibut stomachs and the weights of this species as percentages of total fish in the kittiwake chick diets (see Fig. 7 in Roseneau and Byrd 2000 and p. 3 of the text).

The study also demonstrated that there was a significant relationship between the numbers of capelin found per halibut stomach and per mid-water trawl in the Barren Islands sector of the study area (see Fig. 9 in Roseneau and Byrd 2000; Pearson Correlation Coefficient, $r = 0.99$, $P < 0.02$). Although a similar relationship was not found between the numbers of sand lance per halibut stomach and per mid-water trawl, the data suggested that one might be present for these variables, if a longer time series of data were available.

In summary, results from the 1995-1999 APEX large fish as samplers project confirmed that analyzing the stomach contents from sport- and subsistence-caught predatory fish, such as halibut, can supply low-cost relative abundance data on forage fish that can be used to monitor long-term changes in prey bases important to seabird and marine mammal populations. Furthermore, if sufficient data can be collected at regular intervals, within-season variation can also be detected by this relatively simple technique (see Fig. 6 in Roseneau and Byrd 2000). The strong relationships between the halibut stomach data and the kittiwake chick diet and mid-water trawl data sets also

indicated that changes observed in halibut stomach contents can provide a variety of valuable information on capelin and other forage fish stocks that will be useful to long-term monitoring studies of seabirds in areas where seabird foraging areas and sport and subsistence fishing activities regularly overlap.

Given these results, we believe that if similar work was conducted during the EVOS-sponsored Gulf Ecosystem Monitoring (GEM) program, it would provide valuable long-term information on capelin and sand lance populations and other forage fish stocks in the spill area. We also believe that these types of long-term monitoring projects could benefit from increased public participation in them. As a result, we designed a transition study to explore and evaluate the feasibility of developing similar forage fish monitoring studies for GEM that would not only directly involve charter boat operators, but also local subsistence and personal use fishermen, students, teachers, village and IRA council natural resource specialists, and other citizens from oil spill communities in the Kachemak Bay – lower Cook Inlet, Resurrection Bay, Kodiak Island, and Prince William Sound regions in the sampling efforts. The proposed project addresses the ongoing need to develop strong public interest and participation in EVOS-sponsored research and the upcoming GEM program.

NEED FOR THE PROJECT

A. Statement of Problem

Monitoring forage fish stocks during the EVOS-sponsored GEM program would provide valuable information on the long-term status of species important to a variety of northern Gulf of Alaska seabird, marine mammal, and fish populations (e.g., common murres, *Uria aalge*; black-legged kittiwakes, *Rissa tridactyla*; harbor seals, *Phoca vitulina*; northern sea lions, *Eumetopias jubatus*; salmon, *Oncorhynchus* spp.; Pacific cod, *Gadus macrocephalus*; halibut). It would also provide important information on the spatial and temporal fluctuations in populations of two key forage fish species (e.g., capelin, sand lance) that might help explain changes that might occur in northern Gulf of Alaska and Prince William Sound seabird, marine mammal, and fish populations important to subsistence-dependent communities; commercial, sport, and subsistence fishermen; charter boat operators and ecotourism businesses; and other resource users in these regions. However, it can be prohibitorily expensive to monitor forage fish over large regions for long periods of time using standard fisheries techniques, including hydroacoustic, trawl, and beach seine surveys. Furthermore, even if it was feasible to use some combination of these methods to track changes in forage fish populations, past experience strongly suggests that direct involvement of local resource users and other members of the public would be unlikely. The proposed study addresses the ongoing need to develop strong public interest and participation in EVOS-sponsored research and the upcoming GEM program.

B. Rationale/Link to Restoration

The proposed project is based on recently completed APEX Projects 95163K, 97163K, 98163K, and 99163K, a successful 5-year pilot study that used stomach contents from sport-caught halibut to sample forage fish populations in Kachemak Bay – lower Cook Inlet (see Roseneau and Byrd 1996, 1997, 1998, 1999, 2000). The project is designed to explore and evaluate the feasibility of developing similar community-based studies to help monitor long-term trends on forage fish populations in several regions of the spill area during the upcoming EVOS-sponsored Gulf Ecosystem Monitoring (GEM) program. The project will provide information needed by Trustee Council scientists to help assess and understand the types and levels of community participation that may be available for long-term GEM forage fish monitoring studies. Also, if project results are favorable, the information can be used to begin designing cost-effective, community-based forage fish monitoring studies to track long-term trends in capelin and sand lance stocks in the

Kachemak Bay – lower Cook Inlet, Resurrection Bay, Kodiak Island, and Prince William Sound regions for GEM. The project addresses the need to increase public interest and participation in EVOS-sponsored research and monitoring work.

C. Location

The project will be directed from the Alaska Maritime National Wildlife Refuge (AMNWR) headquarters in Homer, Alaska, and information will be collected from up to 11 oil spill communities in four separate study areas: Kachemak Bay - Cook Inlet, Resurrection Bay, Kodiak Island, and Prince William Sound. The communities include Homer, Seldovia, Port Graham, Nanwalek, Seward, Valdez, Cordova, Chenega Bay, Tatitlek, Kodiak, Ouzinkie, and possibly other villages in the Kodiak archipelago (e.g., Port Lions). All communities involved in the proposed project will benefit from the study.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Community involvement is the central theme of the proposed project. The study is specifically designed to explore and evaluate the feasibility of directly involving residents (e.g., subsistence and personal use fishermen, charter boat operators, students, teachers, village and IRA council natural resource specialists, and other residents) from a number of oil spill communities in long-term forage fish monitoring studies that could become valuable components of the soon-to-be implemented GEM program.

PROJECT DESIGN

A. Objectives

The project objective is to explore and evaluate the feasibility of involving residents of oil spill communities (e.g., subsistence and personal use fishermen, students, teachers, village and IRA council natural resource specialists, other members of the public) directly in long-term forage fish monitoring studies that could become valuable components of the GEM program.

B. Methods

The project will be directed from AMNWR headquarters in Homer, Alaska, and information will be collected from 11 oil spill communities in four separate study areas: Kachemak Bay - Cook Inlet, Resurrection Bay, Kodiak Island, and Prince William Sound. The communities will include Homer, Seldovia, Port Graham, Nanwalek, Seward, Valdez, Cordova, Chenega Bay, Tatitlek, Kodiak, Ouzinkie, and possibly other villages in the Kodiak archipelago (e.g., Port Lions). A color poster summarizing the 1995-1999 APEX Project 99163K results will be prepared before data collection begins (see Roseneau and Byrd 2000). Fourteen large copies (one per community and three backups) and 600 smaller versions (50 per community) will be printed for use during community meetings and public presentations. Also, 110 copies of the 1995-1999 APEX Project 99163K final report and 110 copies of scanned color photos showing sand lance and capelin will be printed to hand out during meetings (10 of each per community). *Note: Electronic copies of the forage fish photos and report will also be made available to the communities for residents with computers capable of handling these files.*

Data Collection

During the data collection phase of the project, the principal investigator will visit each community on two separate occasions for three days at a time to give public presentations and meet directly with a variety of residents, including subsistence and personal use fishermen, students, teachers, city and village council members, community facilitators and natural resource specialists, and other members of the public. Presentations and meetings will be set up ahead of time by contacting various key members of the communities (e.g., community facilitators; natural resource specialists and managers; school teachers and principals; city and tribal council members; fisheries biologists, if present) and other entities (e.g., Youth Area Watch program managers and coordinators). During the presentations and meetings, including those held at local schools, information will be provided on the upcoming EVOS-sponsored GEM program and the forage fish sampling method developed by APEX Projects 95163K, 97163K, 98163K, and 99163K; see Roseneau and Byrd 1996, 1997, 1998, 1999, 2000). Community members attending the presentations and meetings will be asked to comment on their interest in participating in similar studies during the GEM program. They will also be asked for information on the species and general time-frames, locations, and quantities of predatory fish typically caught during local subsistence and other types fisheries. In addition, attendees will be asked for their opinions on how meaningful participation in long-term forage fish sampling efforts based on the large fish as samplers projects could best be achieved in their communities. They will also be asked to comment on the types and levels of support that might be needed to encourage and maintain participation in community-based long-term forage fish studies (e.g., stipends for local project coordinators and students collecting predatory fish stomachs from fishermen; other potential needs, such as supplying small freezers to store samples before shipping them to research facilities and covering costs of shipping samples to researchers). *Note: The oil spill communities are fishing communities and many of the residents also live subsistence lifestyles. Making two separate trips to them will markedly increase the number of people that can be interviewed.*

Data Analysis

Information gathered during the community visits will be organized into a variety of topics and summarized in a final report. Topics will include, but will not be limited to (1) the general types and levels of local interest expressed by residents in participating in community-based GEM forage fish studies; (2) the number of potential initial participants; (3) the species and general time-frames, locations, and quantities of predatory fish [e.g., halibut and other right-eye flounders (Pleuronectidae), Pacific cod *(Gadus macrocephalus)*, lingcod *(Ophiodon elongatus)*, rockfish *(Sebastes* spp.] typically taken by potential participants (e.g., subsistence and personal use fishermen; charter boat operators, if present; other interested residents); and (4) the general levels and kinds of support that would be required to encourage and maintain participation in community-based long-term forage fish studies (e.g., stipends for local project coordinators and students collecting predatory fish stomachs from fishermen; other potential needs, such as supplying small freezers to store samples before shipping them to research facilities, and covering costs of shipping samples to researchers). The report will provide the kinds of information needed by Trustee Council scientists to help assess and understand the levels and types of community participation that may be available for incorporation in long-term GEM forage fish monitoring studies.

