19.09.02 (8 of 12)

01513

Exxon Valdez Oil Spill: The Continuing Legacy

Project Number: 01513

Restoration Category:

Proposer: Alaska Sealife Center

Lead Trustee Agency:
Cooperating Agencies:

Alaska SeaLife Center: Yes

Duration: 1st year, 2 year project

Cost FY 01: $50,000.00

Cost FY 02: $15,000.00

Geographic Area: Prince William Sound, Kenai Peninsula, Kodiak

Injured Resource: Bald Eagle, Black Oystercatcher, Clams, Common Murre, Marbled Murrelet, Mussels, Pacific Herring, Pink Salmon, Sea Otter, Sockeye Salmon, Harbor Seal, Harlequin Duck, Killer Whale, Pigeon Guillemot.

ABSTRACT

"Exxon Valdez Oil Spill: The Continuing Legacy" is an interactive exhibit designed inform the public about the current status of wildlife species injured by the spill. It will combine pieces of the existing exhibit "Legacy of an Oil Spill, 10 Years After" with new audio and visual components that will allow easy updating of information as the status of injured species changes over time. This exhibit will be a permanent installation at the Alaska SeaLife Center and will serve for years as a source of public dissemination to hundreds of thousands of visitors.

INTRODUCTION

The restoration being proposed is the effective dissemination of information to the public about the current status of species injured by the Exxon Valdez Oil Spill. We will use at least two of the existing text panels and the 16x8 foot mural from the "Legacy of an Oil Spill, 10 Years After," and combine them with new components to create an interactive experience that is engaging and easy to update. The existing text panel on the Exxon Vadez Oil Spill Trustee Council will be retained to explain what the Council is and how the settlement money was divided. The panel describing the Restoration Plan will also be retained. A new panel will be developed which describes how the Alaska SeaLife Center (ASLC) was funded and how it fits into the Restoration Plan. The centerpiece of the exhibit will be the combination of the 16x8 foot mural depicting the wildlife of Prince William Sound with audio wands that explain the status of the wildlife. A new graphical key to the mural will be developed that identifies selected species by number. Visitors will be able to pick up an audio wand and type in the number of the species in which they are interested. They will then hold the wand to their ear and hear a brief message describing the injury to that species and the its current status, including descriptions of any research taking place on that species. Visitors will have at least fourteen different messages to choose from. We will also build three acrylic cases that will be filled with rocks to represent beach sediment profiles from three different locations in the spill zone. We will incorporate actual oiled rocks into these profiles to give visitors a clear picture of the location and condition of the oil today. A new graphic panel will also be developed to interpret these beach profile displays. The rocks will be removable and can be rearranged as new data becomes available on the status of the oil. The work for FY 00 will be to design, fabricate, and install the entire exhibit. The work for FY 01 will be to update the audio component with new messages to reflect the latest knowledge about the injured species and the research that is focused on them.

NEED FOR THE PROJECT

A. Statement of Problem

The problem that this project addresses is reaching large numbers of the public with up-to-date information on diverse projects. The study of species injured by the Exxon Valdez Oil Spill is undertaken by many different agencies and institutions. Gathering the information gained from these studies at one central location is important to disseminating an accurate picture of the overall effects and recovery progress from the Exxon Valdez Oil Spill. While the Oil Spill Public Information Office does a wonderful job of gathering information on these diverse projects and producing regular publications, they do not provide a public exhibit setting as attractive as the Alaska Sealife Center. The Alaska Sealife Center has had nearly 350,000 visitors during its first two years of operation. This includes thousands of school students from both Alaska's urban centers and bush villages like Shaktoolik and Razdolna. The Alaska Sealife Center's exhibit hall provides an ideal opportunity to reach large numbers of the visiting public with Exxon Valdez Oil Spill information. The impact of this information is heightened by the

presence of live examples of many of the species on exhibit at the Sealife Center. The species which are included in the mural and will be interpreted with audio messages are:

1. Bald Eagle
2. Black Oystercatcher
3. Clams
4. Common Murre
5. Marbled Murrelet
6. Mussels
7. Pacific Herring
8. Pink Salmon
9. Sea Otter
10. Sockeye Salmon
11. Harbor Seal
12. Harlequin Duck
13. Killer Whale
14. Pigeon Guillemot

B. Rationale

This work should be done because of its potential to reach large numbers of people with up-to-date information about the Exxon Valdez Oil Spill. The public needs access to such information in order to dispel popular misconceptions and to help create an informed constituency that can participate in discussion and policy-making on oil spill related issues.

C. Location

This project will be undertaken at the Alaska SeaLife Center. Some of the exhibit design and fabrication may be contracted with a company in Anchorage or elsewhere.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

During the research for the audio components, community facilitators will be contacted for information on the local perspective regarding the species in question. Where appropriate, local anecdotal information will be included along with scientific data in the final audio messages that are prepared for the public. In any case where such information is used, community facilitators and the Traditional Ecological Knowledge Specialist will be consulted for review of the final audio messages.

Community outreach will also include providing complimentary tickets to the Alaska SeaLife Center to local Native Alaskan families, especially those that can not visit without admission assistance. The ASLC will donate 100 adult tickets and 200 tickets for children ages 7-12, and requests matching support from the Trustee Council. Community outreach personnel from local tribal groups and Native corporations will distribute the tickets to families. This will encourage participation and interaction with the exhibit, and we find that Native visitors often provide interesting, relevant information to ASLC interpreters and other visitors.

PROJECT DESIGN

A. Objectives

1. To provide up-to-date information to the public on species injured by the Exxon Valdez Oil Spill in a location that will reach a large number of people. .

2. To provide a concrete visual display of where oil lies today at selected beaches.

3. To explain the makeup and role of the Exxon Valdez Oil Spill Trustee Council.

4. To explain how and why the construction of the Alaska Sealife Center was funded.

3. To create an interactive audio experience that is both engaging and informative.

4. To create an exhibit that is easy to update.

5. To create a visually attractive exhibit that grabs attention.

B. Methods

We chose to use a combination of methods to disseminate information to the public. These methods will be visual in the form of text, pictures, artwork, and a full scale display of beach sediment and audio in the form of recorded messages about selected species. This combination of methods will accomodate diverse learning styles and increase the effectives of the exhibit. One of the best things about using programmable audio wands for the audio messages is that it allows the public to actively choose the

information they want to hear. One visitor may only care about sea otters, while another may want to listen to every message. This kind of visitor control increases the appeal of the exhibit. The audio component also provides a nice alternative to much of the other information at the Alaska Sealife Center, which is mostly presented in a non-audio format. Additionally, the exhibit design uses existing elements from another exhibit, which helps control cost and extend the useful life of a previous Trustee Council funded project.

Cooperating Agencies, Contracts, and Other Agency Assistance

We anticipate a need for cooperation from principal investigators of many different projects in providing information on their projects and helping to review final audio messages.

We anticipate the need for cooperation from whomever it is that conducts periodic surveys of beach sediment and oil condition in the field. We do not plan to travel to the beaches and collect oiled rocks ourselves, nor have we requested a budget for such activity. We will request collection or rocks and other beach profile information through the Exxon Valdez Oil Spill Public Information Office or other appropriate agencies.

We plan to contract out the production of the new poster graphics to the private sector, most likely to the same company, Art Services North, that produced "Legacy of an Oil Spill, 10 Years After." This will ensure consistency in the look and feel of new components with the existing components we plan to use.

We will also pay a private company to provide sound recording services, since this is an area involving specialized knowledge and equipment not available at the Alaska Sealife Center.

SCHEDULE

A. Measurable Project Tasks for FY 01

February 1:	Complete design of new exhibit panels and components.
March 1:	Complete research and writing of audio messages.
March 15:	Complete recording of audio messages.
April 1:	Complete fabrication of new exhibit panels and components.
April 15:	Complete installation of exhibit.

B. Project Milestones and Endpoints

March 15:	Create an interactive audio experience that is both engaging and informative.
April 1:	Create an exhibit that is easy to update. Create a visually attractive exhibit that grabs attention.
April 15:	Provide up-to-date information to the public on species injured by the Exxon Valdez Oil Spill in a location that will reach a large number of people. Provide a concrete visual display of where oil lies today at selected beaches. Explain the makeup and role of the Exxon Valdez Oil Spill Trustee Council. Explain how and why the construction of the Alaska Sealife Center was funded.
April 15, FY02:	Provide updated audio information on species injured by the Exxon Valdez Oil Spill.

C. Completion Date

This project will be completed by April 15, 2002.

PUBLICATIONS AND REPORTS

We do not plan to submit any manuscripts for publication in relation to this project, though we certainly will provide press releases and marketing support to advertise the opening of the new exhibit.

PROFESSIONAL CONFERENCES

We do not plan to attend any professional conferences in relation to this project.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will require close coordination with many Trustee Council funded projects. We will be seeking the latest status and descriptions of the latest research taking place on the injured species that are depicted in the mural. Some of this information will be available from the Oil Spill Public Information Office, but much of it will have to be gathered directly from Principal Investigators and community facilitators. Some of the projects are housed at the Alaska SeaLife Center, so the information is readily at hand. Others will require coordination with state and federal agencies. Part of the beauty of this project is the gathering of all of this diverse information into one exhibit that will reach thousands of people. As far as public education goes, this project really embodies coordination and integration of the entire restoration effort.

PROPOSED PRINCIPAL INVESTIGATOR

Jim Pfeiffenberger
Exhibits Manager, Alaska SeaLife Center
P.O. Box 1329
(907) 224 6337
(907) 224 6320
jimp@alaskasealife.org

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:		Authorized FY 2000	Proposed FY 2001
Personnel			$7.1
Travel			$0.4
Contractual			$21.9
Commodities			$0.0
Equipment			$14.1
Subtotal		$0.0	$43.5
Indirect	15%		$6.5
Project Total		$0.0	$50.0
Full-time Equivalents (FTE)			0.2
Other Resources			$2.6

LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 2002		
			$15.0		

Dollar amounts are shown in thousands of dollars.

Comments:

The conservative indirect rate of 15% accounts for overhead costs of operating the public education/exhibits component of the Alaska SeaLife Center, including maintenance and operation of exhibit space, marketing to increase attendance , ticketing, interpretive services, clerical and accounting support, and administrative supervision.

Approximately $400 is budgeted for the P.I. to attend the Trustee Council's Annual Restoration workshop in Anchorage.

The budget for admission assistance of $2,600 for Native Alaskan families will enhance community involvement and participation, and will be matched by an equal number of tickets to be donated by the ASLC (noted in "Other Resources"). Tickets purchased at full price by the 150,000 to 200,000 annual visitors to the ASLC who will interact with the exhibit can also be considered as other resources.

FY01

Project Number: 01573

Project Title: "Exxon Valdez Oil Spill: The Continuing Legacy"

Name: The Alaska SeaLife Center

FORM 4A
Non-Trustee
SUMMARY

Prepared: 12-Apr-00

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2001
Jim Pfeiffenberger (P.I.)	Exhibits Manager		1.5	3690.00		5.5
	Responsible for research and writing of exhibit text and administering project					0.0
Cliff Menzel	Maintenance Supervisor		0.5	3290.00		1.6
	Responsible for installation of exhibit					0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.0	6980.00	0.0	
					Personnel Total	$7.1

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2001
Travel for Jim Pfeiffenberger (P.I.) to attend Trustee Council					0.0
Annual Restoration Workshop in January, 2001	77.00	1	2	125.00	0.4
(No ticket needed-- R/T 250 miles by car @ $0.31/mile)					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.4

FY01

Project Number:
Project Title: "Exxon Valdez Oil Spill: The Continuing Legacy"
Name: The Alaska SeaLife Center

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 12-Apr-00

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

Contractual Costs:	Proposed
Description	FY 2001
Audio mastering (recording and editing) information for audio sticks @ 10 studio hours x $100/hour	1.0
Contractual services with Art Services North to produce the following exhibit components: Title panel, panel describing the EVOS funding that built the SeaLife Center, and graphic panels with numbered indentification keys for each species on the mural Railing and deck on which identification keys and racks for the audio wands are mounted	17.0
100 adult tickets for admission to the ASLC at $10 each and 200 tickets for children ages 7-12 at $8 each (group rates) to be distributed to local Native Alaskan families, encouraging attendance and involvement (ASLC will match number)	2.6
Printing and mailing costs for flyer publicizing new exhibit to ASLC members, public schools, and others 5,000 2-color pieces, including graphic layout, printing, and postage	1.3
Contractual Total	$21.9

Commodities Costs:	Proposed
Description	FY 2001
Commodities Total	$0.0

FY01

Project Number:
Project Title: "Exxon Valdez Oil Spill: The Continuing Legacy"
Name: The Alaska SeaLife Center

FORM 4B
Contractual & Commodities DETAIL

Prepared: 12-Apr-00

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

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2001
Ten-wand audio sound stick system	1	7.5	7.5
Software for audio updating capability	1	5.0	5.0
Lighting fixtures to highlight exhibit	10	$80.00	0.8
Acrylic cases to display beach profiles	3	$250.00	0.8
			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**		$14.1

Existing Equipment Usage:	Number	
Description	of Units	
Wall mural (4 panels each 4' x 8') from the current EVOS exhibit at ASLC, showing species injured in spill (Original cost $4,058)	1	
EVOS information panels from current exhibit (Original cost $2,560)	2	

FY01

Project Number:
Project Title: "Exxon Valdez Oil Spill: The Continuing Legacy"
Name: The Alaska SeaLife Center

FORM 4B
Equipment
DETAIL

Prepared: 12-Apr-00

Distribution and Habitat of Rockfish (*Sebastes* spp.) in Nearshore Waters of Prince William Sound, Alaska

Project Number:	01579
Restoration Category:	Research
Proposer:	John Thedinga and Scott Johnson NMFS Auke Bay Laboratory ABL Program Manager: Dr. Stanley Rice NOAA Program Manager: Bruce Wright
Lead Trustee Agency:	NOAA
Cooperating Agencies:	University of Alaska
Duration:	3 years
Cost FY01:	$64,700
Cost FY02:	$44,900
Cost FY03:	$19,300
Geographic Area:	Prince William Sound
Injured Resource/Service:	Rockfish

ABSTRACT

Information is limited on the life-history and habitat of many commercially important rockfish species in Alaska, especially juvenile stages. Rockfish are classified as an injured species but the status of rockfish stocks in Prince William Sound (PWS) is unknown as is their recovery from the *Exxon Valdez* oil spill. A survey of nearshore waters is needed to identify habitats used by rockfish, especially those habitats that may be essential to maintain healthy populations. This project uses a remotely operated vehicle (ROV) equipped with video camera to link habitat and rockfish assemblages in nearshore waters of PWS. A combination of underwater video and beach seining offers an effective way to identify and describe rockfish habitat.

INTRODUCTION

Rockfish (*Sebastes* spp.) were injured by the *Exxon Valdez* oil spill but the extent of injury and recovery after the spill remain unknown (Exxon Valdez Oil Spill Trustee Council 1999). Lack of knowledge on rockfish distribution, habitat, and abundance in Prince William Sound (PWS) limits the assessment of the overall health of rockfish stocks. In addition to possible effects from the oil spill, a regime shift in the Gulf of Alaska resulting from a climate change in the latter 1970s has caused shifts in the composition and abundance of some forage species (Anderson et al. 1997; Schumacher 1999) which may also hinder recovery of rockfish stocks. The shift from a crustacean-dominant trophic structure to a groundfish-dominant trophic structure has resulted in a decrease in shrimp and crab abundance, important prey of rockfish (Rosenthal et al. 1988). Global warming may also affect prey availability as well as quantity and quality of essential habitats (e.g., eelgrass meadows). The linkage between rockfish and their habitat needs to be identified in PWS to protect those habitats essential for stocks to recover and to establish a baseline that can be part of a long-term ecosystem monitoring program.

Rockfish are difficult to study because adults generally inhabit areas (e.g., rocky pinnacles and bedrock walls) that are not easy to sample with traditional sampling gear. Many rockfish species utilize shallow (<90 m deep), nearshore areas during their early life, such as eelgrass meadows and kelp forests, but little is known about the life history of juvenile rockfish in Alaska. Tagging studies to monitor movement and growth are also difficult because rockfish have well-developed swim bladders and are subject to embolism, so many do not survive being brought to the surface.

Adequate sampling methods (e.g., seining) are available for some nearshore habitats (e.g., eelgrass meadows) but not for others (e.g., steep, rocky shorelines with kelp). Manned submersibles have been used to document habitat and abundance of Pacific rockfish in rocky coastal areas (>35 m deep) of Southeast Alaska (Carlson and Straty 1981; Krieger 1993; O'Connell and Carlile 1994) and British Columbia (Murie et al. 1994). Manned submersibles are limited, however, by expensive operational costs and their inability to operate effectively in shallow water (<3 m deep) or in thick kelp forests. Similarly, SCUBA has been used to describe habitat and abundance of rockfish in kelp forests and rocky reefs (Hallacher and Roberts 1985; Matthews 1990). Use of SCUBA with compressed air is also limited, however, to depths less than approximately 30 m due to physiological limitations associated with time at depth. A remotely operated vehicle (ROV) equipped with a video camera bypasses some of the limitations of a manned submersible or SCUBA divers. The most effective way to make *in situ* observations of rockfish and describe their habitat is with an underwater camera. Most fish are not attracted or disturbed by the ROV, allowing close viewing of fish and habitat characteristics. Recently, an ROV has been used to identify and describe rockfish habitat in nearshore waters of Southeast Alaska (Scott Johnson, pers. comm. Auke Bay Laboratory).

This project will survey for juvenile and adult rockfish in a variety of nearshore habitats in PWS. Use and stability of nearshore habitats will be key components in the survey. Ten sites will be surveyed in 2001 and 2002 (20 sites total), and at each site, up to 5 different habitat types will be

examined for use by rockfish. Quantity and quality of habitats, along with numbers of rockfish may provide an index that could be used to compare across years and regions, which will be useful in tracking changes specific to regions or caused by climate change. A similar study was initiated by the Auke Bay Laboratory in Southeast Alaska in 1998, and this study is modeled after that study. Long-monitoring in both regions would provide biological response data for rockfish and their habitat over a wide geographical area in Alaska.

NEED FOR PROJECT

A. Statement of Problem

Rockfish were injured by the *Exxon Valdez* oil spill. Some dead rockfish were recovered following the spill, and oil ingestion was the likely cause of death (Exxon Valdez Oil Spill Trustee Council 1999). The original extent of injury to rockfish populations is unknown, however, as is their recovery status. In addition to direct injury from contact with oil, rockfish harvests have increased four-fold due to closures of the commercial salmon and shellfish fisheries following the spill, and harvest rates have remained high in some areas. Over-fishing coupled with environmental damage can have long-lasting detrimental effects on these long-lived fish.

Because of unique life history characteristics, rockfish are unable to sustain high fishing mortality and are slow to recover from environmental disturbance. Pacific rockfish are some of the longest-lived fishes known with maximum ages for many species exceeding 50 years (Archibald et al. 1981; Leaman and Beamish 1984; Love et al. 1990). Many rockfish are not sexually mature until at least age 5 and some species may not mature for 20 years (Wyllie 1987; Love et al. 1990; O'Connell and Fujioka 1991). Because rockfish exhibit extreme longevity, slow growth, and late maturity, depressed stocks often recover very slowly, and even with curtailment of all human use, impacts and rebuilding of depressed or depleted stocks may take many years. Life-history information on juvenile rockfish in Alaska is scarce. Preliminary observations in Southeast Alaska identify eelgrass and other nearshore, vegetated habitats (*Laminaria*) as important rearing areas (Scott Johnson, pers. comm. Auke Bay Laboratory). These nearshore habitats are sensitive to human disturbance and need to be identified in PWS.

Health of many Pacific Coast stocks of rockfish is poor. Some populations may be at risk of extinction unless remedial action is taken now (Musick et al. 2000). For example, Puget Sound, Washington and neighboring Canadian waters have been identified as a "hot spot" where some rockfish stocks are now at risk. Similarly, for the first time in history, much of California will be under a complete rockfish moratorium during the first four months of the year for both sport and commercial fisheries to protect declining rockfish stocks (Ballanti 2000). Increased fishing pressure from more people entering PWS via the new Whittier road is expected to further stress rockfish populations already heavily exploited by sport fisheries. Indirect effects of global warming and the regime shift in the Gulf of Alaska may also influence rockfish abundance by

causing a reduction in available prey sources or by damaging critical habitats. For example, eelgrass is an important indicator of the health of the marine environment and is utilized by rockfish and other important groundfish species in PWS (Dean et al. 2000). Eelgrass habitat has disappeared in many coastal areas of the world. Long-term impacts of global warming caused by climate change may accelerate loss of eelgrass habitat. Possible explanations for the decline in eelgrass include loss of light from increased sedimentation, heavy algal growth from increased nutrient levels, and rising sea levels. Currently, basic information on the quantity and quality of essential habitats (e.g., eelgrass) for rockfish in Alaska is unknown.

B. Rational

Basic life-history information on the complex of rockfish populations in the northern Gulf of Alaska is scarce. Yet, this commercially important species was injured by the spill and recovery of rockfish stocks remains unknown. Linking rockfish assemblages and habitat in PWS would not only aid in determining their recovery after the oil spill, but could also be the start of a program to monitor other factors that may have deleterious effects on rockfish populations. These factors include the regime shift in the Gulf of Alaska, global warming, and increased fishing pressure. Rockfish are difficult to study because adults generally inhabit areas that are difficult to sample with traditional sampling gear and little is know about juvenile habitat. Rockfish have well-developed swim bladders and are subject to embolism, so many do not survive being brought to the surface. An effective way to make *in situ* observations of rockfish and describe their habitat is with an underwater camera. An ROV is a relatively inexpensive method to survey rockfish habitats.

C. Location

The project will be implemented in PWS. A variety of habitat types (e.g., eelgrass meadows, bedrock walls) will be sampled throughout PWS in summer 2001 and 2002. For comparison, similar habitat types will be monitored by the Auke Bay Laboratory throughout Southeast Alaska under a different funding source. The Southeast Alaska study was initiated in 1998. Select sites in PWS and Southeast Alaska could eventually serve as index sites to monitor changes in rockfish populations and habitat resulting from global warming, shoreline development, and human disturbance (e.g., oil spills).

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

We will request survey location information from fisherman in PWS. We will incorporate video footage on the NOAA/ABL website.