Draft data collection and analysis protocols will also be developed for use during potential community-based GEM forage fish monitoring studies and appended to the final report. These protocols will based on information obtained during the1995-1999 APEX large fish as samplers studies and the community visits.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Alaska Department of Fish and Game (ADF&G) fisheries biologists will be interviewed as a potential source of contacts in some communities. No contracts are needed for the study. The Alaska Maritime National Wildlife Refuge will donate one month of the project manager's time (G.V. Byrd) to the project. The refuge will also provide computers and office space for the study.

SCHEDULE

A. Measurable Project Tasks for FY 02 (1 October 2001 – 30 September 2002), and FY 03 (1 October 2002 – 15 April 2003)

FY 02

1 Oct – 15 Nov 2001:	Prepare color poster of 1995-1999 APEX Project 99163K results, and have copies of it and the Project 99163K final report and forage fish photos printed for meetings; prepare draft meeting agendas; begin contacting key individuals in study communities (e.g., natural resource specialists and managers; community facilitators; school teachers and principals; village, tribal, and IRA council members, subsistence fishermen, charter boat operators) and personnel in charge of the Youth Area Watch Programs (Projects 02210 and 02610) to explain the purpose of the study and set up meetings.
16 Nov – 31 Dec 2001:	Continue contacting key individuals to set up community meetings and schedule public presentations; continue supplying information on the study to key individuals and Youth Area Watch program managers and coordinators.
1 Jan – 31 Mar 2002:	Begin visiting communities to give presentations and hold meetings with key individuals and other interested residents to collect information for the study.
1 Apr – 30 June 2002:	Continue visiting communities to give presentations and hold meetings with key individuals and other interested residents to collect information (see January-March above).
1 July – 31 August 2002:	Complete visiting communities and collecting information.
1-30 Sep 2002:	Begin compiling and organizing information collected during the January-August visits to the communities and meetings with Youth Area Watch personnel.

FY 03

1 Oct - 31 Dec 2002:	Finish compiling and organizing he FY 02 information; analyze information and organize results.
1 Jan – 15 Mar 2003:	Begin preparing draft final report of FY 02 activities.
16 March -15 Apr 2003:	Finalize and submit final report of FY 02 activities to Chief Scientist for peer-review on or before 15 April.

B. Project Milestones and Endpoints

November 2001	Complete preparing materials needed for community visits and public presentations.
December 2001	Complete setting up the first round of community visits to collect data.
March 2002	Complete the first round of community visits to collect data.
August 2002	Complete the second round of community visits to collect data.
September 2002	Begin compiling and organizing information collected during January-August.
December 2002	Finish compiling, and analyzing FY 02 data and organizing results.
April 2002	Submit final report of FY 02 activities to Chief Scientist.

C. Completion Date

A final report of FY 02 activities will submitted to the Chief Scientist on or before 15 April 2003.

PUBLICATIONS AND REPORTS

The proposed project is a transition study designed to evaluate the feasibility of directly involving fishermen, natural resource specialists, students, and other residents of communities in Kachemak Bay – lower Cook Inlet, Resurrection Bay, Kodiak Island, and Prince William Sound in community-based GEM forage fish monitoring projects to track long-term trends in capelin and sand lance stocks in large sections of the spill zone during the GEM program. The types of information collected by the study will not be particularly appropriate for standard scientific publications. However, if the study is funded, a comprehensive final report will be prepared and submitted to the Chief Scientist by 15 April 2003. The report will provide the kinds of information needed by Trustee Council scientists to help assess and understand the levels and types of community participation that may be available for incorporation in long-term GEM forage fish monitoring studies. It will also provide a sound basis for designing community-based forage fish monitoring projects.

PROFESSIONAL CONFERENCES

Study results will be presented at the annual Trustee Council-sponsored workshop in January 2003.

NORMAL AGENCY MANAGEMENT

The proposed project is not something that AMNWR or the FWS are required to do by statute or regulation. Furthermore, the types of information collected by the proposed study are not part of the normal AMNWR resource monitoring plan. The project could not be conducted without support from the EVOS Trustee Council.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Possible community involvement in forage fish monitoring studies has already been discussed with Nancy Yeaton (Natural Resources Specialist and Community Facilitator, Nanwalek IRA Council), Edgar Otis (Natural Resources Specialist, Port Graham Village Council), Lillian Elvsaas (Community Facilitator, Seldovia Village Tribe), and a representative of the Youth Area Watch Program (Joshua Hall, Anchorage School District). Similar discussions will be held with representatives and facilitators from other oil spill communities and the Youth Area Watch programs (Projects /210 and /610) before implementing the study. During the study, visits to communities will be closely coordinated with community representatives and facilitators, natural resource specialists, Youth Area Watch personnel, and other appropriate members of the public. *Note: All discussions held to date with community representatives, natural resource specialists, and Youth Area Watch personnel about developing community participation in forage fish monitoring studies have been positive.*

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This is a new study, not a continuing project.

PROPOSED PRINCIPAL INVESTIGATOR

Name: David G. Roseneau
Affiliation: Alaska Maritime National Wildlife Refuge
Mailing address: 2355 Kachemak Bay Drive (Suite 101), Homer, Alaska 99603-8021
Phone number: (907) 235-6546
Fax number: (907) 235-7783
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PRINCIPAL INVESTIGATOR

1. David G. Roseneau (Co-Principal Investigator)

Mr. Roseneau will be responsible for the project in the field and the office. He will travel to the communities in the four study areas to give public presentations on the previously successful APEX large predatory fish as samplers studies (Projects 95163K, 97163K, 98163K, and 99163K), and talk to and interview students, teachers, natural resource specialists, facilitators, subsistence fishermen, and other members of the public about possible participation in similar projects during the upcoming GEM program. He will make certain that the work stays on schedule and is coordinated with all participants, and he will analyze the data and write the final close-out report. Mr. Roseneau received his B.S. degree in wildlife management and M.S. degree in biology from the University of Alaska - Fairbanks in 1967 and 1972, respectively. His thesis research was on the numbers and distribution of gyrfalcons, *Falco rusticolus* on the Seward Peninsula, Alaska. He joined the U.S. Fish and Wildlife Service in January 1993, and was project leader for EVOS-sponsored common murre restoration studies at the Barren Islands during 1993-1994 (Projects 93049 and 94039). Mr. Roseneau was also principal investigator of the 1995-1999 APEX Barren Islands seabird and large fish as samplers studies (Projects 95163J, 95163K, 96163J, 97163J, 97163K, 98163J, 98163K, 99163J, and 99163K), and the 1996-1997 and 1999 Barren Islands and 1998 Chiswell Islands common murre population monitoring projects (Projects 96144, 97144, 98144, and 99144). Currently, he is principal investigator for the 2001 Chiswell Islands common murre population monitoring project (Project 01144). Prior to 1993, Mr. Roseneau worked as a consulting biologist for over 20 years. During that time, he conducted and

managed marine bird, raptor, and large mammal projects in Alaska and Canada for government agencies and private-sector clients, and he also participated in several large-scale murre (*Uria* spp.) monitoring projects. In 1976-1983, as co-principal investigator of NOAA/OCSEAP Research Unit 460, he conducted monitoring studies of murres and black-legged kittiwakes *(Rissa tridactyla)* at capes Lisburne, Lewis, and Thompson in the Chukchi Sea, and St. Lawrence, St. Matthew, and Hall islands in the Bering Sea. He also studied auklets (*Aethia* spp.) at St. Lawrence and St. Matthew islands, and participated in murre and kittiwake projects at Bluff in Norton Sound. During 1984-1986, he also participated in monitoring studies of murres and kittiwakes in the northeastern Chukchi Sea, and in 1987-1988, 1991-1992, and 1995-2000, he conducted additional murre and kittiwake monitoring work at capes Lisburne and Thompson, and Chamisso and Puffin islands. Mr. Roseneau is experienced in collecting and analyzing data on numbers, productivity, and food habits of seabirds; relating trends in numbers and productivity to changes in food webs and environmental parameters (e.g., air and sea temperatures, current patterns); and assessing potential impacts of petroleum exploration and development on nesting and foraging marine birds. He also has experience collecting and analyzing certain types of data on forage fish, and he has designed and successfully tested a new technique for sampling capelin *(Mallotus villosus)* and Pacific sand lance *(Ammodytes hexapterus)* by using stomach contents from sport-caught Pacific halibut *(Hippoglossus stenolepis)*. He has broad knowledge of rock climbing techniques and has operated inflatable rafts and other outboard-powered boats in the Bering, Chukchi, and Beaufort seas and on various Alaskan rivers in excess of 3,000 hrs. He has also accrued several hundred additional hours operating time in small boats and larger, more powerful vessels (e.g. 25 ft, 300-400 hp HydroSports and Boston Whalers) in Kachemak Bay, Prince William Sound, and Kenai Peninsula and Barren Island waters. During his career, Mr. Roseneau has authored and co-authored 100 reports and publications, including 33 on Alaskan seabirds and 5 on a new sampling technique for capelin and sand lance. He has also made over 30 public presentations on seabirds, raptors, and caribou at scientific and wildlife law enforcement conferences and meetings.