PROJECT DESIGN

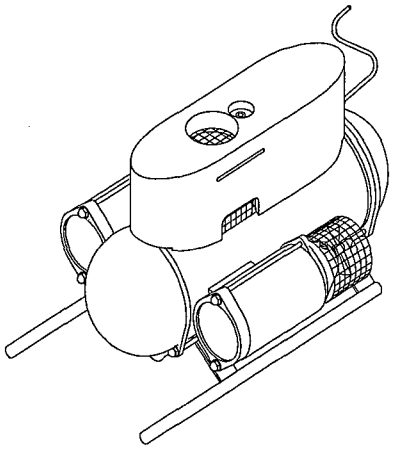
A. Objectives

Identify and describe juvenile and adult rockfish assemblages by habitat type in nearshore waters (<90 m deep) of PWS.

1. Identify nearshore habitats used by juvenile and adult rockfish
    A. Identify habitats where rockfish are seen with the ROV or captured by beach seine (eelgrass, kelp, bedrock wall, etc.)
    B. Describe habitat where rockfish are observed (depth, substrate, salinity, etc.)
2. Determine distribution and relative abundance of juvenile and adult rockfish
    A. Make distribution maps based on observations with ROV and fish captured from seining
    B. Record number of observations by habitat type or catch per seine haul
    C. Describe fish assemblages and behavior (e.g., solitary or in schools, hovering off bottom or in shelter hole)
3. Capture juvenile rockfish in specific habitat types for positive identification
    A. Capture juveniles with seines, gill nets, jigs
    B. Identify juveniles by mtDNA analysis
    C. Contribute rockfish samples to the University of Alaska for genetic archives
4. Measure area and condition of select eelgrass meadows
    A. Measure area with ROV and GPS
    B. Measure stem density, blade length, and biomass

B. Methods

This project is designed to identify and describe rockfish and their habitat via a remotely operated vehicle (ROV) equipped with a video camera. A charter vessel will transport three researchers to several locations in PWS in summer 2001 and 2002. We propose to use a "Video Ray" ROV because of its small size and maneuverability. It weighs only 4 kg, is equipped with a high-resolution video camera, 3 thrusters, 2 lights, and can dive to 80 m. Depth and heading are displayed on a console, and a color monitor and VCR will provide real-time viewing and taping of all underwater operations. The ROV will be deployed directly from a charter vessel or from a small skiff. The Auke Bay Laboratory has experience in operating an ROV and will have a larger model available as a backup while in PWS.



Ten sites will be sampled throughout PWS in 2001 and 2002 (20 sites total). At each site, five habitat types will be surveyed with the ROV: <7 m deep, eelgrass *(Zostera marina)* meadows; <20 m deep, rocky-bottom areas with kelps (*e.g., Macrocystis, Laminaria*); steep, bedrock wall

faces 20–70 m deep; flat, soft-bottom basins 25–70 m deep; and complex bottoms of boulder or broken rock 25–70 m deep. Sample sites will be selected based on previous acoustic sampling, catch data from ADF&G, and images from the charter vessel's depth sounder. Sample sites will be identified with GPS coordinates.

A depth finder aboard the support vessel will aid in locating suitable depths for the ROV and in identifying low- and high-relief areas. In most cases, the ROV will be deployed to the bottom in the deepest water of a particular habitat type and maneuvered upslope to the surface near shore along an approximately straight-line transect. In eelgrass, the ROV will be maneuvered over the top of the eelgrass to avoid clogging thrusters, whereas in kelp canopies, the ROV will be maneuvered in and around the edges to avoid entanglement. Most observations with the ROV will be during daylight hours. Fish assemblages, substrate type (boulder, bedrock, etc.) vegetation type (*Laminaria*, *Zostera*), depth, and slope will be determined by video analysis. A sensor attached to the ROV will provide a temperature profile of all habitat types and we will measure salinity at the surface and 15 m depth with a Van Dorn-style water bottle and refractometer.

If rockfish are observed with the ROV in deep water (>10 m) habitats and cannot be identified (especially juveniles), a sample of fish will be collected by jigging or with a gillnet. A beach seine will be use to sample eelgrass and understory kelp habitats (<10 m deep) to verify ROV observations and to collect a sample of fish for species identification. The seine will be set as a "round haul" by holding one end on the beach and backing around in a skiff with the other end. All seining will be within 2 hours of low tide. Because juvenile rockfish can be difficult to identify, a subsample of juveniles collected from each area will be analyzed for mtDNA for positive identification. By monitoring these sites annually, changes in rockfish species composition, relative abundance, and habitat quality can be monitored. At low tide, eelgrass meadows will be measured for area, and sampled for shoot density, blade length, and biomass as measures of overall eelgrass health.

C. Cooperating agencies, contracts and other agency assistance

A charter vessel will providc a platform for research in PWS. A contract will be awarded to analyze juvenile rockfish mtDNA samples.

SCHEDULE

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

July: Survey rockfish in PWS with ROV and beach seine

August: Begin data analysis

Spring: Complete annual report (FY 01 findings)

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

Winter: Attend Annual Restoration Workshop

Spring: Attend Western Groundfish Conference

July: Survey rockfish in PWS with ROV and beach seine

October: Complete data analysis

A. Measurable tasks for FY 03 (October 1, 2002 - September 30, 2003)

November: Begin final report

April: Submit final report

B. Project Milestones and Endpoints

July 2001: Initiate field study

April 2002: Submit annual report

July 2002: Complete field study

April 2002: Submit final report and incorporate video footage with final report for the NOAA/ABL website

C. Completion Date

Final report will be submitted April 15, 2002
Manuscript will be submitted April 15, 2002

PUBLICATIONS AND REPORTS

Final report Report will include data from 2001 and 2002 from PWS and will include comparisons with southeast Alaska

Peer-reviewed manuscripts: Thedinga J. F. and S. W. Johnson. Distribution and habitat of rockfish in nearshore waters of Prince William Sound, Alaska.

PROFESSIONAL CONFERENCES

No conferences planned in FY 01, Western Groundfish Conference FY 02, Oil Spill Symposium FY 02.

NORMAL AGENCY MANAGEMENT

This project seeks to determine methods to determine the recover status of rock fish through a cooperative relationship between NMFS and the Trustees.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

NMFS will coordinate with the Trustees by providing labor requirements and laboratory overhead. Investigators and agencies will coordinate by sharing data.

PROPOSED PRINCIPAL INVESTIGATOR

Name	John Thedinga
Affiliation	NMFS
Address	Auke Bay Laboratory
	11305 Glacier Hwy
	Juneau, AK 99801
Phone	907-789-6025
Fax	907-789-6094
E-mail	john.thedinga@noaa.gov

PRINCIPAL INVESTIGATOR

GS-12 Fisheries Research Biologist - John F. Thedinga. BS Fisheries and Wildlife Management, University of North Dakota (1975); MS Fisheries Science, University of Alaska (1986). He has been employed by the National Marine Fisheries Service, Auke Bay Laboratory since 1978 specializing in research on the effects of logging on salmon and freshwater habitat. He has been principle investigator and co-investigator on several projects. Recently he was co-investigator of Trustee project 98076 and principal investigator of Trustee project 00163A. He has published over 20 scientific papers. He is experienced in the operation of ROVs.

CO-INVESTIGATORS

GS-12 Fisheries Research Biologist - Scott W. Johnson BS Zoology, San Diego State University (1975); MS Fisheries Science, Humboldt State University (1982). He has been employed by the National Marine Fisheries Service, Auke Bay Laboratory since 1982 specializing in research on the effects of logging, mining, and natural disturbances on salmon and freshwater habitat. He has been principle investigator on several projects and co-investigator of Trustee project 95074. He is currently principal investigator of nearshore habitat studies in Southeast Alaska. He has published over 20 scientific papers. He is experienced in the operation of ROVs.

OTHER KEY PERSONNEL

LITERATURE CITED

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Schumacher, J. 1999. Regime shift theory: A review of changing environmental conditions in the Bering Sea and Eastern North Pacific Ocean. Proceedings of the Fifth North Pacific Rim Fisheries Conference, held 1-3 December 1999, Anchorage, Alaska.

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2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001
Personnel		$24,000.0
Travel		$2,394.0
Contractual		$19,800.0
Commodities		$3,000.0
Equipment		$11,500.0
Subtotal	$0.0	$60,694.0
General Administration		$4,008.5
Project Total	$0.0	$64,702.5
Full-time Equivalents (FTE)		0.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 2002		
			44.9K		

Dollar amounts are shown in thousands of dollars.

Comments:
This project uses a remotely operated vehicle (ROV) equiped with video camera to monitor rockfish populations and their habitats in PWS.

NOAA Contribution: Principal Investigator - John Thedinga 1 mo. @ 8K
Co-PI - Scott Johnson 3 mo. @ 24K,
Jacek Maselko 1 mo. @ 5.2K
Backup ROV, digital video equipment

FY01

Prepared: 4/14/00

Project Number: ~~00~~ 01519
Project Title: Habitat of rockfish in nearshore waters of PWS
Agency: National Oceanic & Atmospheric Administration

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FY 2001
Name	Position Description					
John Thedinga	PI	GS12/4	3.0	8000.0		24,000.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Subtotal			3.0	8000.0	0.0	
					Personnel Total	$24,000.0

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 2001
Description					
Juneau to Anchorage (Restoration Workshop/Thedinga)	444.0	1	3	150.0	894.0
Cordova - field sampling (3 people)	350.0	3	3	150.0	1,500.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2,394.0

FY01

Prepared: 4/14/00

Project Number: 00
Project Title: Habitat of rockfish in nearshore waters of PWS
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed FY 2001
Description	
Vessel charter - PWS (14 days @1200/day)	16,800.0
DNA analysis	3,000.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$19,800.0

Commodities Costs:	Proposed FY 2001
Description	
Power inverter and misc ROV supplies	1,000.0
Video tapes, film	1,000.0
Rov console enclosure	1,000.0
Commodities Total	$3,000.0

FY01

Prepared: 4/14/00

Project Number: 00
Project Title: Habitat of rockfish in nearshore waters of PWS
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Contractual & Commodities DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2001
Video Ray ROV	1	11500.0	11,500.0
			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**	$11,500.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Digital video recorder	1	
Color monitor	1	
Digital camera	1	

FY01

Prepared: 4/14/00

Project Number: 00
Project Title: Habitat of rockfish in nearshore waters of PWS
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Equipment
DETAIL

Project Title: Sea Otter Population Surveys

Project Number:	~~00~~ 01520
Restoration Category:	Monitoring
Proposers:	Jim Bodkin and Angela Doroff
Lead Trustee Agency:	DOI/USGS
Cooperating Agencies:	
Alaska Sea Life Center:	No
Project Duration:	1st year, 2-year project
Cost FY 01	$41.6
Cost FY 02	$54.4
Geographic Area:	Kodiak, Kenai Peninsula
Injured Resource/Service:	Sea otter

ABSTRACT

The current status of sea otter populations affected by the Exxon Valdez oil spill (EVOS) outside Prince William Sound are unknown. Although sea otter oiling and mortality was widespread along the Kenai Peninsula and Kodiak Archipelago, only one sea otter survey has been conducted in this area since 1990 (USFWS unpub. data). Moreover, large-scale declines in sea otter populations across the north Pacific have been observed in recent years. It has been proposed that the Aleutian sea otter decline can be traced back to large scale oceanic process that ultimately linked the offshore and nearshore marine ecosystems (Estes et al. 1998). The declines in sea otters may be a result of predation by killer whales (*Orcinus orca*), in response to declines in other pinniped species in the Bering Sea and Gulf of Alaska. The geographic extent of the decline in otter populations is unknown, however, large declines in Steller sea lions (*Eumatopias jubatus)* and harbor seals *(Phoca vitulina*) are reported east to at least Prince William Sound. If the decline in sea otters is related to pinniped declines through prey switching, the phenomenon may extend into the spill area. Previous research supported by the EVOS trustee council resulted in the design, testing and implementation of cost effective aerial survey method for sea otters that is both accurate and precise (Bodkin and Udevitz 1999). This method has been

employed in Prince William Sound since 1993. While, the statistical power to detect change with this survey method is good (e.g. we are currently detecting significant population trends of less than .04 annually in PWS, power > 0.80 at alpha = .05) the immediate value of the proposed surveys will be in providing current baseline data within the spill area and delineating the geographic and numerical magnitude of the sea otter decline observed elsewhere in the north Pacific. We propose to conduct aerial surveys of the Kenai Peninsula and Kodiak Archipelago during fiscal years 2001and 2002. Costs of surveys will be shared with USGS and USFWS.

INTRODUCTION

Perhaps the major factor contributing to our lack of understanding about the effects of the Exxon Valdez oil spill (EVOS) was the lack of baseline pre-spill data. Little has been done to remedy this situation outside of Prince William Sound for what might arguably be considered the most exemplar of EVOS injured resources, the sea otter (*Enhydra lutris).* This "data gap" continues to constrain our ability to understand ecosystem change as well as identify the recovery of injured resources outside Prince William Sound .

Sea otters, a conspicuous casualty of the spill, inhabit shorelines throughout the entire spill area, including Prince William Sound, the Kenai Peninsula and Kodiak Archipelago. Further, seas otters are recognized as a "keystone species" in nearshore communities, playing an important role in ecosystem function (Power et al. 1996). Although surveys of sea otters are conducted regularly in Prince William Sound, no EVOS Trustee Council (EVOSTC) support has gone toward estimating sea otter population size outside Prince William Sound.

In the decade since the spill, there has been a dramatic decline in sea otter abundance in the western and central Aleutian Islands. The geographic extent of the decline is unknown. The series of events leading to the otter decline began with large-scale oceanic changes in the north Pacific/Bering sea that ultimately led to reductions in Steller sea lions (*Eumatopias jubatus*) and harbor seals (*Phoca vitulina).* Both species are principal food items of killer whales *(Orcinus orca).* In response to the decline in pinnipeds, it is possible that killer whale predation has shifted to sea otters. Since the pinniped decline extends to Kodiak and Prince William Sound, it is conceivable that Killer whale predation on sea otters may extend into the spill area. The effect of reduced otter densities in the Aleutians include a shift from an algal dominated, to an herbivore

dominated nearshore ecosystem, with potentially profound cascading effects throughout the system, including a variety of nearshore fishes, birds and mammals.

In the absence of data on the distribution and abundance of sea otter populations outside Prince William Sound, we are neither prepared for another EVOS-like event, nor able to interpret the potential cascading effects of large-scale ecological events. We propose to survey sea otters in the Kodiak Archipelago and Kenai Peninsula over a two-year period, using an aerial survey method developed with EVOSTC support. The survey results will provide baseline data on sea otter population distribution and abundance as well as provide an evaluation of the geographic extent of the decline in otter populations observed in the Aleutian Islands. The cost of the surveys will be shared among the EVOSTC, USGS and USFWS.

NEED FOR THE PROJECT

A. Statement of Problem

Sea otter populations in Prince William Sound and the Gulf of Alaska were injured as a result of the EVOS (Ballachey et al 1994), with nearly 400 carcasses recovered from the Kenai and Kodiak areas. Bodkin and Udevitz (1994) estimated the mortality of sea otters along the Kenai coast may have ranged from 494 to 706 otters. While extensive surveys of sea otter populations in Prince William Sound have been completed annually since 1993, the current status of Kenai Peninsula and Kodiak Archipelago sea otter populations are unknown.

The Kenai Peninsula was last surveyed in 1989, using line and strip protocols from a helicopter (DeGange et al. 1994). The area surveyed included 2,423 km of shoreline from Cape Puget to Anchor Pt. and included coastal and offshore sampling to the 50m

isobath. Population estimates were adjusted for group size bias and detection bias. Detection bias was estimated by comparing strip counts to "hover" counts, compensating for animals not detected on strip counts. Estimates of abundance were 2,330 (se=279) and 2,146 (se=194) for the spring and fall of 1989 respectively. No prior or subsequent estimates of sea otter abundance are available for the Kenai Peninsula.

The Kodiak Archipelago was also surveyed in 1989 using the same helicopter method used along the Kenai Peninsula. The area included 2,960 km of shore line north of Rocky Pt. and the Buskin River. Group size and detection bias were estimated as in the Kenai Peninsula survey. The estimated Kodiak sea otter population size in October 1989 was 13,526 (se= 1,199). In 1994 Kodiak was again surveyed, using the fixed-wing method developed by Bodkin and Udevitz (1999). Although the two surveys used different methodologies, both estimates are corrected for undetected otters, and are therefore comparable. The estimated Kodiak sea otter population size in July 1994 was 9,738 (se= 2,615), which represents a decline of nearly 3,800 animals, at a rate of 7%/year. The cause of the decline at Kodiak is unknown, but is similar in magnitude and in the temporal scale to the decline observed in the central and western Aleutians.

In summary, estimating the distribution and abundance of sea otter populations along the Kenai and Kodiak coasts will be valuable in (1) providing baseline data on the current distribution and abundance of sea otters in areas of the spill where sea otter mortality occurred, (2) contributing to long-term population trend data which may be used in assessing initial damage and subsequent recovery of sea otter populations in the event of future oil spills, and (3) provide information on the geographic extent of a decline in sea otter populations in the spill area that may be independent of spill-related processes, but of importance to the state of the north Pacific/Bering sea ecosystem.

B. Rationale/Link to Restoration

Determination of sea otter restoration and recovery requires assessment of population status. Current data from spill-impacted areas outside Prince William Sound is 6-10 years old and other large-scale processes may be affecting sea otter populations in the spill area. Survey results from Kodiak in 1989 and 1994 suggest a significant decline. While the cause of the decline is unknown it may be linked to other large-scale processes in the north Pacific and may be independent of the EVOS. The proposed work will identify the direction and magnitude of change in sea otter populations and may allow evaluation of the relatedness of potential changes to events other than EVOS.

C. Location

Surveys will be conducted at the Kenai Peninsula and Kodiak Archipelago. Specific areas will be those used in previous surveys that may be modified to include known or anticipated changes in otter distribution.

Communities affected by the project include Seward, Homer, Port Graham, English Bay. Seldovia, Old Harbor and Kodiak.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The project will continue to inform and coordinate our community involvement activities, including the collection of indigenous knowledge with Dr. Henry Huntington, TEK specialist Chugach Regional Resources Commission and Hugh Short, Community Coordinator, EVOS Restoration Office. We will continue to solicit advice from the above parties and gather information on TEK through local community facilitators, and residents.

Efforts will be made to participate in and provide public involvement in the design and implementation of this project. Information gathered from this project will be shared with local communities. Project staff has and will continue to present information to local communities or prepare articles or photographs for Trustee Council publications. Boat and air charter contracts, and other services will be contracted from local sources when possible.

PROJECT DESIGN

A. Objectives

Provide current, unbiased estimates of sea otter abundance along the coasts of the Kenai Peninsula and the Kodiak Archipelago.

B. Methods

We will use previously developed aerial survey techniques which employ counts along systematic transects, and intensive search units (ISU's) to estimate a correction factor for each survey (Bodkin and Udevitz, 1999). We will conduct a single survey of the entire Kodiak Archipelago in the year 2000, and the Kenai Peninsula in 2001.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

USGS personnel, led by Jim Bodkin, will be responsible for conducting the Kenai Peninsula aerial survey in 2001, analyzing survey data and preparing annual reports.

USFWS personnel, led by Angela Doroff, will be responsible for conducting the Kodiak aerial survey in 2002, analyzing survey data and preparing annual reports.

SCHEDULE

A. Measurable Project Tasks for FY 01

Sea Otters

June - August	Sea otter aerial survey, Kenai Peninsula (conducted by USGS)

B. Project Milestones and Endpoints

FY01

December-March:	Coordinate and plan surveys, community involvement, prepare equipment.
June-August:	Conduct aerial sea otter surveys.
September-Nov:	Data analysis and report preparation. Coordinate with local communities.

This is a projected two year monitoring program designed to assess the recovery and status of an injured species. The FY01 survey of the Kenai Peninsula will be conducted by USGS, the FY 2002 survey will be conducted by the USFWS. At the end of each year results will be compared with prior population estimates and evaluated in terms of the restoration goals to assess if and how sea otter populations have changed since their previous survey.

C. Completion Date

All project objectives will be met following FY02. The project may be terminated prior to FY02 if restoration guidelines for sea otters are met.

PUBLICATIONS AND REPORTS

Annual reports will be presented to the Chief Scientist by April 15 the following year. A final report will be prepared at the end of the proposed schedule unless continued monitoring is warranted or when recovery objectives are met. Special reports (publications) will be prepared during the course of the study if warranted. Publications will be prepared for peer-review journals when sufficient data has been collected to satisfy manuscript preparation. Journal publications will not be generated until after the project is completed.

PROFESSIONAL CONFERENCES

None in FY01.

NORMAL AGENCY MANAGEMENT

While sea otter population monitoring is a responsibility of the USFWS Marine Mammals Management Office, the proposed areas are not considered high priority at this time. The Aleutian Islands and Southeast Alaska, which has never been systematically surveyed for sea otters, are the two most important survey areas for the USFWS. Given the reality of flat-funded budgets, it is unlikely that the Kenai Peninsula and Kodiak

Archipelago would be surveyed for at least 5-10 years unless the work can be cooperatively funded between USGS, USFWS and the EVOSTC.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

As described in the Introduction, this research relies on methods from other Trustee sponsored research, including project /043. Equipment purchased under this project will be used to conduct the proposed research and data collection and analysis will follow previously established protocols and standards.

EXPLANATION OF CHANGES IN CONTINUED PROJECTS

None, this is a new proposal

PROPOSED PRINCIPAL INVESTIGATORS

James Bodkin
Alaska Biological Science Center
USGS-Biological Resources Division
1011 E. Tudor Rd.
Anchorage, Alaska 99503
PHONE: (907) 786-3550
FAX: (907) 786-3636
james_bodkin@usgs.gov

Angela Doroff
U.S. Fish and Wildlife Service
Marine Mammals Management
1011 E. Tudor Rd.
Anchorage, Alaska 99503
PHONE: (907) 786-3803
FAX: (907) 786-3801
angela_doroff@fws.gov

PERSONNEL QUALIFICATIONS

Jim Bodkin, Research Wildlife Biologist, and team leader for coastal ecosystem research in Alaska for the Alaska Science Center of USGS, Biological Resources Division. He has over 25 peer-reviewed scientific publications and directs an active coastal marine research program. He has studied and published on sea otter foraging ecology and community structuring since 1988 and has been principal investigator for sea otter survey methods development. Mr. Bodkin was a co-principal investigator for the Nearshore Vertebrate Predator Project (NVP), and continues to examining the recovery of sea otters.

Angela Doroff, Wildlife Biologist on the sea otter program in the Marine Mammals Management office. She has over 10 years of experience working in Alaska on a variety of sea otter projects including, population surveys, forage ecology, and demographic studies and over 9 peer-reviewed scientific publications. Ms. Doroff is currently co-leading the sea otter program for the Marine Mammals Management Office.