Selected Publications

Roseneau, D.G. and G.V. Byrd. 1997. Using Pacific halibut to sample the availability of forage fishes to seabirds. Pp. 231-241 *in* Forage Fishes in Marine Ecosystems, Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems, University of Alaska Sea Grant College Program Report No. 97-01, University of Alaska-Fairbanks, Fairbanks, Alaska.

Murphy, E.C., A.M. Springer, and D.G. Roseneau. 1991. High annual variability in reproductive success of kittiwakes (Rissa tridactyla L.) at a colony in western Alaska. J. Anim. Ecol. 60: 515-534.

Springer, A.M., E.C. Murphy, D.G. Roseneau, C.P. McRoy, and B.A. Cooper. 1987. Paradox of pelagic food webs in the northern Bering Sea - I. Seabird food habits. Cont. Shelf Res. 7: 895-911.

Murphy, E.C., A.M. Springer, and D.G. Roseneau. 1986. Population status of *Uria aalge* at a colony in western Alaska: results and simulations. Ibis 128: 348-363.

Springer, A.M., D.G. Roseneau, D.S. Lloyd, C.P. McRoy, and E.C. Murphy. 1986. Seabird responses to fluctuating prey availability in the eastern Bering Sea. Marine Ecol. Prog. Ser. 32: 1-12.

Springer, A.M. and D.G. Roseneau. 1985. Copepod-based food webs: auklets and oceanography in the Bering Sea. Marine Ecol. Prog. Ser. 21: 229-237.

Murphy, E.C., D.G. Roseneau, and P.J. Bente. 1984. An inland nest record for the Kittlitz's murrelet. Condor 86: 218.

Springer, A.M., D.G. Roseneau, E.C. Murphy, and M.I. Springer. 1984. Environmental controls of marine food webs: food habits of seabirds in the eastern Chukchi Sea. Can. J. Fish Aquat. Sci. 41: 1202-1215.

OTHER KEY PERSONNEL

1. G. Vernon Byrd (Project Manager)

Mr. Byrd will supply overall guidance to the project, including providing advice during data collection and analysis and report writing, and he will also review presentations and reports as needed. Mr. Byrd received a B.S. degree in wildlife management from the University of Georgia in 1968, did post-graduate studies in wildlife biology at the University of Alaska-Fairbanks in 1975, and completed his M.S. degree in wildlife resources management at the University of Idaho in 1989. His thesis, entitled "Seabirds in the Pribilof Islands, Alaska: Trends and monitoring methods", explored statistical procedures for analyzing kittiwake (*Rissa* spp.) and murre (*Uria* spp.) population data. Mr. Byrd has worked for the U.S. Fish and Wildlife Service for over 20 years, focusing on studies of marine birds in Alaska and Hawaii. His major interests center around monitoring long-term trends in seabird populations, including numbers of birds and reproductive performance, and he has worked at murre colonies in the Aleutian Islands, the Bering and Chukchi seas, and western Gulf of Alaska. Mr. Byrd was a co-author of the final T/V *Exxon Valdez* oil spill damage assessment report for murres. Also, he was project manager of the 1993-1994 Barren Islands common murre restoration monitoring projects (Projects 93049 and 94039), the 1995-1999 APEX Barren Islands seabird and large fish as samplers studies (Projects 95163J, 95163K, 96163J, 97163J, 97163K, 98163J, 98163K, 99163J, and 99163K), the 1996-1997 and 1999 Barren Islands and 1998 Chiswell Islands common murre population monitoring projects (Project 96144, 97144, 99144, and 98144), and EVOS-sponsored work designed to remove predators from seabird nesting habitats (Projects 94041 and 95041). Currently, Mr. Byrd is project manager for the 2001 Chiswell Islands common murre population monitoring project (Project 01144). He has authored and co-authored over 50 scientific papers and 75 U.S. Fish and Wildlife Service reports on field studies, and has made over 35 presentations on seabirds at scientific conferences and meetings. Mr. Byrd is the supervisory wildlife biologist at the Alaska Maritime National Wildlife Refuge, the premier seabird nesting area in the national public land system.

Selected Publications

Roseneau, D.G. and G.V. Byrd. 1997. Using Pacific halibut to sample the availability of forage fishes to seabirds. Pp. 231-241 *in* Forage Fishes in Marine Ecosystems, Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems, University of Alaska Sea Grant College Program Report No. 97-01, University of Alaska-Fairbanks, Fairbanks, Alaska.

Byrd, G.V., E.C. Murphy, G.W. Kaiser, A.J. Kondratyev, and Y.V. Shibaev. 1993. Status and ecology of offshore fish-feeding alcids (murres and puffins) in the North Pacific Ocean. Proceedings of "Symposium on the Status , Ecology, and Conservation of Marine Birds of the Temperate North Pacific". Canadian Wildlife Service, Ottawa.

Byrd, G.V., and J.C. Williams. Whiskered Auklet. 1993. A chapter describing the biology of the species in The birds of North America, No. 76 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia PA, and the American Ornithologists' Union, Washington, D.C. 12 pp.

Byrd, G.V., and J.C. Williams. Red-legged Kittiwake. 1993. A chapter describing the biology of the species in The birds of North America No. 60 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia PA, and the American Ornithologists' Union, Washington, D.C. 12 pp.

Springer, A.M. and G.V. Byrd. 1989. Seabird dependence on walleye pollock in the southeastern Bering Sea. Pages 667-677 in Proceedings of the International Symposium on the Biology and Management of Walleye Pollock. Alaska Sea Grant Rep. No. 89-1, Univ. of Alaska-Fairbanks, Fairbanks, Alaska.

LITERATURE CITED

Roseneau, D.G, and G.V. Byrd. 1996. Using predatory fish to sample forage fishes, 1995. Appendix K (13 pp.) *in* APEX: Alaska Predator Ecosystem Experiment (D.C. Duffy, Compiler), *Exxon Valdez* Oil Spill Restoration Proj. Annual rept. (Restoration Proj. 95163), Alaska Natural Heritage Program, Univ. of Alaska - Anchorage, Anchorage, Alaska.

_____. 1997. Using Pacific halibut to sample the availability of forage fishes to seabirds. Pp. 231-241 *in* Forage Fishes in Marine Ecosystems, Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems, University of Alaska Sea Grant College Program Report No. 97-01, University of Alaska-Fairbanks, Fairbanks, Alaska.

_____. 1998. Using predatory fish to sample forage fishes, 1997. Appendix K *in* APEX: Alaska Predator Ecosystem Experiment (D.C. Duffy, Compiler), *Exxon Valdez* Oil Spill Restoration Proj. Annual rept. (Restoration Proj. 97163), Alaska Natural Heritage Program, Univ. of Alaska - Anchorage, Anchorage, Alaska.

_____. 1999. Using predatory fish to sample forage fishes, 1998. Appendix K *in* APEX: Alaska Predator Ecosystem Experiment (D.C. Duffy, Compiler), *Exxon Valdez* Oil Spill Restoration Proj. Annual rept. (Restoration Proj. 98163 A-T), Paumanok Solutions, 102 Aikahi Loop,Kailua, Hawaii 96734.

_____. 2000. Using predatory fish to sample forage fishes, 1995-1999. Appendix K *in* APEX: Alaska Predator Ecosystem Experiment (D.C. Duffy, Compiler), *Exxon Valdez* Oil Spill Restoration Proj. Annual rept. (Restoration Proj. 99163 A-T), Paumanok Solutions, 102 Aikahi Loop,Kailua, Hawaii 96734.

Roseneau, D.G., A. B. Kettle, and G. V. Byrd. 2000. Barren Islands seabird studies, 1999. Appendix J *in* Apex: Alaska Predator Ecosystem Experiment (D.C. Duffy, Compiler), *Exxon Valdez* Oil Spill Restoration Proj. Annual rept. (Restoration Proj. 99163 A-T), Paumanok Solutions, 102 Aikahi Loop,Kailua, Hawaii 96734.

2002 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FFY 2001	Proposed FFY 2002
Personnel	$0.0	$26.1
Travel	$0.0	$20.8
Contractual	$0.0	$0.0
Commodities	$0.0	$3.5
Equipment	$0.0	$0.0
Subtotal		$50.4
General Administration	$0.0	$3.9
Project Total	$0.0	$54.3
Full-time Equivalents (FTE)	0.0	0.4
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
Estimated FFY 2003	Estimated FFY 2004	Estimated FFY 2005	Estimated FFY 2006	Estimated FFY 2007	Estimated FFY 2008
$11.6	$0.0	$0.0	$0.0	$0.0	$0.0

Dollar amounts are shown in thousands of dollars.

Comments: This proposed transition project is based on recently completed APEX Projects 95163K, 97163K, 98163K, and 99163K, a successful 5-year pilot study that used stomach contents from sport-caught halibut to sample forage fish populations in Kachemak Bay – lower Cook Inlet. The project is designed to evaluate the feasibility of developing similar community-based studies to help monitor long-term trends in forage fish populations in several regions of the spill area during the upcoming EVOS-sponsored Gulf Ecosystem Monitoring (GEM) program. The project will provide information needed by Trustee Council scientists to help assess and understand the types and levels of community participation that may be available for long-term GEM forage fish monitoring studies. Also, if project results are favorable, the information can be used to begin designing cost-effective, community-based forage fish monitoring studies to track long-term trends in capelin and sand lance stocks in the Kachemak Bay – lower Cook Inlet, Resurrection Bay, Kodiak Island, and Prince William Sound regions for GEM. The project addresses the need to increase public interest and participation in EVOS-sponsored research and monitoring work. During the transition work, data collection and analysis protocols will also be developed for use during potential community-based GEM forage fish monitoring efforts. Funds listed for FFY 2003 are estimated project close-out costs.

The Alaska Maritime National Wildlife Refuge will donate 1 month of the project manager's time to the project. The refuge will also provide computers and office space for the study.

FY02

Project Number: 02561
Project Title: Evaluating the Feasibility of Developing a Community-based Forage Fish Sampling Project for the EVOS GEM Program
Agency: DOI-FWS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: 04/10/01

6/12/97

2002 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 200[illegible] - September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 2002
David G. Roseneau	Project Leader (Principal Investigator)	GS11/6	4.5	5.8	0.0	26.1
G. Vernon Byrd	Project Manager	GS13/1	1.0	0.0	0.0	0.0
C. Berg	Program Manager	GS12	0.5	0.0	0.0	0.0
	Subtotal		6.0	5.8	0.0	
					Personnel Total	$26.1

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 2002
Travel to Anchorage to meet with Youth Area Watch and EVOS staff	0.2	2	4	0.2	1.2
Travel to Seldovia to give presentations and interview potential participants	0.1	2	6	0.2	1.4
Travel to Nanwalek to give presentations & interview potential participants	0.1	2	6	0.2	1.4
Travel to Port Graham to give presentations & interview potential	0.1	2	6	0.2	1.4
Travel to Seward to give presentations & interview potential participants	0.1	2	6	0.2	1.4
Travel to Kodiak to give presentations & interview potential participants	0.4	2	6	0.2	2.0
Travel to Ouzinkie to give presentations & interview potential participants	0.1	2	6	0.2	1.4
Travel to Chenega Bay to give presentations & interview potential participants	0.4	2	6	0.2	2.0
Travel to Tatitlek to give presentations & interview potential participants	0.1	2	6	0.2	1.4
Travel to Valdez to give presentations & interview potential participants	0.4	2	6	0.2	2.0
Travel to Cordova to give presentations & interview potential participants	0.4	2	6	0.2	2.0
Estimated car rental & taxi costs (all communities)			64	0.05	3.2
				Travel Total	$20.8

FY02

Prepared: 04/10/01

Project Number:
Project Title: Evaluating the Feasibility of Developing a Community-based Forage Fish Sampling Project for the EVOS GEM Program
Agency: DOI-FWS

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 2002
No contracts are needed for the proposed project	0.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FFY 2002
Costs of printing 110 copies of the 99163K final report ($3.00 each)	0.3
Costs of printing 14 large laminated copies of a color poster summarizing the 99163K final report (1 per community + 2 @ $125.00 each)	1.8
Costs of printing 550 small copies of a color poster summarizing the 99163K final report (50 per community @ $1.00 each)	0.6
Costs of printing 110 copies of scanned photos of capelin and sand lance (10 per community @ $1.00 each)	0.1
Costs of printing 550 copies of questionnaires (50 per community @ $1.00 each)	0.6
Field notebooks, other meeting supplies	0.1
[Note: FWS will furnish additional office supplies; office, warehouse, lab, and freezer space; and telephone and postage costs]	
Commodities Total	$3.5

FY02

Project Number:
Project Title: Evaluating the Feasibility of Developing a Community-based Forage Fish Sampling Project for the EVOS GEM Program
Agency: DOI-FWS

FORM 3B
Contractual & Commodities DETAIL

Prepared: 04/10/01

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 2002
No equipment is needed for the project			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 and printers (non oil spill equipment)	2	FWS
[Note: The FWS will also supply office space and supplies for the project]		

FY02

Project Number:
Project Title: Evaluating the Feasibility of Developing a Community-based Forage Fish Sampling Project for the EVOS GEM Program
Agency: DOI-FWS

FORM 3B
Equipment
DETAIL

Prepared: 04/10/01

Project Title: Bottom-up vs. Top Down: What Forces Control the Variability of Subtidal and Intertidal Fishes, Invertebrates and Algal Communities in Kachemak Bay?

Project Number:	02565
Restoration Category:	Research and Monitoring
Proposer:	Kachemak Bay Research Reserve
Lead Trustee Agency:	ADFG
Duration:	1st year, 1 year project
Cost FY02:	$49,900
Geographic Area:	Kachemak Bay/Lower Cook Inlet
Injured Resource/Service:	Subtidal and intertidal communities, sediments, mussels, clams, archeological resources

ABSTRACT

We propose to establish intertidal and subtidal transects on rocky and sediment shores in Kachemak Bay and to study the relationship between bottom-up controls (current patterns, nutrient concentrations, phytoplankton distributions) and the spatial patterns of adult populations and their larvae over time. Our primary goal is to understand the interaction of the nearshore oceanographic environment with coastal marine communities in the Gulf of Alaska. We will accomplish this by partnering with existing research and monitoring programs funded by NOAA in Kachemak Bay and by adopting protocols developed by PISCO who are studying these interactions along the West Coast of North America.

INTRODUCTION

Benthic organisms within estuarine and marine nearshore ecosystems are sensitive to environmental gradients and may serve as indicators of changes occurring in the coastal ocean (Warwick and Clarke, 1993). These benthic communities often include organisms with life spans ranging from days to seasons or years, and they frequently occur in large numbers, thus providing an attractive baseline for statistical analyses. For these reasons, and logistical accessibility, detecting change in nearshore biological communities is a key component of experimental ecological research and applied monitoring programs.

The ecological linkages between the nearshore ocean and the benthos are poorly understood. For example, production in some intertidal communities may be regulated by the delivery of nutrients from the ocean or by drainage from nearby rivers and estuaries, larval recruitment may be regulated by coastal current patterns, and wave energy may structure communities by direct forces on organisms or through sediment transport processes. However, it is clear that there is strong physical and biological coupling between the nearshore and intertidal habitats. Such "edge" communities at the transition between one regime and another may provide a rare opportunity to study linkages and how changes in the environment can affect those linkages.

Menge et al. (1997) demonstrated a correlation between nearshore concentrations of chlorophyll-a and growth rates of rocky-shore organisms at 2 sites 10's of km apart within an upwelling region. They suggest that oceanic processes (e.g., local water-exchange rates alongshore or inshore-offshore) may be driving these site differences. Inshore nutrient levels can directly affect productivity of nearshore algae (Bustamente et al., 1985, Ormond and Banaimoon, 1994), and the feeding and growth rates of a variety of suspension-feeding organisms are generally enhanced in higher flow conditions (Sanford et al., 1994).

This project is linked to FY02 EVOS proposal #02556. While this project can be conducted independently, the cumulative value of these projects being undertaken simultaneously is great.

NEED FOR THE PROJECT

A Statement of Problem

The planet is experiencing an unprecedented loss and impoverishment of its biological wealth as measured by species extinctions and degradation of its ecological systems. Benthic organisms within the marine nearshore ecosystem are sensitive to environmental gradients and may serve as indicators of changes occurring in the coastal ocean. Benthic communities often include organisms with life spans ranging from days to seasons or years, and they frequently occur in large numbers, thus providing an attractive baseline for statistical analyses. For these reasons, and logistical accessibility, detecting change in nearshore biological communities is a key component of experimental ecological research and applied monitoring programs. But quantifying the distribution, abundance, and diversity of nearshore organisms over large spatial scales is problematic for scientists and resource managers. Monitoring biological communities for a

response to natural or anthropogenic perturbations encounters two fundamental problems. The first is the large temporal and spatial variability of organism abundances in natural ecosystems, which masks our ability to statistically separate an actual change caused by a perturbation from natural cycles. Second, extrapolating or generalizing the results of localized studies to broad areas is fraught with problems; yet biological sampling is too labor-intensive to attempt everywhere (Underwood & Petraitis 1993).

One of the greatest challenges for conservation biologists is to unravel the causes of variation in communities. All conservation efforts in the nearshore, including the design of marine reserves, are crucially dependent on knowing these dynamics. A comprehensive understanding of the dynamics of the nearshore eastern Pacific Ocean ecosystems requires *in situ* investigations along the relevant biogeographic and oceanographic scales. Our goals therefore include quantifying patterns of distribution, abundance and diversity of the biota in nearshore ecosystems and determining how ecological and oceanographic processes influence these patterns. Determining the causes of community variation is a particularly daunting task for nearshore marine communities because three prominent, interdependent sources of variation are poorly understood — coastal nutrients and productivity (so-called "bottom-up" effects), dispersal of organisms, and large-scale temporal oceanic climate changes.