LITERATURE CITED

Ballachey, B.E., J.L. Bodkin and A.R. DeGange. 1994. An overview of sea otter studies. *in* T. Loughlin editor. Marine mammals and the Exxon Valdez. Academic Press. San Diego, CA pages 47-59.

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Bodkin, J. L. and M.S. Udevitz. In press. Status of attempts to estimate population trends of sea otters. Symposium on Surveys, Status and Trends of Marine Mammal Populations. 25-27 February 1998, Seattle WA.

DeGange, A.R., D.C. Douglas, D.H. Monson and C. Robbins. 1994. Surveys of sea otters in the Gulf of Alaska in response to effects of the Exxon Valdez oil spill. Final report, marine mammal study #6. Exxon Valdez Oil Spill Restoration Office. Anchorage, AK.

Estes, J. A. , M. T. Tinker, T. M. Williams, and D. F. Doak. 1998. Killer whale predation on sea otters linking oceanic and nearshore ecosystems. Science 282: 473-476.

Power, M.E., D. Tilman, J.A. Estes, B.A. Menge, W.J. Bond, L.S. Mills, G. Daily, J.C. Castilla, J. Lubchenco, and R.T. Paine. 1996. Challenges in the quest for keystones. Bioscience A6:609-620.

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001						
Personnel		$16.5						
Travel		$2.3						
Contractual		$17.6						
Commodities		$1.0						
Equipment		$0.5	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$37.9			Estimated FY 2002	Estimated FY 2003		
General Administration		$3.7						
Project Total	$0.0	$41.6			$54.4			
Full-time Equivalents (FTE)		0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY01

Prepared: 4/13/00

Project Number: 01520
Project Title: Sea otter population surveys
Agency: DOI -- USGS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FY 2000
Name	Position Description					
J Bodkin	Research Wildlife Biologist	GS-13/4	1.0	7.2		7.2
G.Esslinger	Zoologist	GS 9/2	1.5	6.2		9.3
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.5	13.4	0.0	
					Personnel Total	$16.5

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 2000
Description					
					0.0
Anch/Seward/Anch	0.3	1	20	0.1	2.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.3

FY01

Prepared: 4/13/00

Project Number:
Project Title: Sea otter population surveys
Agency: DOI-- USGS

FORM 3B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:		Proposed FY 2000
Description		
80 hrs aircraft charter @ 220.00/hr		17.6
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$17.6

Commodities Costs:		Proposed FY 2000
Description		
Aircraft tie-down time		1.0
	Commodities Total	$1.0

FY01

Prepared: 4/13/00

Project Number:
Project Title: Sea otter population surveys
Agency: DOI-- USGS

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2000
safety equiopment			0.5
			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**	$0.5

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

FY01

Prepared: 4/13/00

Project Number:
Project Title: Sea otter population surveys
Agency: DOI-- USGS

FORM 3B
Equipment
DETAIL

Growth Rates of Cutthroat Trout and Dolly Varden in Prince William Sound, Alaska: Comparison of Populations in Oiled and Unoiled Sites with Similar Geographic Features

Project Number: 01_522

Restoration Category: Monitoring and Research

Proposer: USFS, Pacific Northwest Research Station

Lead Trustee Agency: USFS

Cooperating Agencies: Dept. of Fisheries and Wildlife, Oregon State University

Duration: 3 years

Cost FY 01: $76.9

Cost FY 02: $181.9

Cost FY 03: $139.6

Geographic Area: Prince William Sound

Injured Resource/Service: Dolly Varden
Cutthroat Trout

ABSTRACT

Dolly Varden and cutthroat trout are listed as injured resources whose recovery is unknown. They were originally listed as injured because studies following the oil spilled found that growth rates of populations in oiled areas were less than those of populations in unoiled areas. We are proposing to examine growth rates of populations in oiled and unoiled areas by comparing sites with similar geographic features. Results from this study will determine the status of these species.

INTRODUCTION

Dolly Varden (*Salvelinus malma*) and cutthroat trout (*Oncorhynchus clarki clarki*) are important fish resources in Prince William Sound and are listed as injured resources whose recovery is unknown. These species were believed to be negatively impacted by the oil spill based on differences in growth rates between fish from oiled and unoiled sites. Recovery is assumed to occur when growth rates in oiled and unoiled areas, after considering geographic differences, are similar. Results from our proposed work on comparison of growth rates will help determine if these species have recovered.

NEED FOR THE PROJECT

A. Statement of Problem

Dolly Varden and cutthroat trout are important ecological and recreational resources in Prince William Sound. Populations of resident (i.e., remain in freshwater) and anadromous (i.e., sea-going) forms of each species are found throughout Prince William Sound (Mills 1988). Anadromous individuals spend varying amounts of time in freshwater (up to 4 years) before going to the marine environment (Scott and Crossman 1979). There, both species feed in nearshore and estuary areas (Scott and Crossman 1979, Morrow 1980). Dolly Varden feed on crustaceans, small invertebrates, and fish (Armstrong 1971) and cutthroat feed on fish (Narver and Dahlberg 1965).

Areas used by these fish were impacted by petrogenic hydrocarbons from the *Exxon Valdez* oil spill. Benthic organisms in nearshore areas are particularly susceptible to petrogenic hydrocarbons (Teal and Howarth 1984). In Prince William Sound, the size of epifauna and numbers of amphipods, which are food sources for Dolly Varden, decreased in areas exposed to the spill (Jewett and Dean 1993, Jewett et al.1993). Hepler et al. (1993) found that Dolly Varden and cutthroat trout populations in oiled areas had slower growth rates compared to populations in unoiled streams from 1989 to 1990, the year of the spill. A similar pattern was observed for cutthroat trout in 1990 to 1991. However, growth rates of Dolly Varden in oiled areas did not differ from those in unoiled areas during that period (Hepler et al. 1993). Survival rates for each species from 1989 to 1990 were less in oil impacted areas than in unimpacted areas (Hepler et al. 1993). Hepler et al. (1993) hypothesized that chronic starvation and/or direct exposure to petrogenic hydrocarbons were responsible for the differences in growth and survival of the species in oiled and unoiled areas. The *Exxon Valdez* Oil Spill (EVOS) Trustee Council officially lists these species as injured resources whose recovery is unknown.

B. Rationale/Link to Restoration

Reduced growth and survival rates could have long-term impacts on populations of Dolly Varden and cutthroat trout in areas exposed to oil. These species may live up to 8 years (Morrow 1980) and the expected persistence of oil in the nearshore environment (Lee et al.

1979) suggests the potential exists for long-term impacts to these species. Decreased survival would have obvious population implications. The extent would depend on population size; smaller populations would be most susceptible to eventual extinction (Rieman et al. 1993). There may be less obvious impacts also. Potential for loss of genetic variability, which is needed for long-term adaptation, increases as population size decreases (Nelson and Soule 1987). Reduced growth rates of individuals can lead to increased susceptibility to mortality and decreased reproductive potential (Adams 1990). If any of these impacts were to occur for extended periods, even at low levels, affected populations would face increased probability of extinction.

Initial assessments of the oil spill effects suggested that Dolly Varden and cutthroat trout populations in oiled areas were negatively affected. Original damage determinations were made by comparing populations in unoiled sites at Makaka Creek and Boswell Bay (Hithchenbrook Island) in eastern PWS with populations in oiled areas at Rocky Bay (Montegue Island), Green Island, and Eschamy Bay. The latter two are in western PWS. Hepler et al. (1993) found that populations of both fish in oiled areas had slower growth rates from 1989 to 1990 than populations in unoiled areas. Similar results were found for cutthroat trout from 1990 to 1991 (Hepler et al. 1993). Growth rates of Dolly Varden were similar during the same period, however. No formal studies of growth have been conducted since then.

The general criteria for recovery was that growth rates of each species in oiled areas will be the same as that in unoiled areas. Recently, the criteria were amended so that variation related to geographic differences among areas must be considered.

We collected Dolly Varden and cutthroat trout in FY 96 and 97 from sites throughout PWS as part of Project 98145, which is examining relations among populations of these species. We have made some preliminary examinations of otoliths from cutthroat trout in unoiled sites in different parts of PWS to determine growth rates. We compared growth rates of fish from eastern PWS with those of fish from western PWS (Fig. 1). Slopes of the relation between size and age are different for the two areas. Fish from eastern PWS grow at a faster rate than those from western PWS. A closer examination of fish from comparable sites is shown in Fig. 2. Fish from Milton Lake (eastern PWS) were consistently larger at a given age compared to fish from Unakwik Inlet (western PWS). These preliminary results suggest that conditions for growth are better in eastern PWS and simply comparing growth rates of populations in oiled and unoiled sites may not be appropriate.

Determination of growth rates was not an objective of the original proposal for Project 98145. We initiated examination of growth rates after working in PWS for two summers (FY 96 and 97). We observed wide variation in conditions across PWS that believed that this could influence growth rates. Eastern PWS has more well-developed intertidal areas than western PWS. Intertidal areas in eastern PWS are also shallower and more extensive than those in western PWS. Environmental conditions that influence growth appear to be more favorable in eastern PWS. The growing season in western PWS is 4-6 weeks shorter than that in eastern PWS (K. Holbrook, US Forest Service, Anchorage, AK). Air temperatures are also cooler in

western PWS.

These results are preliminary and should not be construed that growth rates are actually different between eastern and western PWS. These data have limitations. A primary one is that we did not have individuals from all age/size classes in a population. Project 98145 focused collection efforts in intertidal areas and lower portions of watersheds. Consequently, few small, younger-aged fish were collected. A valid comparison of growth rates must include all age-classes.

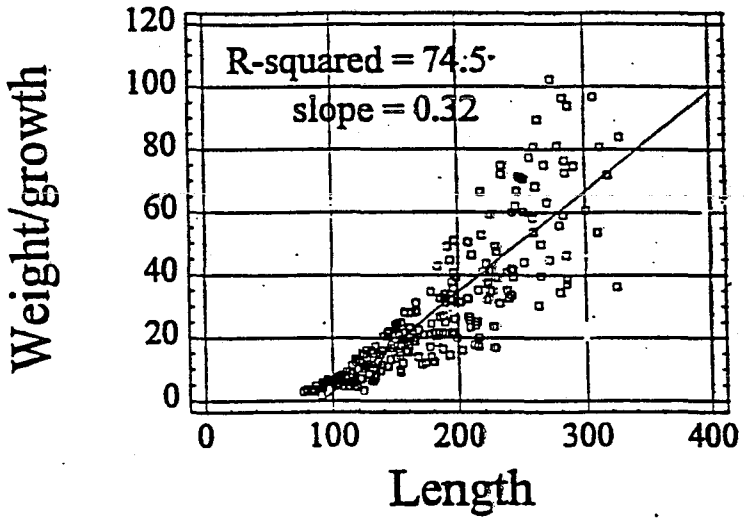
C. Location

This study will examine sites located throughout Prince William Sound. Benefits should be realized in communities throughout the Prince William Sound.

COMMUNITY INVOLVEMENT

We quartered out of Cordova, AK for field collections in Project 98145 and will continue to do so for this study. Cordova provided a central location from which to access study sites, had good facilities, and allowed us access to additional field equipment and persons with knowledge of streams in Prince William Sound. We will continue to communicate with people in Cordova on an individual basis about our work and will make presentations on results when they become available. We will charter planes and boats for transport to field locations, secure lodging, and purchase food and other supplies in Cordova during the study if the proposal is funded.

A. Prince William Sound- Eastside



B. Prince William Sound- Westside

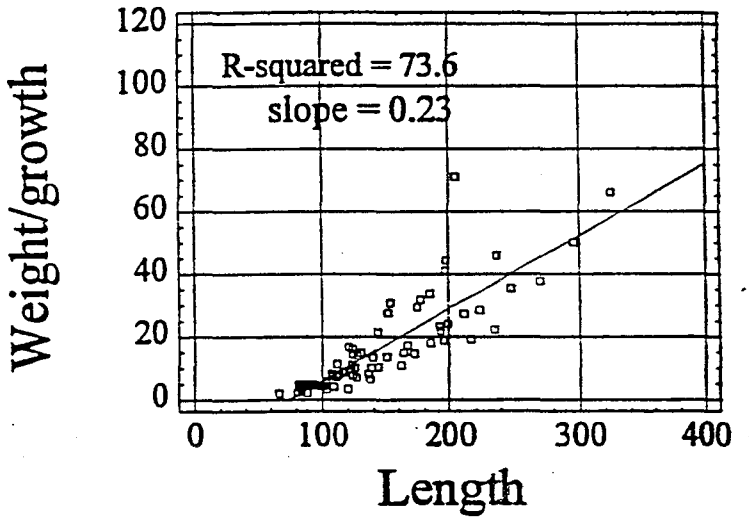


Fig. 1. Estimated growth rates of cutthroat trout from unoiled sites in eastern (A) and western (B) Prince William Sound. Growth rates are from otoliths. Fish were collected in FY 96 as part of Project 97145.

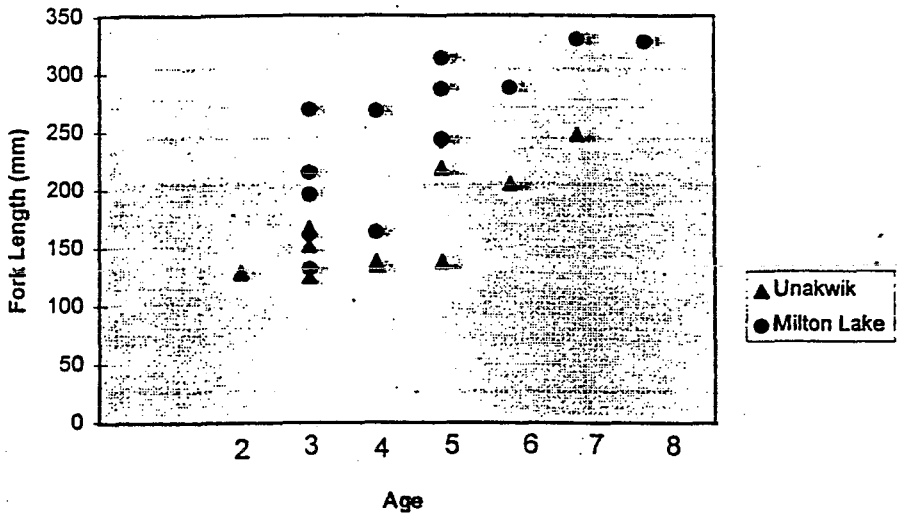


Fig. 2. Comparison of estimated size at age of cutthroat trout from Milton Lake (eastern Prince William Sound) and Unakwik Inlet (western Prince William Sound). Both sites are unoiled. Growth rates are from otoliths. Fish were collected in FY 96 as part of Project 98145.

PROJECT DESIGN

A. Objectives

The objective of this proposed study is to:

1. Determine growth rates of Dolly Varden and cutthroat trout in oiled and unoiled areas with similar geographic features based on analysis of otoliths.

We will test the following hypotheses:

1. Populations of each species from oiled and unoiled areas with similar geographic features have similar growth rates.

B. Methods

In order to distinguish between differential and equal growth rates in fish from "oiled" and "un-oiled" areas, it is necessary to distinguish 1) marine growth from freshwater growth and 2) to be able to measure growth over a standard time interval. Our approach is to use sagittal otoliths as an internal "record collector" of an individual's prior environmental history and its prior growth rate.

Marine growth

Elemental concentrations in otoliths have been shown to vary with numerous environmental variables including temperature (Radtke, 1989; Townsend et al., 1995), salinity (Secor et al., 1995), water chemistry (Mugiya et al., 1991) and significant life history events such as the migration from freshwater to marine environments (et al., 1996; Secor and Piccoli, 1996). Elemental concentrations also vary with ontogenetic variables such as size or age (Edmonds et al., 1992; Hoff and Fuiman, 1993; Campana and Gagne, 1994) and growth rate (Kalish, 1989; Sadovy and Severin, 1992, 1994). In addition, genotype may influence elemental concentrations, as levels at the otolith core can differ between fish from distinct geographic regions (Campana and Gagne, 1994; Thresher et al., 1994) or between anadromous and resident salmonids (Kalish, 1990). These studies suggest that in general:

$$C_{oncentration} = E_{nvironment} + O_{ntogeny} + G_{enotype} + \mathbf{0}_{rror},$$

that is, the concentration of an element in the otolith is dependent upon the combined influences of environment, ontogeny, genotype, and error. The relative importance of these four factors is likely to vary among elements and among species. Because several factors may influence otolith composition, interpretation of natural variation can be difficult.

Natural variation in element concentrations has been interpreted primarily in two ways. Variation along a transect from otolith core to margin has been interpreted as a record of environmental experience in temperature (Radtke et al. 1989; Townsend et al. 1995) and salinity (Radtke et al. 1996; Secor and Piccoli, 1996). Differences among individuals have been used to infer stock or population structure (Mulligan et al., 1987; Edmonds et al., 1989, 1992; Campana and Gagne, 1994; Campana et al., 1994). Because this study also includes a measure of genetic relatedness (see

above), as well as age, transect variation in otolith composition could be a useful approach for studying movements of migratory anadromous salmonids.

We propose to compare natural variation in element concentration with age, genetics (stock origin) and environmental conditions at time of capture. We assume that otolith element concentrations at the edge of the otolith were deposited under the environmental conditions at capture and that the correlation of core concentrations to edge concentrations reflects the individual's inherent physiological/genetic bias to deposit that element. Consequently, it will be important to 1) sample individuals in different habitats, 2) establish relative changes within an individual and 3) to corroborate signals with other evidence such as genetics and age information. Although we expect strontium to be the best indicator of marine residence (Kalish, 1990), our study will independently demonstrate which elements are good indicators of marine residence. Transects across the otolith will then help reconstruct a picture of marine and freshwater residence of an individual.

Growth and age

If successful, otolith element concentration can distinguish the relative proportion of the otolith produced in freshwater from that produced in salt water. In general, faster growing fish produce larger rings, but body growth does not necessarily show a linear relationship with otolith growth (Mosegaard et al. 1988, Bradford and Geen, 1992). For this study, we must be able to partition growth as well as time. We need to know 1) how long a fish has been in the marine environment and 2) how well it grew. For this study we will compare "oiled" and "un-oiled" fish hierarchically. Genetically similar fish (same stock) of the same age found in both areas constitute the most powerful comparison, followed by similar age/ different stocks and different age/similar stocks, followed by all fish combined. We will assume that sub-annular marks are non-randomly deposited and the number of sub-annular marks measures time in the marine environment. Differential growth in the "oiled" and "un-oiled" areas will be measured as otolith dimension (radius or area) produced in saltwater normalized by time in salt water.

Proposed Work Plan

Growth documentation: Samples must be collected in fresh water and in salt water. In both cases the timing of collections should be such that specimens collected are likely to have been in the habitat for several months. Saltwater collections will be made in July, 1999 and freshwater in September, 1999. A minimum of 50-60 specimens per site per year will be collected for this purpose and "edge analysis" of otolith microchemistry will be used to evaluate the concordance of otolith chemical signals and habitat at capture. Specimens will be approximately half adults and half juveniles.

Differential growth: Microchemistry transect analyses will be used to identify the most recent portion of the otolith that was deposited in a marine environment. We will assume that fish in the "oiled" area did not spend time in the "un-oiled" area. Differential growth will be evaluated as time normalized otolith growth in the marine environment. We will make paired comparisons of each oiled site (e.g., Bay of Isles (Knight Island), Green Island, and Eschamy Bay) with a nearby unoiled site. We will also determine growth rates from unoiled sites in eastern PWS that were used as

controls in the initial assessment by ADFG.

Study limitations

Unvalidated time measurement. We assume that sub-annular marks are deposited non-randomly and have a temporal component. If there is individual variation in deposition rate and if there is a bias with that variation and presence in "oiled" or "un-oiled" areas, our results will be spurious. We expect to find individual variation but we do not expect to find that variation correlated with marine habitat.

Spurious environmental correlation. Otolith size - fish size relationships have an important temperature component (Mosegaard et al, 1988). If temperature regimes in "oiled" and "un-oiled" areas differ significantly, the metabolic signal associated with higher temperature in otolith deposition will mask growth differences.

Prior to initiation of the study it is not possible to determine the level of differences we might be able to detect. Small effects of 5-10% are unlikely to be detected whereas order of magnitude effects are highly likely to be detected.

Possible Additional Analysis

We will explore the possibility of using RNA/DNA ratios in the white muscle tissue to determine the instantaneous growth rates of cutthroat trout and of Dolly Varden. Growth is directly related to the RNA/DNA ratio. Grant (1996) used a fluorescence technique developed by Clemmensen (1993) to determine the RNA/DNA ratio and the growth rate of brown trout (*Salmo trutta*). G. Reeves is determining potential of using this technique in a on-going study on of the influence of salmon carcasses on the growth rate of juvenile coho salmon (*O. kisutch*) in beaver ponds on the Copper River Delta. Initial results are encouraging.

Use of the RNA/DNA ratio would have several benefits. First, it would allow the estimation of instantaneous growth rates, which are reflective of the suitability of the immediate or recent environment in which a fish is found. This would provide valuable insight into the environmental conditions and complement findings from the otolith work. Fish do not have to be sacrificed to collect the muscle tissue required for this analysis. Consequently, a larger sample can be potentially collected than will be done for the otolith.

While use of the RNA/DNA ratios appears promising, it has not always worked successfully. Much work is required to establish standards for determining the RNA and DNA levels. Samples are easily contaminated from a number of sources making it difficult to insure purity of standards and samples, especially for RNA. RNA can be inherently unstable making it difficult to get accurate measures of the true amount of RNA (F. Allendorf, pers. comm.).

If this proposal is funded, we will collect samples of cutthroat trout and of Dolly Varden in some oiled and unoiled areas of PWS in the July or September, 2000 and do some preliminary analysis on

them. If results are favorable, we would expect to be able to use existing funds to do the work in FY02 by diverting money designated for otolith analysis to RNA/DNA ratios.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

We will develop a cooperative agreement with the Dept. of Fisheries and Wildlife, Oregon State University (OSU), Corvallis, OR to complete growth analysis. We will pursue this avenue to save overhead costs. If the EVOS Trustee Council were to contract the grant directly to the university, overhead would be approximately 40%. The USFS has a cooperative agreement with the university that charges 8% for overhead. The growth laboratory at OSU has been involved in numerous studies involving a variety of salmonids for more several years.

We will need to obtain a permit from ADFG to collect fish if the growth proposal is funded. Scientific studies of a limited nature, such as this one, can be exempted from NEPA requirements. We will pursue this exemption by filing a Categorical Exclusion. This document will be prepared by the USFS, Cordova District in FY00, as they did in FY96-98 for Project \145.

SCHEDULE

A. Measurable Project Tasks for FY 00 (October 1, 2000 - September 30, 2001)

October 2000:	Develop cooperative agreement with OSU
November - December 2000:	Identification of potential field sites Application for collection permit from ADFG
March 2001:	Secure charter vessel for field sampling Assemble required field gear and ship to Cordova
March - June 2001:	Preliminary analysis of otolith from previously collected fish Development of analysis protocols
July 2001:	Collection of cutthroat adults in saltwater and juveniles in freshwater
August 2001:	Initiate analysis of fish collected in July
September 2001:	Collect samples of Dolly Varden adults in freshwater Prepare progress report

B. Project Milestones and Endpoints

Major tasks and dates over the projected duration of the study are as follows:

July and September 2001:	Collect samples
March 2002:	Report Initial Analysis
July and September 2002:	Collect second year samples
May 2003:	Present preliminary results
September 2003:	Present final results and report Submit papers on results to peer-reviewed journals

C. Completion Date

This project is scheduled to be completed in FY03. At that time, we will provide information on the growth rates of each species and determine if recovery has occurred.

PUBLICATIONS AND REPORTS

It is unlikely that we will be preparing or submitting any manuscripts to peer-reviewed journals until the study is completed in FY03.

PROFESSIONAL CONFERENCES

Because data collection and analysis will be incomplete, we do not plan to make any presentations on results from the study until FY02.

NORMAL AGENCY MANAGEMENT

Determination of growth rates of fish is generally not required by statute or regulation for management responsibilities of the USDA Forest Service. Consequently, the agency does not normally fund this type of research, even though it may be valuable in planning and development of management programs. For this study, the USFS is contributing the salary of one of the principal investigators (G. H. Reeves), and assistance with lab work.

There will be no additional injury to Dolly Varden and cutthroat trout populations from the oil spill itself if this study is not funded. However, the status of these species is currently unknown. This study will provide that information. While this project has application in applied and basic science arenas, it is not clear what agency or organization would be interested in funding this project or one like it in the near future.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

We will coordinate with ADFG and USFS to identify sampling sites and will review the sites before sampling begins in FY00 to insure that we do not impose unnecessary damage on any population. We had arrangements with the USFS, Cordova Ranger District, for use of boats and other equipment in Project \145 and expect that would happen with this study. We are not aware of any comparable study that ADFG has or plans at present.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This is a new proposal that has grown out of Project 98145.

PROPOSED PRINCIPAL INVESTIGATORS

Gordon H. Reeves
USFS Pacific Northwest Research Station
Corvallis, OR 97331
541-750-7314
541-750-7329
reevesg@fsl.orst.edu

Douglas F. Markle
Dept. of Fisheries and Wildlife
Oregon State University
Corvallis, OR 97331

541-737-1970
541-737-3590

PERSONNEL

The core personnel for this proposal are eminently qualified to implement this project. Gordon H. Reeves, Co-principal Investigator, is a research fish biologist with the USFS, Pacific Northwest Research Station, Corvallis, OR. He has been in that capacity for 10 years and has worked on anadromous salmonids research in streams throughout the Pacific Northwest and southeast Alaska. He has been involved with the development of conservation and restoration for anadromous salmonids in the Pacific Northwest. He is currently directing a study that is determining the relation of coastal cutthroat trout populations throughout their distributional range. He has published several articles on the ecology of anadromous salmonids and their freshwater habitat in peer-reviewed journals.

Douglas F. Markle, would be the Co-principal Investigator. Dr. Markle is currently a professor in

the Dept. of Fisheries and Wildlife, Oregon State University. He has been involved with numerous studies of life histories and growth of a wide variety of marine and freshwater fishes. He has done some the most cutting-edge work on otolith and growth and has published several articles on the subject. He will supervise the growth comparison objective of this study.

Brief resumes for each of these individuals follow.

GORDON H. REEVES
USDA Forest Service, Pacific Northwest Research Station, Oregon State University, Corvallis, OR 97331.

Education:
B.A. - Biology, State University of New York, Oswego. 1973.
M.S. - Fisheries Science, Humboldt State University. 1978.
Ph.D. - Fisheries Science, Oregon State University. 1985.

Experience:
Assistant Professor, Department of Fisheries and Wildlife, Oregon State University. 1987 to present.
Courtesy Assistant Professor, Department of Fisheries. Humboldt State University. 1986 to present.
Research Fishery Biologist, USDA Forest Service, Pacific Northwest Forest and Range Experiment Station. 1986 to present.
Commercial Fisherman, Trinidad , California. 1978-79.
Research Biologist, New York State Research Foundation. State University of New York, Oswego. 1973-1976.

Professional Societies:
American Fisheries Society, North American Benthological Society. Sigma Xi National Honor Society

Professional Activities:
President, Oregon Chapter of the American Fisheries Society. 1989.
President-elect, Oregon Chapter of the American Fisheries Society. 1988.

Honors and Awards:
Certificate of Merit, USDA Forest Service. 1984
Certificate of Merit and Quality Step Increase, USDA Forest Service. 1986, 1989, and 1994.
Ethics in Science Award, USDA Forest Service. 1989.
Oldfield Team Award, College of Agriculture, Oregon State University. Award given for outstanding research by the Stream Team. 1991.
USDA Forest Service Rise to the Future Award for outstanding contributions in fishery research. 1991.
Conservationist of the Year Award, Pacific Rivers Council. 1992 and 1994.
USDA Secretary's Award for outstanding contribution to research contributing to understanding of

aquatic ecosystems. 1995.

Special Assignments

Member Scientific Panel on Late-Successional Forest Ecosystem - formed by the Agriculture Committee and the Merchant Marine and Fisheries Committee of the U.S. House of Representatives to develop and evaluate alternatives for managing and conserving late-successional forest and aquatic ecosystems on federal lands in northern California and western Oregon and Washington. 1991.

Co-Leader PacFish Team - responsible for developing and evaluating alternatives for managing freshwater habitat of anadromous salmonids on federal lands in northern California, Oregon, Washington, Idaho, and Alaska. 1992-1993.

Member Scientific Assessment Team - develop management strategy for maintaining biodiversity of federal lands in northern California and western Oregon and Washington at request of U.S. Federal Circuit Court Judge. 1992.

Co-leader of Aquatic Group of Forest Ecosystem Management and Assessment Team -responsible for developing and evaluating alternatives for managing federal lands in northern California and western Oregon and Washington. 1993.

Selected Publications

Reeves, G. H., F. H. Everest, and J. D. Hall. 1987. Influence of water temperature on interactions between the redside shiner (*Richardsonius balteatus*) and the steelhead trout (*Salmo gairdneri*). Canadian Journal of Fisheries and Aquatic Sciences 44:1603-1613.

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Reeves, G. H., J. D. Hall, T. D. Roelofs, C. O. Baker, and T. Hickman. 1991. Habitat enhancement and rehabilitation for anadromous salmonids. Pages 519-557. American Fisheries Society Publication No. 19.

Bisson, P. A., T. P. Quinn, G. H. Reeves, and S. V. Gregory. 1992. Best management practices, cumulative effects, and long-term trends in fish abundance in Pacific Northwest river systems. Pages 189-232. in R.J. Naiman, editor. Watershed management: balancing sustainability and environmental change. Springer-Verlag, New York.

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Thomas, J. W., G. H. Reeves, and others. 1993. Viability assessments and management considerations for species associated with late-successional and old-growth forests of the

Pacific Northwest: the report of the Scientific Analysis Team. USDA Forest Service, Portland, OR 530 p.
Reeves, G. H., F. H. Everest, and J. R. Sedell. 1993. Diversity of juvenile anadromous salmonid assemblages in basins in coastal Oregon with different levels of timber harvest activities. Transactions of the American Fisheries Society 122:309-317.
Thomas, J. W., G. H. Reeves, and others. 1993. Forest ecosystem management: an ecological, economic, and social assessment. Report of the Forest Ecosystem Management Assessment Team. USDA Forest Service, Portland, OR
Hicks, B. J. and G. H. Reeves. 1994. Restoration of stream habitat for fish using in-stream structures. Pages 67-92. in K. J. Collier, editor. Restoration of aquatic habitats. Selected papers from the second day of the New Zealand Limnological Society 1993 Annual Conference. New Zealand Department of Conservation, Wellington, New Zealand.
Reeves, G. H., L. E. Benda, P. A. Bisson, and J. R. Sedell. 1995. A disturbance-based ecosystem approach to maintaining and restoring freshwater habitats of evolutionary significant units of anadromous salmonids in the Pacific Northwest. Pages 334-349. *in* J. L. Nielsen, ed. Evolution and the aquatic ecosystem: defining unique units in population conservation. American Fisheries Society Symposium 17.
Reeves, G.H., P.A. Bisson, and J. Dambacher. 1998. Stream fish communities. P. 200-234. In: R.J. Naiman and R.E. Bilby [eds.]. Ecology and management of streams and rivers in the Pacific Northwest coastal ecoregion. Springer-Verlag, New York.
Benda, L. E., D. J. Miller, T. Dunne, G. H. Reeves and J. K. Agee. 1998. Dynamic landscape systems. P. 261-288. In: R.J. Naiman and R.E. Bilby [eds.]. Ecology and management of streams and Rivers in the Pacific Northwest coastal ecoregion. Springer-Verlag, New York.

DOUGLAS F. MARKLE
Dept. of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331

Education
Ph.D. College of William and Mary (1976).
M.S. College of William and Mary (1972).
B.S. Cornell University (1969).

Experience
Professor, Oregon State University (1991-present)
Associate Professor, Oregon State University (1985-1991)
Research Scientist, Huntsman Marine Laboratory, Canada (1977-1985)
Research Assistant, Virginia Institute of Marine Science (1973-1977)
Marine Scientist, Virginia Institute of Marine Science (1971-1972).

Professional Service
American Society of Ichthyologists and Herpetologists, Editorial Board member, 1987, 1989-present; Board of Governors, member, 1990-1994.
The American Fisheries Society, Associate Editor of Early Life History Section, 1988-1990.

Selected Publications

Toole, C. L., D. F. Markle and C. J. Donohoe, in press. Settlement timing, distribution and abundance of Dover sole (Microstomus pacificus) on an outer continental shelf nursery area. Can. J. Fish. Aquat. Sci.

Markle, D. F. and D. C. Simon, in press. Numerical dominance and origin of exotic fathead minnows in Upper Klamath Lake, Oregon. N. Amer. J. Fish. Management.

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Logan, D., E. L. Bibles, and D. F. Markle, 1996. Recent collections of exotic aquarium fishes in the freshwaters of Oregon and thermal tolerance of oriental weatherfish and pirapatinga. Calif. Fish Game 82:66-80.

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Markle, D. F., T. N. Pearsons and D. T. Bills, 1991. Natural history of Oregonichthys (Pices: Cyprinidae) with a description of a new species from the Umpqua River of Oregon. Copeia, 1991 (2): 277-293.

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2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001						
Personnel		$32.0						
Travel		$22.7						
Contractual		$14.4						
Commodities		$2.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$71.1				Estimated FY 2002		
General Administration		$5.8						
Project Total	$0.0	$76.9				$181.9	$139.6	
Full-time Equivalents (FTE)		1.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: Growth Rates of Cutthroat Trout and Dolly Varden in Prince William Sound, Alaska: Comparison of Populations in Oiled and Unoiled Sites with Similar Geographic Features

FY01

Prepared: 4/11, KEH

Project Number: 01522
Project Title: CT/DV Growth Rates
Agency: US Forest Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
Vacant	Rearch Assistant		4.0	4.25		17.0
Vacant	Technician		4.0	2.50		10.0
Vacant	Technician		4.0	1.25		5.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		12.0	8.0	0.0	
					Personnel Total	$32.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
Corvallis Or. To Cordova	1.5	6	60	0.157	18.4
RT Corvallis to Anchorage	1.8	2	3	0.240	4.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$22.7

FY01

Project Number:
Project Title: CT/DV Growth Rates
Agency: US Forest Service

FORM 3B
Personnel
& Travel
DETAIL

Prepared:

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:		Proposed FY 2000
Description		
Charter Boat 12 days @ $1,200.00/day		14.4
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$14.4

Commodities Costs:		Proposed FY 2000
Description		
Misc supplies		2.0
	Commodities Total	$2.0

FY01

Prepared:

Project Number:
Project Title: CT/DV Growth Rates
Agency: US Forest Service

FORM 3B
Contractual & Commodities DETAIL

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

FY01

Project Number:
Project Title: CT/DV Growth Rates
Agency: US Forest Service

FORM 3B
Equipment
DETAIL

Prepared:

Within-bay Distribution of Juvenile Herring in Prince William Sound

Project Number:	01523
Restoration Category:	Research
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	none
Alaska Sea Life Center:	no
Duration:	1st year, 2-year project
Cost FY 01:	$8,800
Cost FY 02:	$33,800
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pacific herring

ABSTRACT

This study proposes to further analyze herring distribution data collected within bays in Prince William Sound (PWS) during the SEA project. Specifically, we propose to examine the small-scale distribution of herring in relation to physical characteristics within bays used as nursery areas. We expect this to result in an explanation of differences in factors that affect survival of juvenile herring among bays discovered during SEA investigations (\320-T). We will examine broader implications by comparing the results to those of Atlantic herring.

INTRODUCTION

The SEA program studied the life history of herring from 1995 to 1998 concentrating on the juvenile stage (\320-T), and presented the synthetic results of herring life history at the EVOS meeting (Norcross et al., In review). Bays on all sides of PWS were nursery areas for ages-0 and -1 herring, with more larvae being retained in bays on the eastern side of PWS. Water from the Gulf of Alaska was transported into PWS and contributed prey species. Variations in local food availability resulted in different diets and growth rates of herring among bays. Summer food availability and possibly competition within nursery areas affected the fall condition of juveniles, and consequently whole body energy content (WBEC) of herring differed among bays. The WBEC of juvenile herring in fall was critical to over-winter survival. A limited amount of food was consumed in the winter and was not sufficient to meet metabolic needs of all juvenile herring. The smallest age-0 fish were at risk of starvation during winter. Over-winter mortality of age-0 herring was modeled using fall WBEC of herring and winter water temperature. Differences in feeding and energetics were detected among nursery areas during both summer and winter, indicating that habitat quality and resultant survival were not equal in all areas or all years. Habitat conditions in various bays and fjords of PWS, as measured by temperature, zooplankton abundance, size of juvenile herring, diet energy, energy source (GOA vs. neritic zooplankton), WBEC, and within-bay competition, were not uniform in space and time (Norcross et al., In review).

We analyzed results of herring around the sound and made some general comparison among nursery areas (Foy and Norcross, 1999; Norcross et al., In review; Stokesbury et al., 1999, 2000; In review). However, we did not analyze the distribution of juvenile herring within individual bays that were used as nursery areas. We know that results of survival and condition varied among bays, but we do not know exactly what characteristics within bays caused these differences. We do know that availability of food in the nursery areas does not appear to be the limiting factor; type or quality of food has not been ruled out. Analysis of distribution of herring within the bays themselves in relation to physical parameters and food availability has not yet been analyzed. Physical variables within the bays have been examined (Gay and Vaughan, In review) and initially indicate explanations for the distribution and retention patterns of herring within bays. Examination of the four bays (Eaglek, Simpson, Whale and Zaikof) that were the focus of the SEA herring studies reveals that the physical characteristics differ among them. Thus, a more in-depth analysis of the specific hydrography associated with each of the bays may explain the distribution of the herring juveniles within the bays, which may, in turn, explain the differences in condition of herring. The distribution of the herring juveniles within the bays in concert with the physical characteristics may help explain the differences in factors that affect survival of juvenile herring among bays found in SEA studies (Norcross et al., In review). Additionally, results of drifters released within PWS (Vaughan et al., 1998) indicate that there may be movement among bays, perhaps on a regional basis. Closer examination of this aspect is needed to evaluate the successful recruitment of herring juveniles.

Much more is known about regional and local distribution of juvenile Atlantic herring (Cushing, 1975; Iles and Sinclair, 1982; Sinclair and Iles, 1985; Grosslein, 1987) than for juvenile Pacific herring. Insight into reasons for differences among bays can be learned by comparing our results of within-bay characteristics and factors affecting juvenile herring to those known for Atlantic herring.

NEED FOR PROJECT

A. Statement of Problem

Pacific herring are listed as a recovering resource. Much research has already been conducted on herring that has provided insight as to the causes of decline of the species and conditions necessary for it to recover. While we cannot directly restore the herring population size, we can investigate specific impediments that prevent this recovery. Knowledge of what factors influence the differential survival of juvenile herring among nursery areas is necessary to understanding recovery of the species.

B. Rationale/Link to Restoration

The proposed project does not require expense sea time to fulfill its objectives. It builds upon results from two components of the SEA project, juvenile herring (\320-T) and physical oceanography (\320-M). We will use the physical oceanographic data and juvenile herring distribution data collected during SEA to examine the small-scale distribution of herring within bays. We will use this small-scale examination of herring to understand the causes of the differential survival among bays. SEA identified the time juveniles spend in nursery areas as a particularly vulnerable period in the life history of herring because that is when they have to eat enough to acquire sufficient energy to survive throughout the winter without feeding (Foy and Paul, 1999). Understanding more about the factors influencing this ability to survive in relation to other factors that potentially impact herring recruitment success (Norcross et al., In review) will improve the understanding of herring recruitment success and will be valuable to managers of herring.

Location

The proposed analysis will be for PWS only.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

The background knowledge on which this proposal is based was collected and analyzed as part of the SEA project, including herring (\320-T), physical oceanography (\320-M) and local and traditional ecological knowledge (\320-T Supplement). During those projects, local commercial fishing vessels were hired, local Cordovans were employed, and purchases were made locally in Cordova. The results of this project will be made available through public media to residents of PWS. We will communicate our results directly to local herring fisheries managers.

PROJECT DESIGN

A. Objectives

The research objectives of this project are:

1. To analyze the within-bay distribution of juvenile herring.

2. To compare the within-bay distribution of juvenile herring to the within-bay physical characteristics.

3. To compare the within-bay distribution of herring to the factors which affect survival, i.e., food availability and energy content.

4. To compare patterns of Pacific herring within nursery areas to those of Atlantic herring within nursery areas.

A. Methods

We will analyze juvenile herring distribution data (\320-T) and physical data (\320- M) previously collected by SEA within bays in PWS to determine the effects of small-scale distribution.

We hypothesize that hydrographic characteristics affect the distribution of juvenile herring within the bays of PWS. We further hypothesize that the particular distribution pattern of herring and the causative hydrography within a bay explains the among-bay differences in the ability of herring to feed and acquire energy necessary to survive through winter. These among-bay differences were one of the principal findings of the SEA herring synthesis (Norcross et al., In review).

We will analyze the distribution of juvenile herring within bays for all available collection periods: May, June, July August, and October 1996, and March, May, July, August, and October 1997, and March 1998. This will use both the hydroacoustic and the net capture data and will require compilation of data in a different format than previously calculated. Comparisons of herring will be of relative, not absolute, abundance. Spatial gradients of distribution of herring within bays will be plots analogous to the spatial gradients plotted of temperature and salinity within bays (Gay and Vaughan, In review) Plots of distribution of juvenile herring within bays will be compared among seasons within single bays. Similar comparisons will be made among bays. These plots will then be compared with the plots of the physical characteristics (Gay and Vaughan, In review).

This analysis will then be expanded beyond the within-bay scale to include data from drifters released in PWS (Vaughan et al., 1998; In review). These data indicate that there is movement of drifters among adjacent bays within PWS. Therefore, we will investigate the possibilities for herring to move out of one bay and into another based on the small-scale hydrographic conditions. The results of this analysis will influence our interpretation of the effect of physical factors on survival of juvenile herring.

During the first year of the study, Brenda Norcross and Michele Frandsen will conduct compilation and analysis of the herring data in the Fisheries Oceanography Lab at UAF in Fairbanks. Shelton Gay and Shari Vaughan of Prince William Sound Science Center, Cordova, already have analyzed most of the physical data (Gay and Vaughan, In review). Frandsen will plot all data for comparisons. Norcross will compare the results of the distribution of the juvenile herring within bays, and in relation to the physical characteristics, with results of the SEA

synthesis (Norcross et al., In review) and specific SEA studies regarding feeding and energetics (Foy and Norcross, 1999; Foy and Paul, 1999).

During the second year of the study, within-bay distribution of herring together with the results of the comparisons with the physical factors will be compared with literature accounts of juvenile Atlantic herring distribution. Norcross also will compare the results with similar published results of Atlantic herring retention (Sinclair, 1988) to discern the broader implications of the processes identified in the proposed study. During that year all results will be compiled and a publishable peer-reviewed manuscript will be written and submitted.

No alternative methodologies are available as this study proposes to examine the only data set of this kind in existence.

B. Cooperating Agencies, Contracts and Other Agency Assistance

The University of Alaska Fairbanks is the only entity requesting funds in this proposal. Results will be shared with herring biologists at ADF&G in Cordova.

SCHEDULE

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

December 30:	Compilation of within-bay herring data
January 16-26 (2 of these days):	Attend Annual Restoration Workshop
March 31:	Production of plots of herring
April 1 – June 30:	Comparison of herring and physical data
July 1 –September 30:	Comparison with factors affecting survival

B. Project Milestones and Endpoints

March 31:	Objective 1: Distribution of herring.
June 30:	Objective 2: Compare herring and physical data
September 30:	Objective 3: Compare to factors affecting survival

C. Completion Date

30 September 2002

PUBLICATIONS AND REPORTS

Annual Report (April 15, 2002)

Final Report (April 15, 2003)

Seasonal and interannual comparisons of within-bay distributions of juvenile herring in Prince William Sound. B.L. Norcross and M. Frandsen. *Estuarine, Coastal and Shelf Science*.

PROFESSIONAL CONFERENCES

ICES meeting, Iceland

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will address questions raised from previous and ongoing Restoration projects about effects of the physical environment on herring within bays. We will incorporate the results from a study proposed by A.J. Paul and R.J. Foy entitled "Overlap of offshore and neritic zooplankton assemblages: implications for juvenile herring."