B. Rationale/Link to Restoration

Evidence suggests that patterns of community structure in intertidal and subtidal communities are functionally linked to oceanic processes and physical characteristics of the shoreline (Schoch et al. 2000a,b). However, there is a lack of information on physical and biological patterns across large spatial scales (100's of km) that would allow rigorous assessments of the relationship between intertidal community patterns and the physical and biological interactions on rocky shorelines, and in the nearshore and offshore ocean. One solution in the marine realm involves using a highly stratified sampling design pioneered by the Partnership for Interdisciplinary Studies of the Coastal Ocean (PISCO: www.piscoweb.org) on the West Coast of North America. By using a high resolution shoreline classification system to quantify physical gradients and create partitions of relatively homogeneous benthic habitats based on physics and physical processes, the variability of the biological communities associated with those habitats is also minimized. This information is being used to guide process-oriented research on the roles of upwelling, productivity, larval transport, recruitment, and species interactions. This project is aimed at understanding the mechanisms underlying the observed patterns, thus providing a unique source of relevant information for managers and policy makers.

With respect to the link to restoration effort, this project is proposed under the strategy "Ecosystem Synthesis/GEM Transition." This project is best linked to "New Projects: Innovative Tools and Strategies for Improving Monitoring." ADFG encourages the Trustees to fund this project this year because it will answer key resource questions and lay the foundation for the development of an intertidal component of the GEM program. Moreover, the proposed research and monitoring effort will help leverage NOAA funds to establish and maintain a long-term oceanographic monitoring program in the Kachemak Bay/Lower Cook Inlet area.

Kachemak Bay is a NOAA National Estuarine Research Reserve (NERR). The NERR system has 26 sites throughout the United States that are dedicated to research and education of the marine/terrestrial interface of estuarine ecosystems. These reserves are a partnership between individual states and NOAA, so that each reserve is allocated approximately 70% of their funding for basic operations from the federal government. The remaining 30% of the funding must come from non-federal sources.

The NERR site in Kachemak Bay, called the Kachemak Bay Research Reserve (KBRR), is well situated to begin studies on coastal ecosystem dynamics. Kachemak Bay is located at the interface between land and ocean waters and thus near the juncture of major oceanographic and land-based processes. The interaction of these forces is the major focus of the research being conducted by KBRR. The KBRR is developing models to understand the variability of factors driving primary productivity in the bay, and specifically the linkages and interactions of water delivered from the offshore ocean and surrounding watersheds. Watershed influences on the intertidal and other habitats in the Bay range from freshwater input, transport of nutrients, sediments and contaminants to topographic influences on winds and precipitation amounts and rates. Changes in watershed vegetation cover due to urbanization, spruce bark beetle infestation, logging and forest fires will alter transport dynamics and nutrient cycling, and thus the habitat quality and structure of biological communities in the Bay's intertidal and subtidal zones. Oceanographic processes, working from the other end of the ocean-bay-shore continuum, influence nutrient transport, life history dispersal mechanisms of plants, invertebrates and fishes, sediments and contaminants. The NERR system has a research mandate to develop a national time series of water chemistry from which natural variability and long-term changes can be measured over different spatial scales. As part of this system, the KBRR has a program to continuously measure seasonal oceanographic water characteristics including nutrients, phytoplankton, temperature and salinity at two stations in the Bay (Homer and Seldovia) as part of the national System Wide Monitoring Program (SWMP). These sensor arrays measure water temperature, conductance, salinity, pH, turbidity, dissolved oxygen, depth, PAR, and fluorescence on a continuous basis.

If successful, this proposal (along with proposals #02556 and #02569) will provide the KBRR with the required matching funds to receive additional support from NOAA to: (1) maintain and operate the exisiting monitoring program (e.g., pay for staff time to operate and maintain the oceanographic sensors); (2) expand the instrument array by adding two additional stations in Halibut Cove and Bear Cove; and (3) operate and maintain the more comprehensive monitoring program. Without these funds, the KBRR will mostly likely not be able to meet the required 30% nonfederal match requirement and will have to decline the NERR operation funds that would be used to run this monitoring program.

C. Location

This project will take place in Kachemak Bay: the north shore from Anchor Point to the Fox River, then the south shore from Fox River to Nanwalek. The project will benefit all the resource management agencies in the Bay, oil spill advisory councils, conservation agencies, and local governments (see attached letters of support). The communities include City of Homer and greater Homer area, Anchor Point, Seldovia, Port Graham, Nanweluk, and small unorganized

communities on the south shore or Kachemak Bay (Halibut Cove, Jakalof Bay, Bear Cove). The benefits of these project will have broader application if these tools, technologies, and monitoring approaches are applied to other areas affected by the spill.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

The KBRR is an integrated research and education program. A goal of KBRR education program is to provide for community involvement and conduct educational programs that will interpret and instruct the public on research projects conducted in the region. While this project does not have an explicit community involvement/data gathering component in this FY02 proposal, the KBRR will interpret research results by the following means:

- The KBRR web page;
- The KBRR interactive research and education programs;
- Conferences, workshops, and presentations on our programs to the community and schools;
- Display information on research projects at KBRR facilities and/or with partner organizations such as the Pratt Museum;
- The results of this project, the GIS database, may have application with developing school monitoring programs.

The Olympic Coast National Marine Sanctuary is already employing a similar database developed by Dr. Schoch, as an integral component for their teacher education program. The Sanctuary educators on the West Coast wish to link Olympic Coast Washington teachers and students with teachers, communities and students in Kachemak Bay, Alaska, with hopes to extend the link to the other west coast Sanctuaries in California using this same model and protocol. This proposed research project will play an important role in laying the foundation for future public education and citizen monitoring efforts.

PROJECT DESIGN

A. Objectives

The objectives of the proposed project are to partner with existing programs and protocols developed by NOAA and PISCO to:

1. Begin studying the relationship between the physical, chemical, and biological patterns of the water column and the patterns of intertidal and subtidal community structure across multiple spatial scales at northern latitudes;

2. Rigorously assess the relationship between intertidal and subtidal adult populations, the distribution and abundance of pelagic larvae, and the physical, chemical, and biological processes that affect recruitment.

3. provide a foundation for GEM by studying a tractable system that has been the cornerstone of ecology for decades.

B. Methods

Studying the diversity and community structure of adult and juvenile populations in nearshore coastal waters has proven to be a difficult challenge. Recent studies by the Partnership for Interdisciplinary Studies of the Coastal Ocean (PISCO: http://www.piscoweb.org/) have pioneered new methods of quantifying the patterns and mechanisms that force diversity and community structure off the west coast of North America. We propose to partner with PISCO to establish core intertidal and subtidal transects near the NOAA SWMP instrument arrays to examine the linkages between concentrations of pelagic larvae, onshore recruitment events, population interactions (predation and competition), and growth rates of fish, invertebrates and algal populations.

The approach for minimizing biological variability is to segment complex biogeochemical shoreline gradients using a combination of qualitative and quantitative partitioning criteria. Previous studies have often failed to develop quantitative links between specific intertidal assemblages and physical attributes of habitats, thus making it impossible to "scale up" in either time or space from limited *in situ* sampling (Menge et al., 1997). The proposed sample design addresses the needs of coastal ecologists seeking to make comparisons among spatially independent beach sites. This model relies on the quantification of physical features known to have direct and indirect biological responses, and uses these as criteria for partitioning complex shorelines into a spatially nested series of physically homogeneous segments. For example, at small spatial scales the quantified geophysical parameters include sediment grain size, wave energy, substrate dynamics, and pore water chemistry. At large spatial scales water chemistry attributes such as salinity, chlorophyll and nutrient concentrations are used to identify major oceanic climates. These nested segments can be used to study within-segment and among-segment variability, which in turn will support studies of the biotic and abiotic processes that control variability. The results of research in Alaska (Cook Inlet and Shelikof Strait), Puget Sound and the outer Olympic Peninsula of Washington, have shown this to be a robust approach, despite the enormous complexity of these regions (Schoch & Dethier 1996). The variance among populations sampled from a group of physically similar but spatially independent habitats are consistently not different from the variance within any one of the group communities. These results imply that the effects of a perturbation on a community or population from one segment can be compared to a community or population from a physically identical but undisturbed segment within the same group of habitats.

Intertidal transects will be established on three replicate beaches at each of three rocky headlands (a nested 3 x 3 design), and on three replicate gravel beaches at each of three fjords (also a 3 x 3

design). A series of three subtidal transects (at 5, 10, and 20m depths) will be established adjacent to each intertidal series. Abundances of all adult fish, invertebrate, and algal populations will be estimated using standard quadrat and core techniques. At least 10 samples will be taken on each transect but power analyses on the first set of data will determine whether more samples are required. Taxonomic identification will be done to species level in the field. If the species cannot be determined then samples will be collected and preserved for later identification in the lab or by taxonomic experts at NOAA or PISCO.