PROPOSED PRINCIPAL INVESTIGATOR

Brenda L. Norcross
University of Alaska Fairbanks
Institute of Marine Science
School of Fisheries and Ocean Sciences
Fairbanks, AK 99775-7220
Phone: 907-474-7990
Fax: 907-474-1943
E-mail: norcross@ims.alaska.edu

PRINCIPAL INVESTIGATOR

Dr. Brenda L. Norcross has been an EVOS investigator on the SEA herring project (\320T) since 1995. She has been the PI responsible for the collection of the juvenile data to be examined in this study. She served as the coordinator of the Herring Group of Sea for five years and is principal author of the SEA herring synthesis paper. She is thus qualified to perform all analysis required for this project.

Education:

A.B., Biology, MacMurray College, Jacksonville, Illinois, 1971

M.S., Biology, St. Louis University, St. Louis, Missouri, 1976

Ph.D., Marine Science, Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, Virginia, 1983

Experience:

Associate Professor, Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 1996-present

Assistant Professor, Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 1989-1996

Assistant Professor, Division of Biological Oceanography and Fisheries Science, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia, 1984-1988

Field Experience:

One fisheries vessel, Principal Investigator, Pelagic fish, zooplankton, hydroacoustics, oceanography, underwater camera (Prince William Sound, 7 days), 1998.

One - five fisheries vessels, Principal Investigator, Pelagic fish, zooplankton, hydroacoustics, oceanography, underwater camera, aerial surveys (Prince William Sound, 34 days), 1997.

Five fisheries vessels, Principal Investigator, Pelagic fish, zooplankton, hydroacoustics, oceanography, aerial surveys (Prince William Sound, 60 days), 1996.

Six fisheries vessels, Principal Investigator, Pelagic fish, hydroacoustics, oceanography, aerial surveys (Prince William Sound, 22 days), 1995.

Selected Publications:

Stokesbury, K.D.E., J. Kirsch, E.D. Brown, G.L. Thomas and B.L. Norcross. 2000. Seasonal variability in Pacific herring (*Clupea pallasi*) and walleye pollock (*Theragra chalcogramma*) spatial distributions in Prince William Sound, Alaska. *Fish. Bull. US.* 98:400-409.

Stokesbury, K.D.E., R.J. Foy and B.L. Norcross. 1999. Spatial and temporal variability in juvenile Pacific herring (*Clupea pallasi*) growth in Prince William Sound, Alaska. *Environ. Biol. Fish.* 56:409-418.

Foy, R.J. and B.L. Norcross. 1999. Spatial and temporal differences in the diet of juvenile Pacific herring (*Clupea pallasi*) in Prince William Sound, Alaska. *Can. J. Zoolog.* 77(5) 697-706.

Norcross, B.L., J.E. Hose, M. Frandsen and E. Brown. 1996. Distribution, abundance, morphological condition and cytogenetic abnormalities of larval herring in Prince William Sound, Alaska, following the *Exxon Valdez* oil spill. *Can. J. Fish. Aquat. Sci.* 53:2376-2387.

Norcross, B.L. and M. Frandsen. 1996. Distribution and abundance of larval fishes in Prince William Sound, Alaska during 1989 after the *Exxon Valdez* oil spill. *In* S.D. Rice, R.B. Spies, D.A. Wolfe and B.A. Wright (eds.). *Exxon Valdez* Oil Spill Symposium Proceedings. *Am. Fish. Soc. Symp.* 18:463-486.

OTHER KEY PERSONNEL

Michele Frandsen has worked as laboratory technician on the SEA project since 1995. She is familiar with the data format and with SEA herring results for PWS. Michele will be responsible for reprocessing the juvenile herring data, and producing plots and graphs of the data.

LITERATURE CITED

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Foy, R.J. and B.L. Norcross. 1999. Spatial and temporal differences in the diet of juvenile Pacific herring (*Clupea pallasi*) in Prince William Sound, Alaska. *Can. J. Zoolog.* 77(5) 697-706.

Foy, R.J. and Paul, A.J. 1999. Winter feeding and changes in somatic energy content for age-0 Pacific herring in Prince William Sound, Alaska. *Trans. Am. Fish. Soc.* 128:1193-1200.

Gay, S.M. In review. Factors influencing the seasonal hydrography of fjords and bays within sub-regions of Prince William Sound, Alaska during the spring and summer of 1994, fall of 1995, and late winter, summer and fall of 1996. *J. Mar. Systems.*

Gay, S.M. and Vaughan, S.L. In review. Seasonal hydrography and tidal currents of bays and fjords in Prince William Sound, Alaska used as nursery habitats by juvenile Pacific herring (*Clupea pallasi*). *Fish. Oceanogr.*

Grosslein, M.D. 1987. Synopsis of knowledge of the recruitment process for Atlantic herring (Clupea harengus) with special reference to Georges Bank. NAFO Sci. Coun. Studies 11:91-108.

Iles, T.D. and Sinclair, M. (1982) Atlantic herring: Stock discreteness and abundance. Science 215:627-633.

Norcross, B.L., E.D. Brown, R.J. Foy, M. Frandsen, S. Gay, T.C. Kline, D.M. Mason, E.V. Patrick, A.J. Paul and K.D.E. Stokesbury. (In review). A synthesis of the early life history and ecology of juvenile Pacific herring in Prince William Sound, Alaska. *Fish. Oceanog.*

Sinclair, M. (1988) Marine Populations: An Essay on Population Regulation and Speciation. Washington Sea Grant Program, University of Washington Press, Seattle, WA. 252 pp.

Sinclair, M. and Iles, T.D. (1985) Atlantic herring (*Clupea harengus*) distributions in the Gulf of Maine – Scotian Shelf area in relation to oceanographic features. *Can. J. Fish. Aquat. Sci.* **42**:880-887.

Stokesbury, K.D.E., R.J. Foy and B.L. Norcross. 1999. Spatial and temporal variability in juvenile Pacific herring (*Clupea pallasi*) growth in Prince William Sound, Alaska. *Environ. Biol. Fish.* 56:409-418.

Stokesbury, K.D.E., J. Kirsch, E.D. Brown, G.L. Thomas and B.L. Norcross. 2000. Seasonal variability in Pacific herring (*Clupea pallasi*) and walleye pollock (*Theragra chalcogramma*) spatial distributions in Prince William Sound, Alaska. *Fish. Bull. US.* 98:400-409.

Stokesbury, K.D.E., J. Kirsch and B.L. Norcross. In review. Mortality estimates of juvenile Pacific herring (*Clupea pallasi*) in Prince William Sound, Alaska. *Can. J. Fish. Aquat. Sci.*

Vaughan, S.L., Mooers, C.N.K., Wang, J., Gay, S.M., and Tuttle, L.B. In review. Physical processes influencing the pelagic ecosystem of Prince William Sound. *Fish. Oceanogr.*

Vaughan, S.L., Gay, S.M. and Tuttle, L.B. (1998) Oceanography of Prince William Sound bays and fjords. Restoration Project 98297 Annual Report.

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001						
Personnel		$0.0						
Travel		$0.0						
Contractual		$36.3						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$36.3			Estimated	Estimated		
General Administration		$2.5						
Project Total		$38.8			$33.8			
Full-time Equivalents (FTE)		0.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY01

Prepared:

Project Number: 01523
Project Title: Within-bay Distribution of Juvenile Herring in Prince William Sound
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TR[illegible]E COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$22.9						
Travel		$5.1						
Contractual		$0.5						
Commodities		$0.5						
Equipment		$0.0						
Subtotal		$29.0			Estimated 2002	Estimated		
Indirect		$7.3						
Project Total		$36.3			$31.6			
Full-time Equivalents (FTE)		0.3						
	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.

FY01

Prepared:

Project Number: 01523
Project Title: Within-bay Distribution of Juvenile Herring in Prince William Sound
Name: Brenda L. Norcross

FORM 4A
Non-Trustee
SUMMARY

2001 EXXON VALDEZ TR[illegible]E COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2000
Brenda Norcross	PI, Associate Professor		1.0	7.6		7.6
Michele Frandsen	Technician		3.0	5.1		15.3
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Subtotal			4.0	12.7	0.0	
					Personnel Total	$22.9

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
Fairbanks to Anchorage (EVOS meeting)	300.0	1	3	140.0	0.7
Fairbanks to Iceland (ICES meeting)	1250.0	1	7	275.0	4.4
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.1

FY01

Prepared:

Project Number: 01523
Project Title: Within-bay Distribution of Juvenile Herring in Prince William Sound
Name: Brenda L. Norcross

FORM 4B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed FY 2000
Description	
Communications	0.5
Contractual Total	$0.5

Commodities Costs:	Proposed FY 2000
Description	
Project supplies (office and miscellaneous supplies)	0.5
Commodities Total	$0.5

FY01

Project Number: 01523
Project Title: Within-bay Distribution of Juvenile Herring in Prince William Sound
Name: Brenda L. Norcross

FORM 4B
Contractual & Commodities DETAIL

Prepared:

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

Existing Equipment Usage: Description	Number of Units	

FY01

Project Number: 01523
Project Title: Within-bay Distribution of Juvenile Herring in Prince William Sound
Name: Brenda L. Norcross

FORM 4B
Equipment
DETAIL

Prepared:

Herring spawning sites: Location or substrate

Project Number:	01524
Restoration Category:	Research
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	none
Alaska Sea Life Center:	no
Duration:	1st year, 2-year project
Cost FY 01:	$120,500
Cost FY 02:	$47,300
Cost FY 03:	0
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pacific herring

ABSTRACT

This study will examine the question "Why are herring spawning areas where they are?" We believe that investigating two factors, location and substrate, will address this question. We hypothesize that not all combinations of oceanography, locations and substrate of herring spawning sites will result in successful recruitment of herring. To examine both factors, we will examine historical spawning and non-spawning sites in Prince William Sound (PWS). Simulated larval herring dispersal will reveal the importance of location. Field surveys and manipulations will identify importance of substrate. Knowledge of spawning site selection could become very important to the recovery of herring.

INTRODUCTION

Commercial fisheries for herring are very important in Prince William Sound (PWS). Since the late 1970s, the value of the fishery was as high as $12.2 million in 1992. Herring also support subsistence fisheries for indigenous peoples of PWS. Ecologically herring are vital as prey for gulls, shorebirds, humpback whale and Steller sea lions. The population of herring crashed in 1993 resulting in the commercial harvest being suspended in 1994, 1995 and 1996. Harvests in 1997 and 1998 were still at low levels. The population appeared to be increasing, but then experienced another collapse in 1999 resulting in no fishery. Because of the importance of this species, these low numbers are cause for great concern. It is critical to investigate all possibilities affecting population size. Understanding choice of spawning sites and the potential to affect recruitment success may be very important for the recovery of this species.

In a review of a manuscript synthesizing the herring research conducted under SEA (Norcross, et al., In review) one reviewer asked, "Why are spawning areas where they are? Are there critical habitats for spawning and nursery areas in the PWS? Are there some conditions that transport larvae originating in a spawning area towards a particular estuary?" These are excellent questions, which we, unfortunately, cannot answer at this time. Pete Peterson asked similar questions at a herring workshop held in Anchorage in November 1999. He wanted to know if certain sites provide better larval transport or retention of larvae within PWS. Several authors (Haegele, et al., 1981; Hourston, et al., 1981; Aneer, 1989) speculate of the effect of the quality of the substrate on the amount and viability of the spawn.

Although variable in amount of spawn received, spawning sites for herring in PWS are somewhat consistent. ADF&G has surveyed five areas, North Shore, Naked Island, Northeast Shore, Southeast Shore and Montague Island, for herring spawning since 1973. Table 1 shows the variability in spawn over these areas, and emphasizes the consistency of spawning taking place in the Northeast and Montague areas. Based on ADF&G aerial surveys from 1973-1998 a sum of all shores to ever receive spawn encompasses most shoreline of the five ADF&G sectors (Figure 1). These observations do not include any spawning on the shores of western PWS. However, when considering the observations from 1930 to 1998 of fishermen, pilots and indigenous peoples (Seitz et al., In review), the area of herring spawn is expanded beyond the ranges observed by ADF&G and includes western PWS (Figure 2). These differences may be a result of spatial differences in sampling, i. e., ADF&G not flying over all areas, though they do survey the major spawning sites. Conversely the difference may be a result of a temporal change in spawning, i.e., herring formerly spawned in western PWS, as the local knowledge extended further backwards in time.

It has been suggested that herring spawning is not habitat limited (Hay, 1985; Hay and McCarter, 1997). Thus, the apparent consistent choice of spawning site by herring may have evolutionary benefits for recruitment. The location may be critical as an appropriate starting location from which herring larvae are distributed to nursery areas around PWS. Simulating physical dispersal of herring larvae from 1996 spawning sites shows that some larvae were retained in PWS while others were transported out. Dispersal patterns differed for each ADF&G spawning area. Those originating in southeast were less widely dispersed and experienced less loss from PWS than those originating in the other areas (Norcross, et. al., In review). Those originating in the other areas were distributed to all regions except southeast and were swept out PWS through Montague Strait.

The substrate may be important in attracting spawners to a particular site and providing appropriate attachment material for the herring eggs. Typically, herring spawn on marine vegetation, such as algae and seagrasses, or on bottom substrate, such as gravel, when it is free from silting (Haegele and Schweigert, 1985). Intertidal work showed that herring did not favor one vegetation type over another (Haegele and Schweigert, 1985). It has been suggested that the type of vegetation that eggs are laid on is a function of water depth at which the eggs are deposited and the type of vegetation found in that area. However, laboratory observations showed that rigidity and texture were important components of suitable substrates (Stacey and Hourston, 1982). Algal species, density or structure may affect choice of spawning site by herring. Some algal species, e.g. *Nereocystis luetkeana*, are smooth, rigid, and buoyant. Other algae, e.g., the Laminariales, are rough, often associated with holes or ridges, have large, flat blades and limited in their buoyancy. Still others, e.g. *Desmarestia viridis*, are finely branched, associated with much surface area, and not at all buoyant. Lastly, some algae, e.g., the reds, are small and grow close to the substrate.

The proposed research will investigate sites that are used for spawning as well as locations in which spawning does not commonly occur. The location of the site within PWS will be studied in conjunction with spawning substrate at the site. We will simulate distribution of herring larvae from spawning sites and estimate the dispersal of larvae from each site. We will conduct a field study to examine algae species, density and structure. This project seeks to answer the question posed by the anonymous reviewer "Why are spawning areas where they are?"

NEED FOR PROJECT

A. Statement of Problem

Pacific herring are listed as a recovering resource, and it is critical to the economy and ecosystem of PWS. It is known that herring repeatedly spawn in the same areas over many years, but it is unknown why they choose these areas. Two factors that could be influencing their choice of a particular site include physical location and its resultant effect on dispersal of larvae and/or substrate type, availability and structure. This apparent consistent choice of spawning site by herring may have evolutionary benefits for recruitment, but we will not know unless we investigate the possibilities. Knowledge of spawning site selection could become very important to the recovery of herring.

B. Rationale/Link to Restoration

This project examines essential information about Pacific herring spawning in Prince William Sound. We will use the results of the 3-D ocean state simulation model (Wang et al., 1999) and the current EVOS project refining that model (00389) to simulate distribution of larval herring from generic spawning locations around PWS. Simultaneously we will also examine the physical attributes at those spawning sites. This study will provide insight into the location and suitability of particular habitats for herring spawning. Knowledge of factors affecting spawning site preference of herring will illustrate the importance of certain places within PWS that need to be protected to maintain a commercially viable herring population.

C. Location

This study will take place in and have primary relevance to Prince William Sound. The results of the study should have broader implications that will help herring managers in other areas.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

We used information provided by Mark Willette, ADF&G, Cordova, and traditional knowledge (Seitz, et al., In review) for the spawning maps that are the starting points of this study. We will hire a vessel to live aboard and for all SCUBA diving work. We will also use a local contact for filling SCUBA tanks and purchasing any necessary SCUBA gear. The results of this project will be made available through public media to residents of PWS. We will communicate our results directly to managers of local herring fisheries.

PROJECT DESIGN

A. Objectives

The research objectives of this project address the two components of the question: location and substrate.

Location:

1. Model distribution of herring larvae within PWS from historical spawning and non-spawning sites.

2. Determine percentage herring larvae retained in PWS from each site.

3. Compare dispersal and retention patterns of simulated herring larvae among historical spawning and non-spawning sites.

Substrate:

1. Determine the specific substrates Pacific herring use for spawning in PWS.

2. Determine if algae or structure is attracting herring.

3. Compare available spawning substrates between historical spawning and non-spawning sites.

4. Determine importance of algal substrate for attracting herring spawn.

B. Methods

Location:

We hypothesize that not all combinations of oceanography and locations of herring spawning will result in equally good dispersal of herring larvae. Under some combination of conditions, more larvae will be lost from PWS. Under other combinations of conditions, most larvae will be transported to the same place. This would result in crowding that has potential for VHSV (Kocan et al. 1997) and competition for food (Norcross et al., In review) within nursery areas, both of which are bad for survival and recruitment of juvenile herring. Still other conditions should result in dispersal of herring larvae around PWS to a variety of suitable nursery areas.

In order to test this hypothesis, we will use the 3-D ocean state model developed and verified by J. Wang for 1995-1998 conditions in PWS (00389). While these four years may not represent all possible oceanographic scenarios within PWS, they are representative of a variety of climatic conditions resulting in different circulation patterns (Vaughan et al., In Review). We will simulate dispersal of herring larvae from spawning locations in the two areas surveyed by ADF&G in which herring continuously spawned, i.e., Northeast and Montague (Table 1), for each of the four years of model development. We will also choose two historic non-spawning locations. One will be the north side of Hinchinbrook Island at which no herring spawning is known by ADF&G (Figure 1) or local knowledge (Figure 2). The other will be on the west side of PWS where no spawning has been recorded by ADF&G (Figure 1) but has been documented through traditional knowledge (Figure 2). We will use a combination of the four spawning locations and four years of circulation regimes to produce models of sixteen scenarios depicting distribution of herring larvae within PWS. Each scenario will be a combination of one spawning region and one circulation regime.

We will analyze the results of these sixteen scenarios statistically using an ANOVA-type of analysis by first examining what percent of larvae are retained within PWS and comparing the difference among the scenarios. For each of the sixteen scenarios of dispersal, we will examine evenness of dispersal. This will provide insight into potential crowding and competition within nursery areas. The results of these analyses will reveal the potential importance of a particular herring spawning location to the recruitment process. Locations with high potential for successful recruitment, i.e., larvae are retained within PWS but are not too crowded, will be interpreted as answering one aspect of the question "Why do herring spawn where they do?"

Substrate:

Substrate will be examined using habitat survey techniques and manipulative field experiments in PWS by SCUBA diving from a vessel having an air compressor. We will stage our field experiments at the same sites that were chosen for the location-simulation modeling, i.e., two spawning and two non-spawning sites. All field work will occur during the herring spawning season. The mean date of herring spawn in PWS is 20 April $\pm$ 12 days (Norcross, et al, In Review). Four UAF SCUBA divers (B. Konar and three student divers) will spend a total of six weeks in the field living aboard a boat on site. Diving will be staged off a smaller, dive support vessel. In early April, we will begin to survey the two herring non- spawning sites. As soon as herring begin to spawn in other areas, we will switch our focus to surveying and completing the manipulative experiments in those areas. It should take approximately three weeks to complete

the survey and experimental work in the herring spawned areas. When this is done, we will finish the survey work of the non-spawned areas.

To determine specific substrate type, two areas historically used by herring for spawning in PWS will be surveyed using subtidal transects. Ten randomly selected transects will be selected at each site. For these, SCUBA divers will swim perpendicular from shore from mean low water to a depth of 15m. At random points along each transect line, water depth and slope will be recorded. Bottom substrate cover will be quantified using a 1 m long point quadrat bar (similar to that described by Cowen *et al.* 1982). Kelp stipes will also be identified and counted within a 1 m^2 three-sided quadrat placed adjacent to the point bar. These data will determine the biological characteristics of the historical spawning grounds. It will also clarify the specific substrate on which eggs are laid.

To ascertain if a particular structural form rather than a specific algal species is attracting the herring, mock algae will be constructed to imitate different algal forms. These artificial structures will be placed in historically spawned areas prior to the herring spawning season. Surgical tubing will be used to imitate the morphology of surface and subsurface canopy forming kelps, e.g., *Nereocystis luetkeana,* and the other Laminariales (Konar 2000). Each of these artificial plants will consist of 8 surgical tubing "stipes", approximately 1 m tall, which will be cable-tied together. The surgical tubing is positively buoyant so the majority of the plant will be suspended above the substrate. Polyethylene surveyors' flagging will be used to imitate low-lying, bushy algal morphology (size and buoyancy), e.g., *Desmarestia viridis.* Each of these artificial plants will consist of 20 flexible flagging "branches" (approximately 20 cm long), which will be cable-tied together. The flagging does not float so the majority of the plant will rest on the substratum and move with the swell. Short pieces of surgical tubing (5-10 cm) will be used to imitate many of the smaller red algal species e.g., *Bossiella* sp., *Ptilota filcina.* These mock substrates will be surveyed after the herring have spawned to determine if herring are choosing a specific structure, tall or short, floating or non-floating, vs. a specific algal species.

To compare available spawning substrates between historical spawning and non-spawning sites, surveys similar to those described above will be conducted in areas where Pacific herring spawning is not surveyed by ADF&G. Water depth, slope, substrate and vegetation type will be compared between historically spawned and non-spawned sites using ANOVAs.

To determine importance of algal substrate for attracting herring spawn a manipulative experiment will be performed. As soon as herring begin to spawn, we will remove all the algae from a 100 m^2 area within three specific sites. As spawning progresses, cleared (test) and adjacent non-cleared (control) areas within the spawning site will be monitored for presence of herring spawn. The objective is to determine if herring will continue to spawn at a specific site after the algal substrate has been removed. Absence of herring spawn on bare rock where algae were cleared would indicate that substrate is an important factor determining "why herring spawn where they do".

During the second year of the study, the results of the Location and Substrate components will be compared to discern the broader implications of the processes identified in the proposed study. During that year, all results will be compiled and a publishable peer-reviewed manuscript will be written and submitted.

No alternative methodologies are available as this study proposes to examine the only data set of this kind in existence.

C. Cooperating Agencies, Contracts and other Agency Assistance

The University of Alaska Fairbanks is the only entity requesting funds in this proposal.

SCHEDULE

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

Location (Norcross):	
September 1 - December 31:	Determine input parameters for herring simulation models
January 16-26 (2 of these days):	Attend Annual Restoration Workshop
January 1– July 1:	Run models
July 1 – September 30:	Analysis of model results
Substrate (Konar):	
September 1 – October 30:	Design field study
November 1-January 31:	Arrange logistics (boats, equipment, contracts, etc..)
January 16-26 (2 of these days):	Attend Annual Restoration Workshop
February 1 – March 31:	Assemble sampling gear and mock algal structures
April - May:	Field surveys and manipulative experiments
June 1-July 1:	Clean up field gear, assemble data.
August 1 – September 30	Analyze data

B. Project Milestones and Endpoints

Location (Norcross):	
1 July:	Objective 1: model distribution of herring larvae
30 September:	Objectives 2 & 3: analyze model results
Substrate (Konar):	
1 July	Objectives 1 & 2: field work
30 September	Objectives 3 & 4: analysis of data.