Larval collectors will sample all weakly swimming zooplankton, including those that are part of the life cycle of benthic species (meroplankton) and those that spend their entire life cycle in the plankton (holoplankton). Larval collectors integrate abundances of larvae over the time periods sampled rather than the point-in-time samples yielded by plankton nets. Sets of three are attached to each mooring at each of three depths. Thus, the typically high short-term variation in abundance of larvae due to the inherent patchiness of plankton is minimized, providing much more reliable estimates of abundance and distribution. Larval samples will be removed from the collectors and stored for counting and identification in the lab.

Physical and chemical measures at the NOAA SWMP sites will provide a continuous record of oceanographic conditions, thereby providing insight into oceanographic changes. Analyses will determine changes on both short-term scales (e.g., internal waves, indicated by sharp temperature changes at temporal scales of hours, and tidal bores, detectable by temperature changes occurring at ~ 6 hr scales) and longer-term scales (days, weeks, months).

Research Questions and Methods Summary

What are the patterns of bottom-up oceanographic processes?

1. Partner with the NOAA System Wide Monitoring Program to measure the magnitude of physical, chemical and biological gradients using existing and proposed instrument arrays at 4 locations in the bay;

What are the patterns of diversity and community structure for adult fishes, invertebrates, and algae?

2. Partner with PISCO investigators to establish 9 intertidal transects and 9 subtidal transects (at each of 3 depths) on each of two habitat types (rocky and sediment) using protocols developed for West Coast surveys;

What are the spatial and temporal patterns of pelagic larvae?

3. Establish offshore larval collectors for bivalves, barnacles, sea stars, crabs, sea urchins, and limpets;

What are the rates of recruitment to adult populations?

4. Establish onshore larval collectors for bivalves, barnacles, sea stars, crabs, sea urchins, and limpets;

Evaluating the scale and consequences of changes in the ocean's biodiversity due to human

activities is seriously compromised by critically inadequate knowledge of the patterns and the basic processes that control the diversity of life in the sea. Studies applied to the nearshore are helping to define the patterns and the processes influencing marine biodiversity. If the biogeochemical processes determining patterns in nearshore habitats can be defined as proposed by this study, then they have a potentially significant contribution to EVOS and GEM, as well as other resource management and policy decisions for coastal areas where the spatial distribution of habitats is a resource management concern. For example, this study has application to oil spill damage assessments, inventory and monitoring programs, global warming, and studies of community structure and diversity. Additional applications are being explored in hindcasting the ecological functions of disturbed habitats for mitigation and restoration projects, and in forecasting impacts based on trends in human or natural perturbation patterns.

By partnering with existing organizations such as PISCO and NOAA, we are able to tie into a much larger dataset being established for the North Pacific. By establishing and maintaining Kachemak Bay as an ecological endpoint to this dataset (and this will be done by adopting the standard protocols developed at the national (NOAA) and west coast (PISCO) scales), we can begin to make comparisons at local and region levels.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Not applicable: all funds requested in this proposal will be used by ADFG/KBRR staff.

SCHEDULE

A. Measurable Project Tasks

If funded, we intend to begin the fieldwork immediately. We anticipate 1 month of fieldwork to establish the intertidal and subtidal transects, 3 months of full-time field data collection, 2 months of data entry and analysis, and 2 months of report writing.

October 31, 2001	begin site selection
April 1, 2002	establish intertidal and subtidal transects
August 31, 2002	complete data collection and entry
September 30, 2002	complete data analysis and preliminary report
April 1, 2003	submit final report

B. Project Milestones and Endpoints

The project milestones are to begin studying the affects of changes in the nearshore ocean on intertidal and subtidal populations, to establish a rigorous assessment of the relationship between adult populations and larval sources and sinks, and to provide GEM with a foundation of a study that could become a monitoring program for bottom-up processes. These will be met by the end of the funding period.

C. Completion Date

The work will be completed, and a preliminary draft report submitted, at the end of the funding cycle with the final report submitted by April 1, 2003. No funding is requested to complete this report.

PUBLICATIONS AND REPORTS

The proposed work is regarded as the foundation for further monitoring of the biological components as explicitly addressed by the National Academy of Sciences in their review of the GEM Science Plan. The data will be published at two levels. First it will be incorporated into the PISCO database and published as part of that much larger data series. Second, the data will be published as a stand-alone paper on the physical and biological processes structuring benthic communities in the Gulf of Alaska. The NOAA NERR system will highlight this project as an example of linking programs together to address both local and regional issues.

PROFESSIONAL CONFERENCES

The principal investigator is professionally obligated to present the results of Kachemak Bay research projects at the annual NERRS Research Conference (travel funded by NOAA), and the annual PISCO Conference (travel funded by PISCO). The PI is requesting funding to attend the AGU/ASLO Conference.

NORMAL AGENCY MANAGEMENT

This project is <u>not</u> required by statute or regulation regardless of whether or not the spill had occurred. The proposed work has not been conducted by either ADFG or KBRR in the past without funds from the Trustees Council.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The work proposed here can be integrated with the physical component of the study described in the accompanying Proposal (#02556): "Mapping the Physics and Physical Processes of Marine Habitats: the First Step in a Spatially Nested Monitoring Program." By using the physical GIS-based database together with the diversity data, we can begin analyzing the relationships between the physics of the nearshore environment and community structure.

Furthermore, we are building on the NOAA System Wide Monitoring Program by using the oceanographic time series data being collected in the Bay to identify and monitor the variability of major estuarine spatial and temporal divisions. The data collected will become a part of the PISCO database archived at the National Center for Ecological Analysis and Synthesis (NCEAS)

in Santa Barbara, CA.

In summary, the KBRR has put forth a substantial effort to obtain funds from non-Council sources. KBRR proposals for EVOS Trustee funds will make it possible to secure additional NOAA funds to maintain and expand the Reserve system-wide monitoring program, which will be great benefit to the GEM program.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

Dr. Schoch is the Science Coordinator for the Kachemak Bay Research Reserve in Homer, Alaska (a NOAA National Estuarine Research Reserve). He has a dual Ph.D. in Biological Oceanography and Geological Oceanography from the College of Oceanic and Atmospheric Sciences at Oregon State University (1999) and continues to work with his post-doc advisors (Lubchenco and Menge) as a Senior Fellow for the Partnership for Interdisciplinary Studies of the Coastal Ocean (PISCO) studying marine ecosystem dynamics. His research interests are in the physical and biological linkages between marine nearshore and continental shelf ecosystems, specifically how physical processes such as currents, wave energy, sediment dynamics, and nutrient fluxes structure intertidal and subtidal communities. His current research projects include studying larval distributions and forces affecting recruitment, monitoring the variability of primary productivity as a function of ocean climate, and investigating kelp bed community dynamics. He serves as the science advisor for the Olympic Coast National Marine Sanctuary Advisory Council, and is the chair of their Research Advisory Committee. He also serves as the technical advisor to the Sanctuary Marine Conservation Working Group, consulting on the design and development of a marine reserve network on the outer coast of Washington. He also consults to the Washington Department of Natural Resources on intertidal habitat modeling in Puget Sound and Georgia Straits.

OTHER KEY PERSONNEL

The grant, if funded, will provide support for a Research Analyst and a Research Assistant (now

being hired) to assist with data entry and analysis. The NERRS Graduate Research Fellowship Program will provide 2 graduate students to assist Dr. Schoch with the fieldwork at no cost to the project.

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Underwood, A.J., and P.S. Petraitis. 1993. Structure of intertidal assemblages in different locations: how can local processes be compared? In Ricklefs, R.E., and D. Schluter (Eds.), *Species Diversity in Ecological Communities* (pp. 39-51). Chicago: Univ. of Chicago Press.

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FY 02 *EXXON VALDEZ* TR[illegible]EE COUNCIL PROJECT BUDGET

October 1, 200[illegible] - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$30.0						
Travel		$2.2						
Contractual		$3.5						
Commodities		$9.5						
Equipment		$0.0						
Subtotal	$0.0	$45.2	Estimated FY 2003					
General Administration		$4.7						
Project Total	$0.0	$49.9						
Full-time Equivalents (FTE)		0.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:The KBRR went through a substantial effort to obtain funds and establish partnerships with other organizations to support the proposed research and monitoring effort. These efforts include:

NOAA/KBRR Support: The proposed EVOS projects (including proposals #02556 and #02569)will meet the required non-federal match for approximately $274K in NOAA operations funds. Federal funds will be used to operate and expand the Reserve monitoring program. These NOAA funds will support, in part, two research staff, the purchase of ocean sensors and a CTD, Reserve research and support facilities and equipment. Without this match, the KBRR will need to decline all or part of these funds, and likely will not be able to implement and maintain the long-term monitoring program.

PISCO: At not cost to the project, PISCO investigators will visit Kachemak Bay to evaluate the selected sites and begin establishing experiments that address other issues relevant to that project's mission. Approximate cost to PISCO is $15,000.

NERRS - A KBRR a graduate research student will utilize the same sites for additional larval recruitment experiments ($17,000).