C. Completion Date

30 September 2002

PUBLICATIONS AND REPORTS

Annual Report (April 15, 2002)

Final Report (April 15, 2003)

The results of this study will be submitted for publication to various journals.

Implications for recruitment of Pacific herring from modeled dispersal of larvae within Prince William Sound. B.L. Norcross and J. Wang. *Fisheries Oceanography.*

Habitat characteristics controlling Pacific herring spawning grounds in Prince William Sound, AK. B. Konar. *Canadian Journal of Fisheries and Aquatic Sciences.*

Why herring spawn where they do. B. L. Norcross and B. Konar. *Fisheries Oceanography.*

PROFESSIONAL CONFERENCES

The fisheries work will be presented by B.L. Norcross at the ICES meeting in Iceland in 2001.

The substrate work will be presented by B. Konar at the 2002 Benthic Ecologists meeting at Tallahasee, Florida.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will address questions raised from previous and ongoing Restoration projects about the choice of herring spawning sites. We will coordinate the results of this research with present (00389) and proposed research of Jia Wang (01389), a 3-D circulation model development for PWS. Most of the SCUBA equipment for this project will be obtained from the NVP Project (Jewett). We are only requesting funds for maintenance of NVP gear and a few items that can not be borrowed.

PROPOSED PRINCIPAL INVESTIGATORS

Brenda L Norcross
University of Alaska Fairbanks
Institute of Marine Science
School of Fisheries and Ocean Sciences
Fairbanks, AK 99775-7220
Phone: 907-474-7990
Fax: 907-474-1943
E-mail: norcross@ims.alaska.edu

Brenda Konar
School of Fisheries and Ocean Sciences
University of Alaska Fairbanks
PO Box 757220
Fairbanks, AK 99775-7220
Phone: 907-474-5028
Fax: 907-474-5804
E-mail: bkonar@ims.uaf.edu

Table 1. Kilometers of shoreline on which herring spawned in PWS, 1973 - 1999.
(ADF&G aerial and spawn deposition survey data.)

Year	Southeast	Northeast	North Shore	Naked Island	Montague	Total
1973	0.00	47.5	4.8	0.0	10.0	62.3
1974	0.00	37.8	0.0	0.0	24.2	62.0
1975	0.00	44.6	0.0	0.0	10.5	55.1
1976	0.00	47.7	0.0	0.0	3.7	51.4
1977	0.00	60.9	0.0	0.0	2.4	63.3
1978	0.00	45.9	0.0	0.0	0.3	46.2
1979	33.8	52.3	0.0	0.0	1.6	87.7
1980	16.6	56.0	0.0	0.0	8.9	81.5
1981	22.4	46.7	9.3	0.0	59.2	137.6
1982	0.5	30.4	25.4	5.6	16.9	78.8
1983	4.5	21.4	16.9	28.5	37.2	108.5
1984	14.0	19.5	26.2	12.2	25.0	96.9
1985	5.2	56.4	53.9	26.4	21.3	163.2
1986	4.5	41.1	59.7	0.0	11.3	116.6
1987	11.1	34.3	42.3	3.7	13.7	105.1
1988	6.1	91.6	24.8	29.5	115.9	267.9
1989	5.6	34.8	48.4	22.1	46.5	157.4
1990	4.2	70.4	29.3	8.7	39	151.6
1991	6.3	45.9	1.9	0.0	39.0	93.1
1992	11.6	51.8	0.0	0.5	56.4	120.3
1993	2.7	8.9	0.0	0.0	21.3	32.9
1994	0.3	0.5	0.0	0.0	22.5	23.3
1995	9.3	3.2	0.0	0.0	20.2	32.7
1996	3.9	16.1	0.3	0.0	23.5	43.8
1997	11.2	25.1	3.3	0.0	28.9	68.5
1998	27.5	11.1	3.4	0.0	25.8	67.8
1999	23.7	7.4	0.0	0.0	9.8	40.9
Total km	225.0	1009.3	349.9	137.2	695.0	2416.4
Avg km	8.3	37.4	13.0	5.1	25.7	89.5
% Total	9.3	41.8	14.5	5.7	28.8	

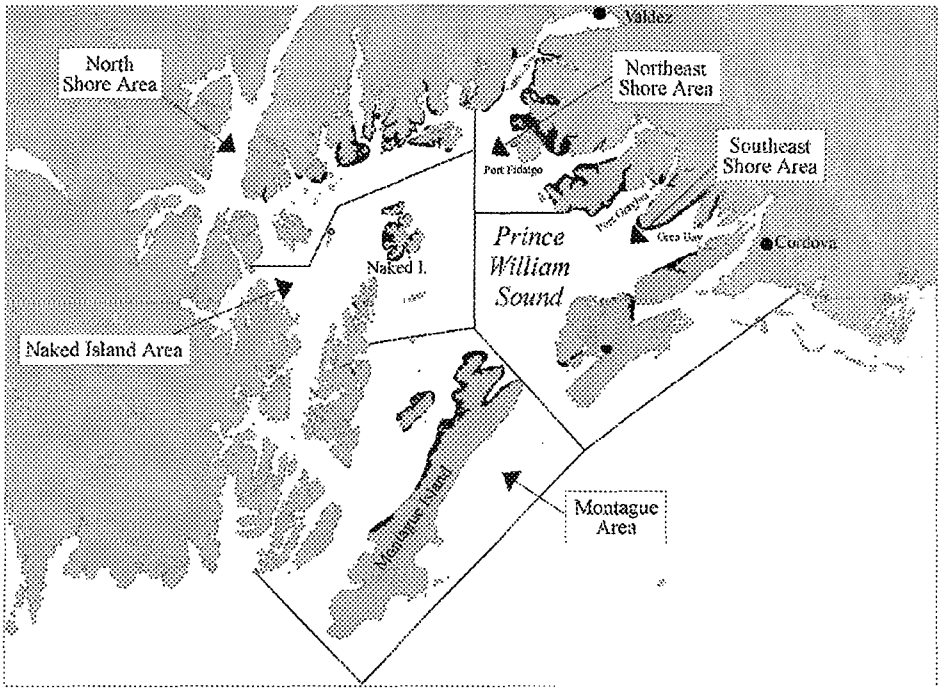

Figure 1. Shorelines in Prince William Sound on which herring spawn was observed by ADF&G surveys from 1973 to 1999 in five sectors.

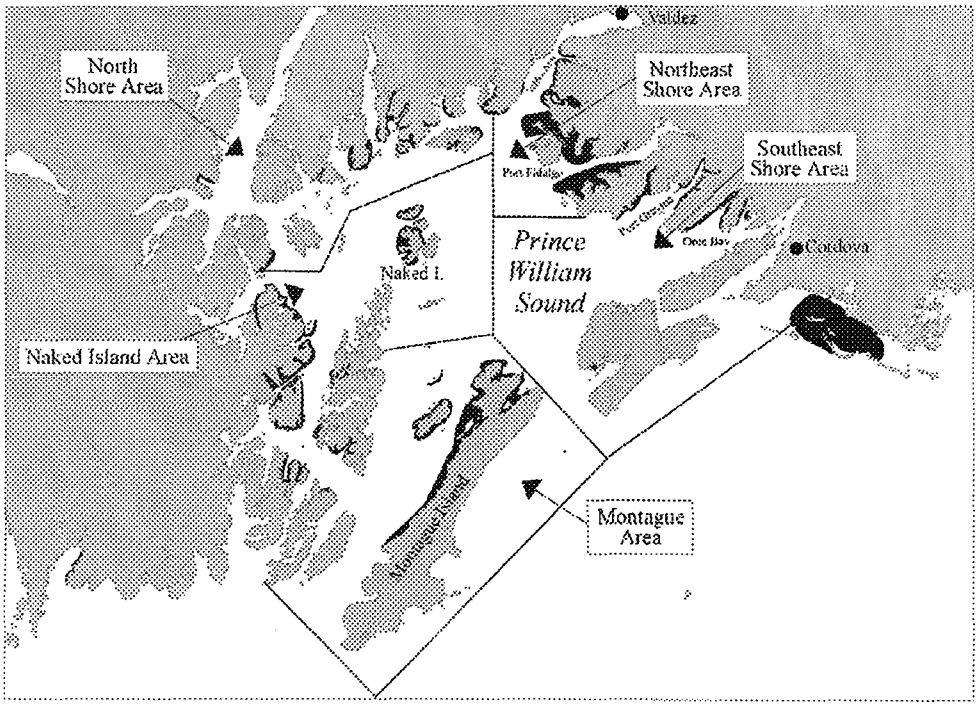

Figure 2. Local knowledge of herring spawning areas (1930-1998) in relation to ADF&G's five sectors (after Seitz et al, In review).

PRINCIPAL INVESTIGATOR

Dr. Brenda L. Norcross has been an EVOS investigator on the SEA herring project (\320T) since 1995. She has been the PI responsible for the collection of the juvenile data to be examined in this study. She served as the coordinator of the Herring Group of Sea for five years and is principal author of the SEA herring synthesis paper (Norcross et al., In Review) and the first paper on larval herring drift in PWS (Norcross et al., in prep). She is thus qualified to perform all analysis required for this project.

Education:

A.B., Biology, MacMurray College, Jacksonville, Illinois, 1971

M.S., Biology, St. Louis University, St. Louis, Missouri, 1976

Ph.D., Marine Science, Virginia Institute of Marine Science, School of Marine Science, College of William and Mary, Gloucester Point, Virginia, 1983

Experience:

Associate Professor, Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 1996-present

Assistant Professor, Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, 1989-1996

Assistant Professor, Division of Biological Oceanography and Fisheries Science, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, Virginia, 1984-1988

Field Experience:

One fisheries vessel, Principal Investigator, Pelagic fish, zooplankton, hydroacoustics, oceanography, underwater camera (Prince William Sound, 7 days), 1998.

One - five fisheries vessels, Principal Investigator, Pelagic fish, zooplankton, hydroacoustics, oceanography, underwater camera, aerial surveys (Prince William Sound, 34 days), 1997.

Five fisheries vessels, Principal Investigator, Pelagic fish, zooplankton, hydroacoustics, oceanography, aerial surveys (Prince William Sound, 60 days), 1996.

Six fisheries vessels, Principal Investigator, Pelagic fish, hydroacoustics, oceanography, aerial surveys (Prince William Sound, 22 days), 1995.

Selected Publications:

Stokesbury, K.D.E., J. Kirsch, E.D. Brown, G.L. Thomas and B.L. Norcross. 2000. Seasonal variability in Pacific herring (*Clupea pallasi*) and walleye pollock (*Theragra chalcogramma*) spatial distributions in Prince William Sound, Alaska. *Fish. Bull. US.* 98:400-409.

Stokesbury, K.D.E., R.J. Foy and B.L. Norcross. 1999. Spatial and temporal variability in juvenile Pacific herring (*Clupea pallasi*) growth in Prince William Sound, Alaska. *Environ. Biol. Fish.* 56:409-418.

Foy, R.J. and B.L. Norcross. 1999. Spatial and temporal differences in the diet of juvenile Pacific herring (*Clupea pallasi*) in Prince William Sound, Alaska. *Can. J. Zoolog.* 77(5) 697-706.

Norcross, B.L., J.E. Hose, M. Frandsen and E. Brown. 1996. Distribution, abundance, morphological condition and cytogenetic abnormalities of larval herring in Prince William Sound, Alaska, following the *Exxon Valdez* oil spill. *Can. J. Fish. Aquat. Sci.* 53:2376-2387.

Norcross, B.L. and M. Frandsen. 1996. Distribution and abundance of larval fishes in Prince William Sound, Alaska during 1989 after the *Exxon Valdez* oil spill. *In* S.D. Rice, R.B. Spies, D.A. Wolfe and B.A. Wright (eds.). *Exxon Valdez* Oil Spill Symposium Proceedings. *Am. Fish. Soc. Symp.* 18:463-486.

Dr. Brenda Konar is a subtidal ecologist at the University of Alaska Fairbanks. She has much experience with subtidal monitoring and surveying programs in cold-water systems (see C.V.). She has designed and implemented many types of manipulative field experiments, including ones that successfully used mock algae to explore plant-herbivore interactions (Konar 2000).

Research Assistant Professor	Staff Scientist
Global Undersea Research Unit	West Coast & Polar Regions
University of Alaska Fairbanks	Undersea Research Center

Education:

Ph.D. Biology, University of California, Santa Cruz, CA, 1998
M.S. Marine Sciences, Moss Landing Marine Laboratories, CA, 1991
B.A. Zoology, San Jose State University, San Jose, CA 1986

Professional Experience:

1999 to present.	Research Assistant Professor in the School of Fisheries and Ocean Sciences Department at the University of Alaska Fairbanks and Staff Scientist for the West Coast National Undersea Research Center.
1993 to 1998.	U.S.G.S. Biological Resources Division Co-op Student -GS/07/04.
1991-1993.	Research Technician in McMurdo Sound, Antarctica for the Moss Landing Marine Laboratories, CA. Project funded by NSF.
1991-1993.	Field Research Coordinator for the California Department of Fish & Game, Bay Protection Division of the Marine Pollution Labs.
1990-1993.	Project Coordinator for the biological assessment of the Lone Tree Landslide, CA. Moss Landing Marine Laboratories, CA. Project funded by the California Department of Transportation.
1991.	Research Associate for the Elkhorn Slough Foundation.
1991.	Phycologist in Resolute Bay. Project funded by the Canadian Museum of Nature.
1990-1991.	Oil Spill Algal Supervisor in Alaska for Coastal Resources Associates.
1990.	Project Manager for the California Department of Fish and Game, Mussel Watch division of the Marine Pollution Laboratories.
1988-1990.	Phycologist for Big Sur biological assessment. Moss Landing Marine Laboratories, CA. Project funded by the California Department of Parks and Recreation and California Department of Transportation.

Recent Publications:

Konar, B. 2000. Seasonal inhibitory affects of marine plants on sea urchins: structuring communities the algal way. Oecologia (in press).

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Konar, B. 1998. Mechanisms that structure and maintain communities at the Semichi Islands, Alaska. Ph.D. Dissertation. University of California, Santa Cruz, California, U.S.A.

Konar, B. 1998. Effects of *Desmarestia viridis* on subtidal community structure: inhibition of urchin movement and algal recruitment. 52nd Annual Meeting of the Phycological Society of America, Flagstaff, Arizona. Journal of Phycology Supplement 34: 29

Konar, B. and C. Roberts. 1996. Large scale landslide effects on two exposed rocky subtidal areas in California. Botanica Marina. 39:517-524.

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sediments: Field and laboratory bioassay experiments. Journal of Experimental Marine Biology and Ecology. 192:233-255.

Konar, B. and M. Stephenson. 1994. Gradients of subsurface water toxicity to oyster larvae in bays and harbors in California and their relation to Mussel Watch bioaccumulation data. Chemosphere. 30:165-172.

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Konar, B. and M. S. Foster. 1992. Distribution and recruitment of subtidal geniculate coralline algae. Journal of Phycology. 28:273-280.

Konar, B. 1991. Ecological studies of geniculate coralline algae with an emphasis on *Bossiella* sp. Thesis. Moss Landing Marine Laboratories, Moss Landing, California, U.S.A.

OTHER KEY PERSONNEL

Three UAF certified SCUBA divers will be hired to work for the 6 week period of diving in PWS.

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Hay, 1985. Reproductive biology of Pacific herring (*Clupea harengus pallasi*). Can. J. Fish. Aquat. Sci. 42 (Suppl. 1):111-126.

Hay, D.E., and McCarter, P.B. (1997) Continental shelf area and distribution, abundance, and habitat of herring in the North Pacific. *Proc. Forage Fish Mar. Ecosys. Symp.*, AK-SG-97-01:559-572.

Hourston, A.S., H. Rosenthal and H. von Westernhagen. 1981. Contition at hatching of Pacific herring larvae from natural and artificial spawn of different intensities on a variety of substrates. Can. Tech. Rept. Fish. Aquat. Sci. No. 1045, 25 p.

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Konar, B. 2000. Seasonal inhibitory effects of marine plants on sea urchins: structuring communities the algal way. Oecologia. in press.

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Stacey, N. and A. S. Hourston. 1982. Spawning and feeding behavior of captive Pacific herring. Can. J. Fish. Aquat. 39: 489-498.

Vaughan, S.L., Mooers, C.N.K., Wang, J., Gay, S.M., and Tuttle, L.B. In Review. Physical processes influencing the pelagic ecosystem of Prince William Sound.

Wang, J., V. Patrick, J. Allen, and M. Jin. 1999. Modeling seasonal ocean circulation of Prince William Sound, Alaska using freshwater of a line source. *In* Computer Modeling of Seas and Coastal Regions IV, C.A. Brebbia, et al. (eds.), Computational Mechanics Publications, Southampton.

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001						
Personnel		$0.0						
Travel		$0.0						
Contractual		$112.6						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$112.6			Estimated 2002	Estimated		
General Administration		$7.9						
Project Total		$120.5			$47.3			
Full-time Equivalents (FTE)		0.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY01

Prepared:

Project Number: 01524
Project Title: Herring spawning sites: Location or substrate
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TR[illegible]EE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001						
Personnel		$40.5						
Travel		$5.4						
Contractual		$38.6						
Commodities		$5.6						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$90.1			Estimated 2002	Estimated		
Indirect		$22.5						
Project Total		$112.6			$44.2			
Full-time Equivalents (FTE)		0.8						
	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.

FY01

Prepared:

Project Number: 01524
Project Title: Herring spawning sites: Location or substrate
Name: Brenda L. Norcross/Brenda Konar

FORM 4A
Non-Trustee
SUMMARY

2001 EXXON VALDEZ TR[illegible]EE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2000
Brenda Konar	PI/Research Assistant Professor		3.0	5.0		15.0
Brenda Norcross	PI/Associate Professor		1.0	8.0		8.0
TBA	3 SCUBA Divers (Temp)		4.5	2.8		12.4
Michele Frandsen	Technician		1.0	5.1		5.1
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		9.5	20.9	0.0	
					Personnel Total	$40.5

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2000
Fairbanks to Cordova		400.0	4	16	140.0	3.9
Fairbanks to Anchorage		300.0	2	8	116.0	1.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$5.4

FY01

Prepared:

Project Number: 01524
Project Title: Herring spawning sites: Location or substrate
Name: Brenda L. Norcross/Brenda Konar

FORM 4B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed
Description	FY 2000
Communications	0.3
Boat Rental	36.0
Dry suit maintenance	0.8
Required dive physicals	0.8
Hazardous Duty Insurance	0.7
Contractual Total	$38.6

Commodities Costs:	Proposed
Description	FY 2000
Food for boat	2.0
Pneumatic drill	0.6
Dive supplies	1.5
Misc. sampling gear	1.5
Commodities Total	$5.6

FY01

Prepared:

Project Number: 01524
Project Title: Herring spawning sites: Location or substrate
Name: Brenda L. Norcross/Brenda Konar

FORM 4B
Contractual & Commodities DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

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

Existing Equipment Usage: Description	Number of Units	

FY01

Project Number: 01524
Project Title: Herring spawning sites: Location or substrate
Name: Brenda L. Norcross/Brenda Konar

FORM 4B
Equipment
DETAIL

Prepared:

BELUGA SLOUGH HABITAT ASSESSMENT & RESTORATION PROJECT

Project Number:	01526
Restoration Category:	Intertidal and Subtidal Communities, Recreation and Tourism
Proposer:	City of Homer
Lead Trustee Agency:	City of Homer
Cooperating Agencies:	Department of Interior, Fish & Wildlife Service Alaska Department of Natural Resources Kachemak Bay National Estuarine Research Reserve
Alaska SeaLife Center:	No
Duration:	1 year
Cost FY 01:	$108,100
Geographic Area:	Kenai Peninsula, Homer
Injured Resource/Service:	Intertidal and Subtidal Organisms, Recreation and Tourism

ABSTRACT

Beluga Slough is undergoing rapid degradation of its protective beach berm by destructive human use. The slough itself provides critical habitat for migrating shorebirds and waterfowl, as well as invertebrates and young fish of several species. Results of a comprehensive feasibility study that includes botanical, biological, and hydrological field studies coupled to community information will be invaluable for developing a hands-on habitat restoration and enhancement plan to reverse the berm's destruction, which in turn will conserve the diversity and overall health of the slough's intertidal and subtidal fauna. The slough's sustained health will benefit migrating and wintering birds and promote recreationally compatible human use of the area.

INTRODUCTION

Kachemak Bay, the premier marine ecosystem in Cook Inlet, is important for its fertile intertidal, nearshore, and subtidal waters. The Bay's richly diverse biota benefits from the sustained health of its waters and adjacent uplands. Between the open bay and uplands within the City of Homer lies Beluga Slough, a classic northern saltmarsh. This important wetland functions as habitat for bivalve and crustacean invertebrates, a nursery for young fish, a possible spawning ground for sticklebacks, critical feeding habitat for migrating shorebirds and waterfowl, wintering habitat for resident ducks and gulls, a natural filter for pollutants, a barrier against ocean-driven erosion of Homer, and a site for human recreation activities.

Beluga Slough encompasses over 150 acres of high value saltwater wetlands. This estuary is located within the City of Homer, sandwiched between Beluga Lake to the east, a residential area to the south, Kachemak Bay to the west and commercial businesses along the Homer Bypass to the north. The lion's share of this site is in public ownership and lies within the recently designated Kachemak Bay National Estuarine Research Reserve (KBNERR). The Department of Interior, Fish & Wildlife Service (DOI-FWS) owns slough property totaling nearly 65 acres; the City of Homer owns a 40-acre parcel, which was purchased in 1998 with *EVOS* restoration funds, in addition to another 23 acres; and the Alaska Department of Natural Resources (ADNR) owns a 7-acre triangle of land adjacent to the Homer Bypass at Beluga Lake. Private property in Beluga Slough totals about 17 acres of land along the southern portion of the site. The 40-acre City-owned parcel has a conservation easement on it, and landowners of the remaining Beluga Slough property have indicated a willingness to consider conservation zoning or easements on their parcels, as well.