FY02

Prepared: 4/12/01

Project Number: 02565
Project Title: Bottom-up or Top Down: What Forces the Variability of Subtidal and Intertidal Fishes, Invertebrates and Algal Communities in Kachemak Bay?
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 02 *EXXON VALDEZ* TF EE COUNCIL PROJECT BUDGET
October 1, 20_ . September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
Recruitment in Progress	Research Analyst III	18A	2.8	5.0		14.0
(Hire in Progress)	Fisheries Biologist I	14A	4.0	4.0		16.0
						0.0
Dr. G. Carl Schoch	Research Coordinator	min. of 4 months at 5K/mo.				no charge
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		6.8	9.0	0.0	
					Personnel Total	$30.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2002
Dr. G. Carl Schoch to present at PISCO annual conference, and the NERR					0.0
annual conference	no charge				no charge
					0.0
Dr. G. Carl Schoch to attend the 2002 AGU/ASLO	1.0	1	4	0.2	1.8
					0.0
Dr. G. Carl Schoch to attend the EVOS annual workshop	0.2	1	1	0.2	0.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.2

FY02

Prepared: 4/12/01

Project Number: 02565
Project Title: Bottom-up or Top Down: What Forces the Variability of Subtidal and Intertidal Fishes, Invertebrates and Algal Communities in Kachemak Bay?
Agency: ADFG

FORM 3B
Personnel
& Travel
DETAIL

FY 02 *EXXON VALDEZ* TF EE COUNCIL PROJECT BUDGET

October 1, 20.. September 30, 2002

Contractual Costs:				Proposed
Description				FY 2002
Fuel for Skiff				3.5
When a non-trustee organization is used, the form 4A is required.			**Contractual Total**	$3.5

Commodities Costs:			Proposed
Description			FY 2002
Misc Supplies and Operating Expenses for Boat			1.5
Materials for building larval collectors	30	0.1	3.0
On-set temperature loggers (to bolt to transects)	30	0.1	3.0
Computer upgrades	1	1.5	1.5
Sieve set (8mm, 4mm, 2mm, 1mm)	1	0.2	0.2
Formalin	1	0.1	0.1
Misc. Lab Equipment			0.2
		Commodities Total	$9.5

FY02

Prepared:

Project Number: 02565
Project Title: Bottom-up or Top Down: What Forces the Variability of Subtidal and Intertidal Fishes, Invertebrates and Algal Communities in Kachemak Bay?
Agency: ADFG

FORM 3B
Contractual & Commodities DETAIL

FY 02 *EXXON VALDEZ* TF EE COUNCIL PROJECT BUDGET
October 1, 20Ot - September 30, 2002

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002
			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
Research Skiff	1	
KBRR headquarters and research facilities	2	
KBRR Computers	3	

FY02

Prepared: 4/12/01

Project Number: 02565
Project Title: Bottom-up or Top Down: What Forces the Variability of Subtidal and Intertidal Fishes, Invertebrates and Algal Communities in Kachemak Bay?
Agency: ADFG

FORM 3B
Equipment
DETAIL

Project Title: Developing a Linked Monitoring Network for the Gulf of Alaska: a workshop to develop a conceptual model and foster partnerships

Project Number:	02569
Restoration Category:	Research and Monitoring
Proposer:	Kachemak Bay Research Reserve, University of Alaska SE
Lead Trustee Agency:	ADFG
Duration:	1st year, 1 year project
Cost FY02:	$15,300
Geographic Area:	Gulf of Alaska
Injured Resource/Service:	Subtidal and intertidal communities, sediments, mussels, clams, archeological resources

ABSTRACT

There are excellent research models such as PICES (http://pices.ios.bc.ca) and PISCO (www.piscoweb.org) in the lower 48 that integrate oceanographic and shoreline components to study the effects of oceanic regime shifts on recruitment and growth of intertidal and shallow subtidal organisms. However, no such program exists in Alaska. We propose to convene a workshop to bring together researchers from across the Gulf of Alaska Region, and the U.S. West Coast to develop a coordinated research program for research and monitoring the nearshore ocean of the North Pacific. We envision a network of local research organizations acting in concert to adopt standardized protocols to address research questions at multiple spatial scales.

INTRODUCTION

Recent breakthroughs in technology and numerous scientific disciplines have made possible unprecedented large-scale studies of the marine environment. These developments show much promise for enabling significant advances in understanding, as well as protecting, oceans. Basic knowledge about several major characteristics of nearshore marine ecosystems is now within reach (e.g. the variation in coastal oceanography, effects of food availability and nearshore oceanography on the dynamics of ecological communities, and connections among ecological communities through larval dispersal).

NEED FOR THE PROJECT

A Statement of Problem

Nearshore intertidal and subtidal lands receive some of the most direct human impacts. Some impacts from human activities will interact with natural cycles at the scale of the entire Gulf of Alaska, while others are likely to have impacts primarily on near-coastal areas. It is difficult to address these multi-scale effects due to logistical costs, political agendas, and the vagaries of funding sources. Thus, our lack of understanding how large scale processes interact with small scale processes is largely systematic. We propose to offer a new model for addressing these issues: an integrated consortium whose collective efforts can address questions at the local level, and through the adoption of standardized protocols, can address questions at nested spatial scales. The GEM program is unprecedented in being able to provide long-term funding to monitor the Gulf ecosystem. The problem remains however, that without a commitment from researchers to adopt standardized protocols across the scale of the Gulf and to gather a long term time series, many of the questions asked by GEM will remain unresolved.

B. Rationale

A key fact underlying much of marine ecology is that most marine organisms possess a pelagic larval stage that is capable of long-distance dispersal. This means that many populations of adults within a given area may disperse their young to other areas, and they in turn may be dependent on distant populations for their own replenishment. Although progress can be made now in establishing the rationale for marine reserves, ultimately an understanding of the dynamics of larval and adult transport is required to design, monitor and evaluate reserves adequately (Allison et al. 1998). For the U.S. West Coast, it is clear that appropriate spatial scales for understanding the ecological dynamics of nearshore ecosystems should range from Alaska to southern California. The northward flowing Alaska Current and the southward-flowing California Current systems dominate this region and exhibit potentially significant variation from north to south at scales of hundreds of kilometers and on temporal scales of decades. Ecologically significant regional variation in currents, upwelling regime, temperature, El Niño events, climate, zooplankton abundance and transport, and the benthic biota are implicit in recent studies. To date,

however, efforts to integrate this knowledge across traditional habitat boundaries and disciplinary boundaries have received limited and sporadic support, at best, from funding agencies.

Historically, most research has been done locally and within a particular discipline. Technologically, we are poised to begin studying ecosystems at multiple spatial and temporal scales. What we are lacking is the organization to tackle multi-discipline, multi-scale issues. Yet these are the very issues raised by the GEM Science Plan and the recent reviews of that plan from the National Academy of Sciences. A coordinated network of researchers, acting in concert, could augment work being done in the lower 48 so that questions can be addressed at local, regional (GOA), oceanic (North Pacific), and global scales.

We propose to convene a group of researchers representing existing organizations from around the Gulf of Alaska to discuss the concept of, and develop the conceptual model for, adopting standardized protocols for a series of monitoring projects. We will invite speakers from programs such as the Partnership for Interdisciplinary Studies of the Coastal Ocean (PISCO) to talk about the research questions addressed by those programs and to discuss successes and pitfalls. We will invite one or more representatives from organizations interested in forming a consortium and who are doing research in the Gulf region including: UAA, UAF, UAS, Alaska SeaLife Center, the Prince William Sound Science Center, and GEM. We will discuss developing a consortium of local researchers representing a uniform spatial distribution around the Gulf of Alaska.

C. Location

The workshop will be held in Homer, Alaska in the Fall of 2001.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Not applicable to this planning project.

PROJECT DESIGN

The oceans are at risk from a variety of threats including direct and indirect effects of human development compounded by natural climate variation. Nearshore marine ecosystems are the focus of many current conservation efforts, yet we lack the basic knowledge necessary for proper management. Ecological and evolutionary principles that were derived from studies in terrestrial environments are not easily applied to marine systems. The young of most marine organisms are water-borne for extensive periods of time, so that the connections between distant communities are potentially great, and local production may not correspond to local recruitment. Seawater carries plankton and nutrients as well as young, and these essentials flow into a local marine community at many levels. Thus recruitment, growth, and mortality of many organisms in a coastal marine community are intimately tied to the characteristics of the water bathing the site, and communities even short distances apart can have fundamentally different structures.

Ocean waters, in turn, are variable over immense spatial and temporal scales, and coastal dynamics are the least understood area of physical oceanography. The primary GEM goal is to understand the interaction of the nearshore oceanographic environment with coastal marine communities over the Gulf of Alaska region. This includes quantifying patterns of distribution, abundance and diversity of the biota in nearshore ecosystems, and determining how ecological and oceanographic processes influence these patterns. We believe that this understanding of both local and biogeographic patterns and processes must span small-to-large spatial scales and short-to-long temporal scales.