Historically, daily high tides reached well beyond their present extent of the Homer Bypass at Beluga Lake. In 1941-42, the Alaska Road Commission filled in the road crossing Beluga Slough, which had previously been a wooden bridge over the intertidal flats, creating a dam and Beluga Lake (ANPC, 1981). Aerial photos from the 1940's show the primary tidal creek extending to where the head of Beluga Lake is today, running east and west near the wetland's southern shoreline. Saltwater last reached Beluga Lake in 1982, when the weir was replaced and raised so that even the highest tide would not enter the lake (Personal Communication – M. Morawitz, 1999). The largest amount of water entering Beluga Slough at a single entry point occurs at this weir, resulting over many years in the formation of a new primary tidal creek running roughly through the middle of the slough.

This site and the mudflat habitat in Mud Bay are the most valuable sites for bird use among eight locations surveyed for birds between Bishop's Beach and the end of the Homer Spit in 1991. While over 80% of all birds counted were in Mud Bay, Beluga Slough had the greatest diversity of species [North, 1991]. Beluga Slough is an extremely active site for feeding shorebirds during the spring migration, especially for peeps such as the least and western sandpipers which feed on worms, bivalves, crustaceans, and other intertidal life residing in or above the mud. Resident and migrating ducks and geese enroute to more northerly or westerly breeding grounds consume large quantities of both invertebrates and saltmarsh plants living in the slough. During the spring of 1999, when heavy snowloads blanketed bird breeding grounds to the west and north of Cook Inlet until mid-May, unusual masses of migrating Canada geese and greater white-fronted geese

took advantage of the exposed mudflats and emerging vegetation in Beluga Slough to survive their forced stopover in Kachemak Bay.

High tides of 19 - 21 feet completely flood Beluga Slough. When the tide has ebbed, the many tidal creeks of Beluga Slough provide excellent habitat for soft-shell clams, amphipods, threespine sticklebacks, young flounders, and juvenile sculpins. These, in turn, are fed upon by birds, mammals, and larger fish. This food chain and web, which extends out into the open water of Kachemak Bay, benefits directly from nutrient outflow from Beluga Slough, namely in detritus resulting from decomposition of plant and animal material originating or trapped in the slough.

The numerous opportunities for passive recreation at Beluga Slough make this site incredibly valuable to Homer residents and visitors alike. Canoers and kayakers occasionally recreate at this site on high tides. A state-of-the-art trail along the slough's west side is used by people for environmental education, walking pets, birdwatching, and exercise. Landowners in the slough are currently planning for the future expansion of this trail to skirt the entire north shore of Beluga Slough and include interpretive signage along its route. Salt marsh ecology classes, offered by the Kenai Peninsula College and Alaska Maritime National Wildlife Refuge (DOI-FWS), attract adults and children into the heart, or low marsh habitat, of Beluga Slough. Educational opportunities focused on Beluga Slough and salt marsh ecology will dramatically increase in 2004, when the new Alaska Maritime Estuary Center (AMEC) opens its doors. This joint facility for the Alaska Maritime National Wildlife Refuge (AMNWR) and Kachemak Bay National Estuarine Research Reserve (KBNERR) will attract over 3,000 students a year to its visitor center and marine-related programs; its world-class interpretive displays and adjoining, unique salt marsh ecosystem (Beluga Slough) will bring over 100,000 visitors each year to Kachemak Bay.

In its present state, Beluga Slough provides a buffer against storm erosion for the City of Homer and its road system. High wave energy is reduced first by the slough's outer storm berm and then by a growing, though relatively unstable, secondary berm. Unfortunately for the health of the slough, high numbers of people recreate on the protective outer gravel berm that separates Beluga Slough from Kachemak Bay. Vegetation critical to the consolidation of this outer berm, namely beach rye grass, is being run over and killed by vehicle traffic at numerous places. Aerial photos taken fourteen years ago show the rapid rate of plant elimination along the entire length of the berm. In addition, people collecting driftwood logs have reduced and are eliminating an important habitat component for new plant growth on the berm. Grass seedlings survive well when drift logs are left onshore to provide the young plants with protection from the harsh elements of seaside life – salt spray, wind, sediment movement and ice abrasion.

Local individuals and visitors to Homer can regularly be found driving, parking, camping, motorbiking, and four-wheeling along most of the Beluga Slough outer berm during all seasons of the year. With grasses and other maritime vegetation being reduced here by these activities, the berm is disintegrating and will soon be able to withstand only mild storms. With less grass roots available to bind the beach's loose gravel, medium to heavy storms have taken a remarkable toll on the fragile berm. Waves from a November storm several years ago flattened the once-domed central portion of this site, pushing gravel in toward the slough. Increasing amounts of large-grain sediments from the berm entering the slough during storms have caused a

decline in the diversity of fauna and flora living near the mouth of this wetland. In the past year wind-driven waves at high tide have breached the berm in many places where vehicle traffic has eliminated any barrier of vegetation and logs have been removed. If this destructive pattern is not soon reversed, the outer berm will undoubtedly succumb to storm action, leaving Beluga Slough with no protection from storm events.

This damaged section of beach is owned primarily by the USFWS. Representatives of this agency need information resulting from a characterization of Beluga Slough to form a protective and restorative plan for the Beluga Slough outer berm. The effort encumbered in this proposal is to perform a feasibility study for a project to restore the outer berm that protects Beluga Slough and its intertidal and subtidal communities. The study, in the form of a National Environmental Policy Act (NEPA)-Environmental Assessment (EA), will provide alternatives for restoration projects at the gravel berm to enhance the intertidal and subtidal wetland communities in Beluga Slough. Botanical, biological, and hydrological studies, coupled to community and historical information, will provide the foundation for the EA. The eventual enhancement potential is to preserve and protect intertidal feeding habitat for migrating shorebirds and waterfowl, which in turn will help to replace and restore recreation and tourism services lost during the *EVOS*.

NEED FOR THE PROJECT

A. Statement of Problem

Beluga Slough is a brackish, shallow estuary with an outlet on Bishop's Beach and separated from outer Kachemak Bay by a storm berm. A tidal creek, which changes course slightly from year to year, breaches this berm at the southeast end of the slough's mouth. Each day brackish water in the tidal creeks rises to flood or nearly flood the channel banks, and several times each month the slough fills completely. This site consists of approximately 150 acres of high value saltwater wetlands owned by various governmental agencies and private individuals.

Historically, Beluga Slough extended to the head of where Beluga Lake now lies. Despite its reduced state, Beluga Slough is presently a fine example of a healthy, readily accessible northern salt marsh. Within the slough's high, low, and levee marsh habitats are thriving salt-tolerant plant communities. The tidal creeks support abundant invertebrate and fish stocks. These habitats also provide food and cover for migrating birds, especially shorebirds and waterfowl, and mammals such as moose and black bears.

Though the estuary itself suffers relatively few direct, negative impacts from humans, save perhaps some degradation of water quality due to man-made toxins entering the site from surface runoff, the outer berm that protects the slough from destructive waves is severely threatened. Excessive vehicle traffic along the entire length of the berm has resulted in a dramatic decline in vegetation at this site. Without enough plant roots, especially those of beach rye grass, to hold the berm's gravel in place, regularly occurring storms have eroded and will continue to erode this protective gravel dune until the barrier no longer exists. Then, erosion of this unique saltmarsh will accelerate to a point where the balance of material being washed to sea outweighs the sediment settling in the slough's increasingly turbid waters. Faunal residents of this area and

human residents of Homer will suffer the consequences of habitat degradation within Beluga Slough.

B. Rationale/Link to Restoration

This proposal is justified as replacement for, and enhancement of, injured intertidal and subtidal resources. These nearshore habitats within Beluga Slough must be protected, as much as reasonably possible, if we are to maintain a healthy and productive ecosystem for populations of migrating shorebirds and waterfowl and provide residents and tourists unique wildlife and recreational experiences.

C. Location

The EA project will be undertaken in Homer, Alaska. Studies of the flora and fauna will be conducted within the parcels of land owned by the City of Homer, DOI-FWS, and ADNR. Hydrological studies will be carried out on these same public lands in the slough and at Beluga Lake, the primary source of freshwater runoff into Beluga Slough. Private individuals owning land in the slough have already expressed a willingness to support studies on their properties.

This project will directly benefit Homer area residents through enhanced passive recreation opportunities. Additionally, given the international interest in the ecosystem of Kachemak Bay, the EA will provide invaluable information to the scientific community on the integration of wetland restoration in high use areas. An eventual product of the restoration project is increased tourism to observe this unique habitat and spectacle of shorebird migration. This will benefit the Cook Inlet region, specifically, and the State, in general.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

This collaborative project will rely heavily on the active participation of individuals, community groups, and governmental bodies. Interests and concerns from these parties will be combined with scientific findings and Trustee Council concerns to form an optimal restoration plan that is in the best interest of Homer residents and their environment. Frequent, open, and candid dialogue is the effective mechanism to achieve this goal.

While scientific information will shape the technical elements of the habitat restoration design, the program will only be effective if placed in a community context. It is incumbent and expected that the project will solicit community involvement and draw upon local resources for input to the planning, scheduling, assessment, and restoration design efforts. A major objective of the project coordinator's scope of work is to communicate with residents, in non-technical terms, on all aspects of the project. It is the project's responsibility to establish and implement procedures for collecting technical, local, and traditional ecological knowledge as well as investigating the issues and concerns raised by the public.

Homer is a community blessed with residents who possess a broad spectrum of knowledge and represent a wealth of talents. It is assumed the project will call on this talent to provide project support. For example, Homer is home to well-known and respected biologists who have already

made in-depth studies of Beluga Slough. These local authorities have intimate knowledge of the project area which translates into project effectiveness and cost savings. These experts are expected to be an integral component of the planning, assessment, and design team. The assessment team, depending on availability, will use local labor and resources, such as equipment and vessels, to assist in collecting data.

PROJECT DESIGN

A. Objectives

The eventual restoration goal, for which this proposal is a critical element, is to restore the outer berm at Beluga Slough in order to protect and preserve the unique intertidal and subtidal communities of this estuary. The principal objective of this project proposal is to develop a National Environmental Policy Act - Environmental Assessment that will provide a feasible restoration project, through the development and evaluation of several project alternatives, to restore the integrity of the outer gravel berm. Alternatives for the project will focus on restoring and rehabilitating the area in such a way as to increase, preserve, and protect a diverse feeding habitat for migrating birds. Data and results from the EA will be incorporated into AMNWR and KBNERR salt marsh ecology education and outreach programs to be developed for AMEC, the new joint facility to be completed in 2004. The willingness of four government agencies (i.e. landowners in Beluga Slough) and private land owners to cooperate in preserving this single biological unit will assure that the people and wildlife of Homer will benefit from the proposed EA and resulting restoration efforts. Additionally, the plan establishes mechanisms to enhance the recreational use of the area in an environmentally compatible manner.

The berm restoration project, possibly the topic of a follow-on proposal to the Trustee Council, is meant to protect the intertidal and subtidal slough habitat behind this barrier and enhance passive recreational opportunities, specifically those centered around the spectacle of the spring shorebird migration. This translates into increased resident and tourist interest in the area, especially during the annual Kachemak Bay Shorebird Festival. With the implementation of an optimal restoration design, Beluga Slough will be prime example of successful wetland and beach rehabilitation in a high use area.

To meet the proposal objectives, scientific and testimonial information is gathered to develop comprehensive restoration alternatives. These alternatives are compared and a preferred restoration alternative is tendered.

The objectives of the project are addressed by, but are not limited to, the tasks listed below.

1. Conduct a review of past documentation to establish an historical perspective for the comparison of past to present community related information and technical data.

2. Collect traditional and local information on prior and expected use of the area in relation to economic, social, and environmental issues. Solicit comments on issues and concerns relative to the impact on resources and services from a restoration project.

3. Measure the diversity, frequency, and abundance of flora and fauna in Beluga Slough and on the outer gravel berm.

4. Determine the geophysical characteristics of Beluga Slough and its protective berm.

5. Develop restoration design alternatives and conduct a comparative study to identify the preferred restoration project design.

6. Write a National Environmental Policy Act - Environmental Assessment.

B. Methods

The feasibility project being proposed involves collecting biological, botanical, hydrological, and community data that is used to produce an EA. Coordination and management of the project are the responsibilities of a representative for the City of Homer. Field, analytical, and formal EA efforts are to be developed and performed by consultant(s) hired by the City. The consultant(s) will formulate the details and methods for field studies. Generally, the elements of the project are as follows:

1. Research past biological, botanical, and hydrological studies of the area in order to develop a catalogue of historical data and information.

2. Conduct field studies to catalogue the flora and fauna presently in Beluga Slough and its protective outer berm. The data will establish a baseline for comparing historical data in an effort to delineate changes in the project area.

3. Conduct a hydrological study of Beluga Slough and Beluga Lake. Perform hydraulic, soil classification (test hole), and sediment transport studies.

The information acquired from the technical and community studies will provide the basis for determining the optimal restoration program. Production of the EA will follow NEPA guidelines.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The City of Homer is the sponsoring, coordinating, and responsible agency for this project. A restoration project in Beluga Slough directly impacts and interfaces with several state and federal agencies. The cooperating agencies include the Department of Interior, Fish & Wildlife Service (DOI-FWS), the Alaska Department of Natural Resources (ADNR) and the Kachemak Bay National Estuarine Research Reserve (KBNERR). These agencies have technical knowledge and vested interest in projects that work to restore and protect habitat. By providing key insight on biological relationships, the agencies can provide valuable support during the analysis of field data, the developing of restoration alternatives, and the selection of the preferred alternative. Aside from providing technical expertise on environmental restoration issues, as property owner of a significant portion of the project area, especially the berm on which restoration efforts will focus, the DOI-FWS has land use interests in Beluga Slough.

With respect to the DOI-FWS role, it is expected they will provide expertise and review functions during the environmental assessment phase of the project. The EA is the primary planning and permitting document for the project. As such, it is a primary tool for communicating the merits and options for follow-on restoration activities at the site and its consequence on neighboring facilities and habitats.

The Alaska Department of Transportation and Public Facilities (ADOT&PF), US Army Corps of Engineers (COE), and Federal Aviation Administration (FAA) possess significant technical knowledge of the area. Additionally, these agencies have vested interest in a Beluga Slough restoration construction project because the area is in proximity to their spheres of influence and responsibility: the Homer Spit Road is an ADOT&PF facility, Beluga Lake (owned by ADNR) is subject to oversight by FAA, and the COE is a permitting agency representing coastal water concerns. Other agencies with peripheral interest are the Alaska Department of Environmental Conservation (ADEC - State Water Quality Certification) and the Alaska Office of Management and Budget: Division of Governmental Coordination (Certification of Consistency with the Alaska Coastal Management Program). In all cases, the EA will provide a basis for understanding the relationship of the project to the environment and be a mechanism to critique the potential of the project in meeting the established restoration goals.

When appropriate, the project will attempt to contract with local talent and resources for specific project services. In some cases experts from outside the Homer area may best meet the objectives of the project. Expectations are to contract with private consultants for biological, botanical, and hydrological studies.

SCHEDULE

A. Measurable Project Tasks for FY 01

October 1 - November 15:	Collect and review historic information and data. Develop contract proposals for consultant(s) effort, advertise for cost proposals, and evaluate proposals. Conduct community involvement (education and information gathering) component of project.
November 15 - December 1:	Analyze proposals.
December 10:	Award contracts.
December 11 - January 1:	Assist contractors in logistics for field efforts.
January 1 - March 27:	Assist with winter field surveys. Analyze historic information and data. Prepare portions of EA.
January:	Attend Annual Restoration Workshop (3-day workshop).
February 1 - March 15:	Conduct community involvement component of project.
March 16 - April 13:	Prepare annual report of activities to date.
April 13:	Submit annual report.
April 16 - September 28:	Consultant(s) conduct field efforts and analyze data. Conduct formal community involvement component of project. Produce EA.

B. Project Milestones and Endpoints

January 1:	Initiate analyzation of historic data.
January 15:	Initiate EA process.
September 1:	Complete EA field studies and analysis of data..
September 28:	Submit EA and Report of Project to Trustee Council.

C. Completion Date

Substantial completion of the project is September 28, 2001. The principal objective to be completed by this date is the production of a NEPA-EA. Elements encumbered by this objective are historic and community perspectives, field studies, restoration design alternatives, no action alternative, comparative study of alternatives, preferred alternative, and final draft of the environmental assessment document.

PUBLICATIONS AND REPORTS

The project does not, at this writing, plan to submit manuscript(s) for peer-reviewed publication(s) in FY 01.

The project will submit to the Council an annual progress report on April 13, 2001 and a final project report on September 28, 2001.

PROFESSIONAL CONFERENCES

The project does not plan to present at professional conferences in FY 01.

NORMAL AGENCY MANAGEMENT

N/A

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The location and nature of this project requires close local, state, and federal agency coordination. During the formulation of this proposal substantive discussions have taken place with community organizations, local authorities, and state/federal agencies: ADNR, ADOT&PF, COE, DOI-FWS, and FAA. As the project unfolds it is expected that the coordination effort will expand.

Interested parties from the public, private, and government sectors are encouraged to engage the project during planning, design, implementation, and review processes. Similarly, the project will share data from the field efforts and welcomes feedback on its analyses, conclusions, and recommendations.

At present, the project addressed by this proposal has not solicited matching funding. This does not preclude such; rather, it is expected the project will take advantage of complimentary work undertaken by other entities, (i.e. shorebird counts, vegetation mapping).

It is planned that the follow-on restoration project will vigorously seek matching funding from non-Trustee Council sources. Potential sources for matching funds are the COE "Project Modifications for Environmental Improvement, Section 1135" and ADNR restoration grants.

EXPLANATION OF CHANGES IN CONTINUING PROJECT

N/A

PROPOSED PRINCIPAL INVESTIGATOR

The City of Homer plans to employ a Project Coordinator to manage the EA process. At present, the City does not know who will fill the Coordinator position.

PRINCIPAL INVESTIGATOR

Not Known

OTHER KEY PERSONNEL

Eileen Bechtol, Planning Director, City of Homer
Technical resource person and responsible party for City

Poppy Benson, U. S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge
Representative of Cooperating Agency and technical resource person

Ruth Carter, Alaska Department of Transportation and Public Safety, Coastal and Harbor Engineering Section
Hydrology and engineering resource person

Geno Del Frate, Alaska Department of Fish and Game, South-central District
Technical resource person

Larry Dugan, U.S. Fish and Wildlife Service, Ecological Services
Technical resource person

Ken Eises, U.S. Army Corps of Engineers, Coastal Engineering
Technical resource person on engineering design and hydrology issues

Dave Erikson, Dames & Moore
Biological resource person

Conrad Field, Natural Resource Conservation Service
Botanical resource person

Carmen Field, Kachemak Bay National Estuarine Research Reserve
Intertidal invertebrate resource person

William Hauser, Alaska Department of Fish and Game, Habitat Restoration Division
Technical resource person

Mac Humphrey, Federal Aviation Administration, Airports: Environmental Division
Technical resource person on FAA environmental concerns

Don McKay, Alaska Department of Fish and Game, Habitat Restoration Division
Technical resource person

Mary Lynn Nation, U.S. Fish and Wildlife Service, Ecological Services
Representative of Cooperating Agency and technical support on NEPA-EA

Glenn Seaman, Kachemak Bay National Estuarine Research Reserve
Representative of Cooperating Agency and technical resource person

Harvey Smith, Alaska Department of Transportation and Public Safety, Coastal and Harbor Engineering Section
Hydrology and engineering resource person

Bruce Talbot, Alaska Department of Natural Resources, Division of Lands
Representative of Cooperating Agency and technical resource person

Art Weiner, Alaska Department of Natural Resources, Wetlands Restoration
Representative of Cooperative Agency and technical resource person

George West, Birchside Studios
Avian resource person

LITERATURE CITED

Alaska Northwest Publishing Company (ANCP). 1981. "*Homer forges ahead, July 1941*" in Bits and Pieces of Alaskan History, Vol. 1, 1935-1959.

United States Department of Interior: Fish and Wildlife Service, M. R. North. 1991. *Memorandum: Bird Use of Homer Spit and Beluga Slough, 30-April - 10 May, 1991.*

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FFY 2000	Proposed FFY 2001
Personnel		$14.4
Travel		$1.7
Contractual		$74.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$90.1
Indirect		$18.0
Project Total	$0.0	$108.1
Full-time Equivalents (FTE)		12.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Dollar amounts are shown in thousands of dollars.

	Estimated FFY 2002	Estimated FFY 2003	Estimated FFY 2004	Estimated FFY 2005	

Comments:

The Indirect Cost multiplier for this project is 20%. The Indirects include, but are not limited to: utilities, phones, copying, office supplies, administrative and finance functions, and mail service.