Many of the testable hypotheses about community processes were first developed and explored in intertidal and subtidal benthic systems. Strong evidence suggests that variation among nearshore benthic communities can depend on recruitment and such bottom-up oceanic influences as phytoplankton productivity and nutrient concentration, all of which vary significantly with currents, upwelling, and other physical oceanographic processes. We propose to develop a consortium of existing research organizations to address these issues in the Gulf of Alaska. Each organization will be the focal point of locally intensive study. However, the consortium will act in concert to develop a large spatial and temporal scale database using standard sampling protocols to address questions at multiple spatial scales. These broad questions include:

1. What processes and physical conditions produce larvae?
2. How long do larval stages last, and where do they go?
3. How and why does production vary along the shore?
4. How variable is recruitment in space and time among major groups of planktonic larvae?
5. What are the primary energy and nutrient sources of intertidal and benthic communities?
6. Under what conditions do recruitment, food, space, natural disturbance, temperature, predators, competitors, and disease limit populations?
7. What are the sources and rates of natural disturbance to intertidal and subtidal communities?
8. What are the rates and patterns of recovery?

Organizations such as PISCO on the west coast of North America are attacking these questions with intensive biological sampling of larvae, recruits, and post-settlement individuals in both subtidal and intertidal communities, combined with simultaneous monitoring of nearshore waters using mooring arrays and remote sensing.

In addition to the GEM consortium level study, each organization will carry out investigator-initiated studies to answer common questions relevant to the local area. The consortium level studies cross multiple spatial scales and are intended to be long term. The investigator-initiated studies may be small scale and short term.

While the monitoring program and coordinated field manipulative experiments will reveal the spatial and temporal patterns of community structure, we also intend to specify the degree to which local coastal populations are interconnected. We will attempt to identify the sources of recruits and dispersal patterns for pelagic larvae of coastal organisms.

A. Objectives

Our specific objective for the workshop is to identify key players and develop a conceptual model for a research and monitoring program that spans the Gulf of Alaska using standardized protocols for a core series of experiments and monitoring programs to determine the processes underlying the dynamics of the coastal ecosystems.

B. Methods

Not applicable.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Not applicable: all funds requested in this proposal will be used by ADFG/KBRR staff. Workshop participant travel will be funded through invitational travel.

SCHEDULE

A Measurable Project Tasks

If funded, we intend to immediately begin organizing the workshop. The organizational effort includes identifying the key participants, inviting and selecting representatives from other collaborative organization such as PISCO, setting a date for the workshop, arranging for travel and lodging during the workshop for each participant. The meeting would be held in the fall of 2001 in Homer, Alaska.

November 30, 2001:	hold workshop and begin report synthesis
February 28, 2002	complete report synthesis in time for the first round of GEM proposals

B. Project Milestones and Endpoints

The objective of the workshop is to develop a conceptual model for a research and monitoring program that spans the Gulf of Alaska using standardized protocols for a core series of experiments and monitoring programs to determine the processes underlying the dynamics of the coastal ecosystems.

C. Completion Date

Our goal is to have the final report completed in time for the first GEM RFP announcement.

PUBLICATIONS AND REPORTS

We do not anticipate publishing the results of the workshop, but a final report will be issued.

PROFESSIONAL CONFERENCES

The workshop proceedings will not be appropriate material for a professional conference.

NORMAL AGENCY MANAGEMENT

This project is not required by statute or regulation regardless of whether or not the spill had occurred. The proposed work has not been conducted by either ADFG or KBRR in the past without funds from the Trustees Council.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

We are coordinating this project with Dr. Lilian Alessa at UAA, Dr. Brenda Konar at UAF, and TBA from the Alaska Sealife Center, and TBA from the Prince William Sound Science Center in Cordova.

In addition we are coordinating this effort with PISCO principal investigators Drs. Bruce Menge, Steven Gaines, and Mark Carr (see attached letters of support).

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

Dr. Schoch is the Science Coordinator for the Kachemak Bay Research Reserve in Homer, Alaska (a NOAA National Estuarine Research Reserve). He has a dual Ph.D. in Biological Oceanography and Geological Oceanography from the College of Oceanic and Atmospheric Sciences at Oregon State University (1999) and continues to work with his post-doc advisors (Lubchenco and Menge) as a Senior Fellow for the Partnership for Interdisciplinary Studies of the Coastal Ocean (PISCO) studying marine ecosystem dynamics. His research interests are in the physical and biological linkages between marine nearshore and continental shelf ecosystems, specifically how physical processes such as currents, wave energy, sediment dynamics, and nutrient fluxes structure intertidal and subtidal communities. His current research projects include studying larval distributions and forces affecting recruitment, monitoring the variability of primary productivity as a function of ocean climate, and investigating kelp bed community dynamics. He serves as the science advisor for the Olympic Coast National Marine Sanctuary Advisory Council, and is the chair of their Research Advisory Committee. He also serves as the technical advisor to the Sanctuary Marine Conservation Working Group, consulting on the design and development of a marine reserve network on the outer coast of Washington. He also consults to the Washington Department of Natural Resources on intertidal habitat modeling in Puget Sound and Georgia Straits.

Dr. Eckert received her undergraduate degree in Biology from Dartmouth College in Hanover, New Hampshire. She received her master's degree in Zoology from the University of Florida in Gainesville and her PhD in Ecology from the University of California in Santa Barbara. She is currently an Assistant Professor of Biology at the University of Alaska Southeast in Juneau where she teaches Ecology, Marine Ecology, Invertebrate Zoology and Introductory Biology. Her research interests include the reproductive and larval ecology of marine invertebrates and their implications for management and conservation. She is currently studying recruitment of

Dungeness crabs in Glacier Bay, growth and movement of sea cucumbers in Southeast Alaska, and the reproductive biology of snow crabs from the Bering Sea.

OTHER KEY PERSONNEL

This grant will provide support for a research assistant to assist Drs. Schoch and Eckert with organizing and reporting on the workshop.

FY 02 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2001	Proposed FY 2002
Personnel		$6.0
Travel		$8.4
Contractual		$0.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$14.4
General Administration		$0.9
Project Total	$0.0	$15.3
Full-time Equivalents (FTE)		0.1
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2003					

Dollar amounts are shown in thousands of dollars.

Comments: The KBRR went through a substantial effort to obtain funds and establish partnerships with other organizations to support the proposed research and monitoring effort. These efforts include:

UAS: The co-principle investigator has agreed to provide their time on this project as matching contribution, and waive associated indirect costs (est. $10000).

NOAA/KBRR Support: The KBRR will provide the meeting facilities (est. $2000). The proposed EVOS projects (including proposals #02556 and #02565) will meet the required non-federal match for approximately $274K in NOAA operations funds. Federal funds will be used to operate and expand the Reserve monitoring program. These NOAA funds will support, in part, two research staff, the purchase of ocean sensors and a CTD, Reserve research and support facilities and equipment. Without this match, the KBRR will need to decline all or part of these funds, and likely will not be able to implement and maintain the long-term monitoring program.

PISCO: PISCO representatives will provide their time at no cost to the project ($2000).

FY02

Prepared: 4/12/01

Project Number: 02569
Project Title: Developing a Linked Monitoring Network for the Gulf of Alaska: a workshop to develop a conceptual model and foster
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 02 *EXXON VALDEZ* TI EE COUNCIL PROJECT BUDGET

October 1, 20.. September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
(Hire in progress)	research assistant		1.5	4.0		6.0
						0.0
Dr. G. Carl Schoch	co-principal investigator - 1 mo.		no charge			no charge
Dr. Ginny Eckert	co-principal investigator - 1 mo.		no charge			no charge
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.5	4.0	0.0	
					Personnel Total	$6.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2002
Dr. Ginney Eckert +TBA	UAS (2)	0.6	2	2	0.1	1.4
Dr. Lilian Alessa +TBA	UAA (2)	0.2	2	2	0.1	0.6
Dr. Brenda Konar +TBA	UAF (2)	0.8	2	2	0.1	1.8
TBA	Seward (2)	0.3	2	2	0.1	0.8
TBA	Cordova (2)	0.6	2	2	0.1	1.4
Dr. Bruce Menge	Corvallis	1.0	1	2	0.1	1.2
Dr. Steven Gaines	Santa Barbara	1.0	1	2	0.1	1.2
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$8.4

FY02

Prepared: 4/12/01

Project Number: 02569
Project Title: Developing a Linked Monitoring Network for the Gulf of Alaska: a workshop to develop a conceptual model and foster
Agency: ADFG

FORM 3B
Personnel
& Travel
DETAIL

FY 02 *EXXON VALDEZ* T EE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed FY 2002
Description	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 2002
Description	
Commodities Total	$0.0

FY02

Prepared:

Project Number: 02569
Project Title: Developing a Linked Monitoring Network for the Gulf of Alaska: a workshop to develop a conceptual model and foster
Agency: ADFG

FORM 3B
Contractual & Commodities
DETAIL

FY 02 *EXXON VALDEZ* TI EE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2002
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

FY02

Project Number: 02569
Project Title: Developing a Linked Monitoring Network for the Gulf of Alaska: a workshop to develop a conceptual model and foster
Agency: ADFG

FORM 3B
Equipment
DETAIL

Prepared: 4/12/01