2001

Prepared:

Project Number: 01526
Project Title: Homer Beluga Slough Habitat Assessment & Restoration Design Project
Name: City of Homer

FORM 4A
Non-Trustee
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FFY 1998
Vacant	Project Coordinator		12.0	1200.0	0.0	14,400.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		12.0	1200.0	0.0	
					Personnel Total	$14,400.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 2001
Project Coordinator: meetings and research in Anchorage	130.0	2	6	100.0	860.0
Official(s) of the City of Homer: meetings in Anchorage	130.0	2	6	100.0	860.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1,720.0

2001

Project Number: 01
Project Title: Homer Beluga Slough Habitat Assessment & Restoration Design Project
Name: City of Homer

FORM 4B Personnel & Travel DETAIL

Prepared:

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

Contractual Costs:	Proposed
Description	FFY 2001
Consultant(s) Firm to design and produce EA. Work includes biologic, botanical, and hydological field studies	70,000.0
Survey	2,000.0
Printing and Photographs	2,000.0
Contractual Total	$74,000.0

Commodities Costs:	Proposed
Description	FFY 2001
Cost associated with office materials, postage, utilities, etc. are addressed in the indirect rate.	
Commodities Total	$0.0

2001

Prepared:

Project Number: 01
Project Title: Homer Beluga Slough Habitat Assessment & Restoration Design Project
Name: City of Homer

FORM 4B
Contractual & Commodities DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

New Equipment Purchases:	Number of Units	Unit Price	Proposed FFY 2001
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

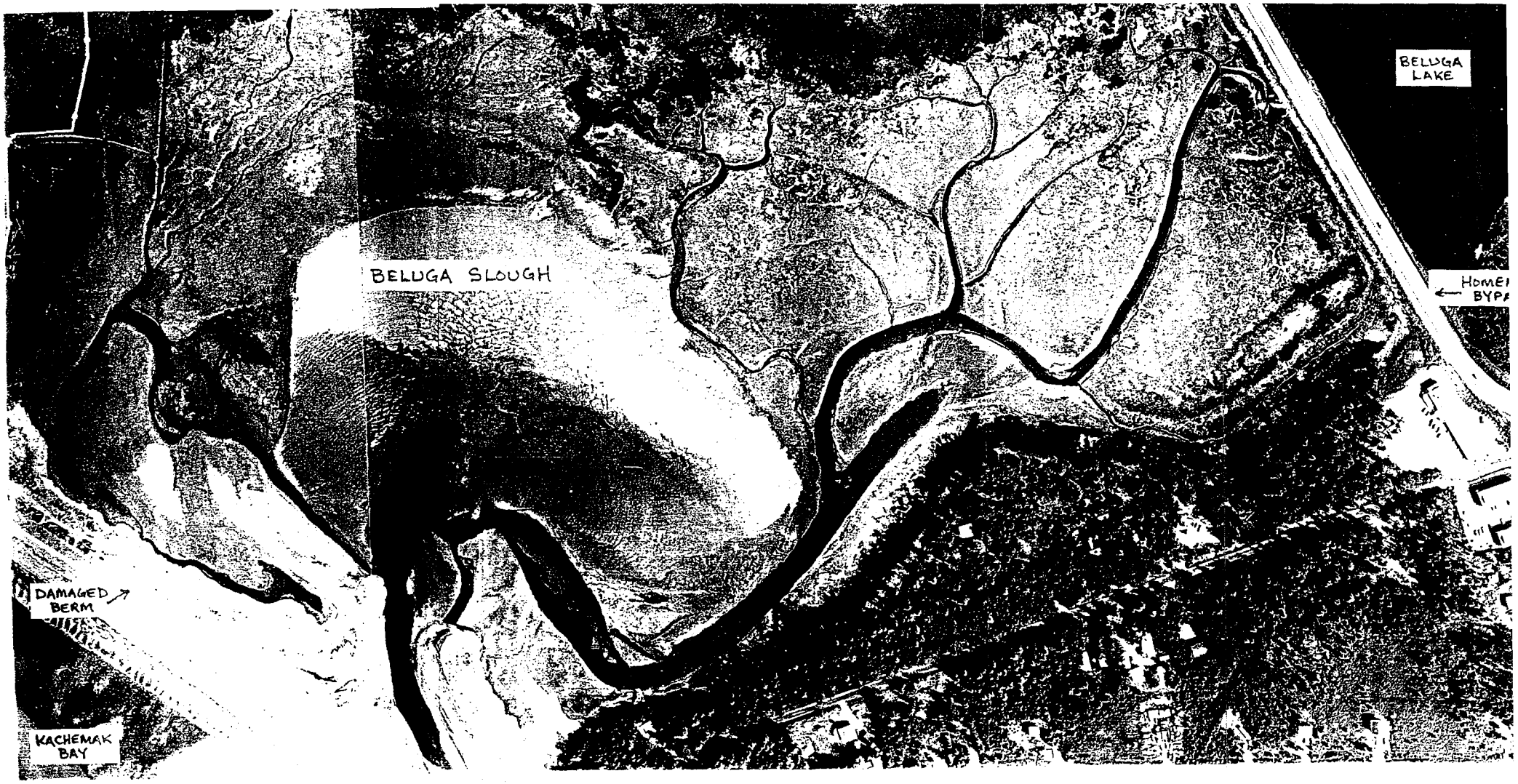
Existing Equipment Usage:	Number of Units	
Description		

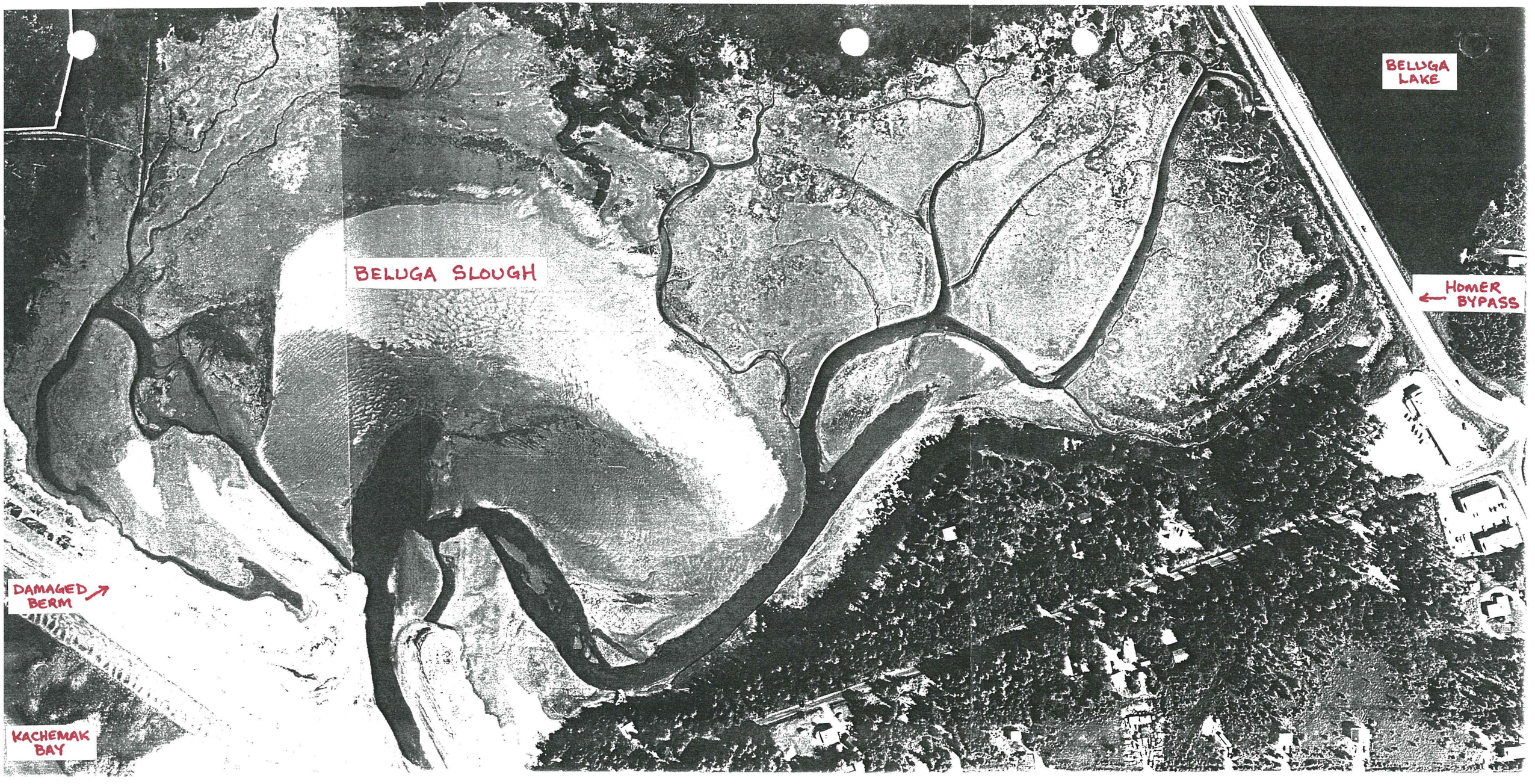
2001

Prepared:

Project Number: 01
Project Title: Homer Beluga Slough Habitat Assessment & Resroration Design Project
Name: City of Homer

FORM 4B
Equipment
DETAIL


BELUGA LAKE
BELUGA SLOUGH
DAMAGED BERM
KACHEMAK BAY


BELUGA LAKE
BELUGA SLOUGH
HOMER BYPASS
DAMAGED BERM
KACHEMAK BAY

Long-Term Monitoring of Intertidal Communities as a Framework for Hypothesis-Driven Research

Project Number:	~~To be assigned~~ 01528
Restoration Category:	Monitoring
Proposer:	NOAA/NOS/Office of Response & Restoration Hazardous Materials Response Division Seattle, Washington
Lead Trustee Agency:	NOAA
Cooperating Agencies:	
Alaska SeaLife Center:	No
Duration:	1st year, 2-year project
Cost FY 01:	$302,800
Cost FY 02:	$300,000
Geographic Area:	Prince William Sound, Kenai Peninsula
Injured Resource/Service:	Intertidal Communities

ABSTRACT

This project extends an assessment of intertidal injury and recovery established in 1989 and operated continuously through FY 2000. The project originally provided basic information on the early effects of the spill and subsequent cleanup which formed the basis for spill response guidance now institutionalized into standard operating procedures. The program has evolved from this operational focus into an umbrella monitoring program for spill impact and recovery hypothesis testing. Specifically, the long-term trends from the 10+ years of monitoring serve to identify more tightly targeted research questions related to issues of recovery in the Prince William Sound intertidal ecosystem.

INTRODUCTION

Hypothesis-driven research is of greatest value when conducted in the context of long-term observations.

Dr. Tom Malone, Horn Point Biological Station, UMCES, March 2000

Intertidal communities in Prince William Sound were among those most directly affected by shoreline oiling and the subsequent cleanup during the *Exxon Valdez* response. The monitoring effort which the proposed work would continue documented short-term impacts from oil and cleanup and over the longer-term has identified and tracked recovery processes in the intertidal zone. It is our belief, based on the ten years of data available to us, that recovery (as defined both in traditional and the more recently developed approach from this program), is not complete. We believe that the framework of a consistent program of intertidal field sampling has provided a unique opportunity to both characterize and investigate the nearshore environment of the Sound. In addition, we also believe there is scientific merit in the continuation of the basic field collections, associated analytical effort, and new targeted research studies, which have been designed and integrated to improve our understanding of intertidal recovery from the spill and document progress toward that end.

Over the last decade, this monitoring program has produced a regular series of reports and peer-reviewed manuscripts (see attached reference list) documenting biological, geomorphological, and chemical conditions on the shorelines of Prince William Sound. From the beginning, these reports have reflected a highly variable but clearly impacted environment. Early comparisons of sites at which aggressive washing techniques were employed and those where they were not suggested that the use of the intrusive methods may have delayed recovery processes. Thus, sound bites in the early 1990s about the cleanup "doing more harm than good" became common in the popular media as well as among project researchers ourselves.

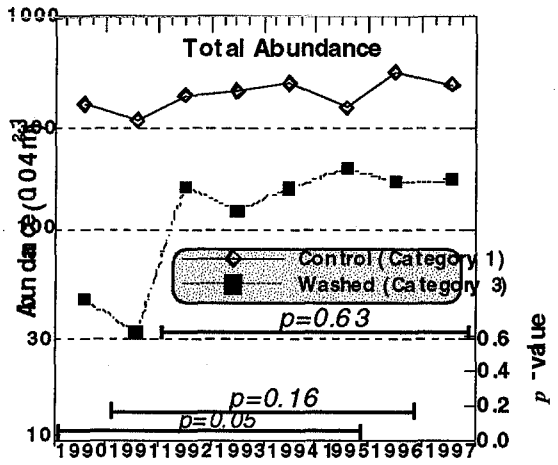
With the benefit of hindsight augmented by several more years of monitoring data, we now know that this was something of an oversimplification and that the true picture (or, the picture as we perceive it today) is a much more complex one with many subtleties, and one that does not easily lend itself to broad generalizations.

The body of data from this program does show that the more aggressive cleanup techniques resulted in an impact of their own beyond that of the oiling impacts. However, comparison of the three defined site categories (unoiled, oiled and not washed, oiled and washed) indicates that the recovery from the sum of these impacts occurred as rapidly as recovery from oiling alone. To express this in another way: the overall extent of damage to intertidal biota was greater at the study sites that were intensively cleaned, but the compensation by the biological communities was such (i.e., greater) that differences attributable to cleanup were negligible within 2-4 years.

Does this suggest that the intertidal environment in Prince William Sound has recovered? No. We believe we are documenting a *recovering* system, but not one that has attained *recovery*. The relatively new analytical framework (Coats et al., 1999; Skalski et al., in press) from which the observations above derive is an approach we have termed "parallelism." The operational definition for parallelism is:

> A condition where time profiles of average abundance at control and impacted sites track one another through time. Observed temporal excursions must act in unison so that the average levels change at the same time while maintaining a constant difference in logarithmic abundance.

In the representative example shown below for total infaunal abundance, the time profiles of control and impacted communities reflect "tracking" of one another from 1992 on. The significance levels at the bottom of the graphic indicate whether the profiles over six-year time frames are different or not. For example, between 1990 and 1995, they are different (p=0.05); between 1992 and 1997, they are not (p=0.63).



Example of parallelism plot, for infauna, 1990-1997

Parallelism is based on metrics of abundance or cover—the most fundamental community measure—and does not take into account important biological considerations of community interactions, life history, or physiology. While the widespread occurrence of compensatory ("recovery") patterns across intertidal taxa is impressive and suggestive of a common response to impact, we recognize that it is an analysis at a general hierarchical level. Although total abundance for a given group of biota may have stabilized, shifts in the community composition within the major assemblages may be indicative of subtler aspects of recovery. The emphasis on basic measures was necessitated by constraints imposed by the original sampling design, sample size, and taxonomic uncertainties (since resolved through consultation with experts). Thus, the statistical underpinnings for our recent analyses are strong, but at this point restricted to somewhat superficial taxonomic organizational levels.

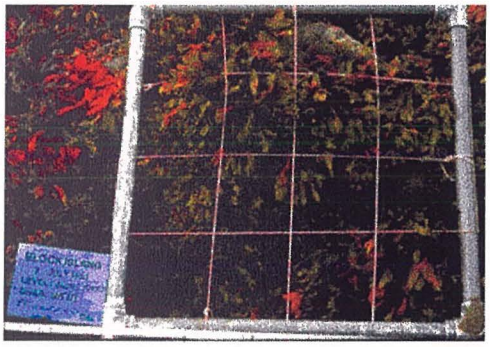
The duration of the current database limits the ability of parallelism to detect ongoing fluctuations in abundance. With each additional year of monitoring data added to this trend analysis, additional statistical power is gained and our ability to resolve gradual long-term trends not currently evident in the data increases.

However, the inherent limitations of the approach requires that alternative techniques be used in concert with time trend analysis in order to present a more complex and complete portrait of the intertidal system. Certain biota continue to show evidence of lingering impact from the spill. Littleneck clams from oiled and washed sites, for example, have shown a consistent trend of convergence toward reference sites that suggests that even using the fundamental community measure of abundance, recovery is in progress and not complete (stabilized) (Shigenaka et al., 1999). Reciprocal transplant experiments conducted as part of our program indicated that six

years after the spill, residual oil continued to affect survival and growth rates of the clams (Fukuyama et al., in press).

Other communities reflect oscillations that may have their origins in the initial spill impact and continue to reverberate in the system. The consistent monitoring framework has permitted us to document these trends, but until recently we have not sought to link the underlying causal mechanisms to the trends except by inference, speculation or other indirect means. That is, we have been able to correlate trends with possible spill impacts—but as statisticians continually remind us, correlation ≠ causation.

For example, we have good qualitative (photographic) evidence as well as quantitative epibiota data from site monitoring to indicate that "something" happened to *Fucus gardneri* (rockweed) cover between 1993 and 1994. Following oiling and cleanup impacts in 1989, cover of this common intertidal alga increased steadily—until 1994, when the cover declined dramatically. At some sites, the percent recover seemingly crashed to levels approaching bare rock. Why did this occur? Was it spill-related? We and others conjectured that this was possibly related to spill- or cleanup-induced changes in population structure to a single age cohort instead of a mixed stand of different cohorts. Because of this, when the 1989 cohort reached the end of its normal life cycle in 1993-1994, cover was drastically reduced. This could be contrasted to a "normal" situation with a mixture of age cohorts, in which the die-off of one cohort would not be expected to significantly affect overall cover due to the presence of many others.



Block Island mid study quad # 8, 1993

Block Island mid study quad # 8,1994

Another example suggestive of a possible spill link is that for infaunal communities and grain-size structure at depositional (i.e., gravel) beaches. There is a large body of literature that links physical characteristics of the environment to infaunal community structure. We have circumstantial evidence to suggest that washing techniques may have changed grain-size at oiled and cleaned beaches to the extent that the return of those beaches to biological conditions comparable to pre-spill has either been delayed or prevented: aerial photographs taken during cleanup in 1989 show vast plumes of silty material being washed out of beaches; after-the-fact statistical correlations show a strong relationship between grain size and infaunal communities.

In the latter case, Monte Carlo tests were applied in a canonical correspondence analysis between a group of physico-chemical parameters (total organic carbon, total Kjehldahl nitrogen, grain size) and 1993-1997 infaunal data. TOC and TKN were not significantly related to infaunal abundance. However, a highly significant ($p \leq 0.001$) relationship existed between infauna and the 63 □ sediment (very fine sand) fraction at study sites. Nevertheless, this does not permit us to directly link the cleanup to biological changes on beaches.

Block Island study site, July 1989, showing sediment plume during cleanup.

The monitoring effort, therefore, has documented certain trends and relationships that may or may not have links to oil or cleanup or both. It seems unlikely that the core monitoring program could permit us to establish or rule out a causal mechanism for the conditions we see. But having identified potential links and associated questions of interest, we can design targeted research to answer our questions in direct and (hopefully) conclusive fashion. Hence, the relevance of Dr. Malone's observation that hypothesis-driven research is of greatest value when conducted in the context of long-term observations: we have independently come to embrace this approach, and are using the ongoing program of monitoring to characterize conditions in the intertidal, define trends of interest, and then to provide a broader context for focused hypothesis-driven research. The two examples discussed above either have been or are currently being implemented as individual research studies taking place at the Kasitsna Bay Laboratory near Seldovia, AK, under discretionary NOAA funding:

- In 1999, we implemented a field experiment in which a series of study plots of Fucus were completely cleared. Another series will be cleared in 2000. these will be tracked over at least five years to observe recruitment patterns and to ascertain if a cyclical pattern of plant cover (similar to that observed in the Sound) is induced. Relatively low-cost follow-up field data collection on an annual basis is proposed within this Trustee proposal.

- In 2000, we have applied for the necessary permits to study the physical and biological effects of shoreline flushing and washing. In this experiment, we propose to use actual shoreline cleanup equipment to flush/wash designated plots on gravel beaches. Before and after grain size data will be collected, as will before and after infauna samples.

These are two examples of targeted research studies that have been derived from and designed around trends observed in the long-term monitoring program. The underlying trends that are driving the focused experiments became apparent only over an extended period of time, underscoring the value of a long-term program.

We believe that this long-term monitoring program has evolved into an effective and cost-effective way to track conditions in the Prince William Sound intertidal. While laboratory and ecotoxicity-based risk assessments can yield relevant and useful information for understanding the effects of contaminants and other anthropogenic stressors, Peterson (2000) has stated that these are inadequate for delineating subtle and indirect impacts from events like oil spills. He suggests that a field sampling-based approach is of particular value because it integrates across all mechanisms, includes chronic effects on long time scales, and includes indirect interactions. We concur, and hope the Trustees will support the continuation of the project.

The *Exxon Valdez* Restitution Program has been the sole source of funding support for this work since 1993; as we near the practical end of that support in FY2000, we are requesting Trustee support for continuation of the project.

NEED FOR THE PROJECT

A. Statement of Problem

Intertidal communities have made substantial progress toward recovery as defined within constraints imposed by the highly variable nature of the data and limitations of the original sampling design of our monitoring program. Our recently described analytical framework, while providing useful insights into temporal trends in the Prince William Sound intertidal community, has its inherent limitations. We recognize that there is a need to both refine and augment the assessment to account for biological considerations of community interaction, life history, feeding methods, etc.; and further, that even under the grosser -scale analytical approach of time trend analysis using basic abundance data, certain important resources cannot be considered as recovered. Therefore, we feel that core monitoring activities will continue to yield interesting and intriguing insights into the status and recovery trends of the Prince William Sound intertidal environment, but also serve as the basis for experimental study design for furthering our understanding the specifics of oil spill and spill response impact.

B. Rationale/Link to Restoration

Peterson (2000) has noted that significant physical and biological activity and processes tend to be concentrated at interfaces, such as that represented by the intertidal environment. In the case of oil spill assessment, the intertidal is of particular importance because it is at this interface where stranded oil, cleanup activities, and critical biological communities intersect. Peterson noted that for intertidal habitats in particular, a wide range of services are provided. These include:

1. Feeding grounds for valued consumers from elsewhere (i.e., marine, terrestrial, and aerial);
2. Spawning grounds;
3. Intrinsic value to shoreline communities due to high biological diversity;
4. Recreational, commercial, subsistence uses;
5. Cultural, recreational, and aesthetic values.

If, as we have postulated, the intertidal environment remains in a state of recovery-related flux, then the services provided will to varying degrees be impaired and a range of other resources, including human users, will remain impacted. Research in many other parts of the world as well as Trustee-sponsored work in Prince William Sound have reinforced the concept and importance

of linkages between the intertidal and the other biotic zones, and we cannot expect complete restoration of service across those zones until impacts in the discrete components have faded.

C. Location

Core studies will be conducted in Prince William Sound and the Sound will be the focus of most of our work. However, there will be an annual need to revisit established experimental sites in the Lower Cook Inlet region (Kachemak Bay/Kasitsna Bay) to make field collections in support of the targeted experiments described previously.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

In Prince William Sound, every effort is made to keep local communities informed of our field activities through phone calls and letters. For the Lower Cook Inlet experimental studies, there is an excellent opportunity to link followup field data collections to community outreach efforts either through the Kachemak Bay National Estuarine Research Reserve or through other educational programs based at the Kasitsna Bay Laboratory. These research collections could easily be incorporated into a future community-based monitoring program, and we have and would continued to encourage efforts to that end.

PROJECT DESIGN

A. Objectives

The objectives of the proposed study are to continue the documentation of status and trends of recovery in intertidal communities (epibiota and infauna) in spill-affected areas of Prince William Sound; and to use the long-term database as a means to identify research areas and implement studies to further our understanding of spill and cleanup impacts.

B. Methods

Methods detailed below describe the field approach as practiced in the monitoring program between 1990 and 2000. While consistency remains a priority in this long-term program, we will consider changes to the general approach if it can be demonstrated that results from a modified approach would be comparable to previously collected data and that continuity of the program is maintained.

Biology: Rocky Habitats

To minimize variability inherent on natural beaches, sampling in rocky habitats will be stratified to focus on the *Fucus* zone, as well as in the typically heavily oiled supralittoral zone (at the upper limit of attached macrobiota). Each elevation to be sampled has been previously and semi-permanently marked with rebar stakes, metal spikes, or surveying putty. Permanent 30 m transects oriented parallel to the waterline have been established at two elevations (upper and middle intertidal, as determined by biological assemblages). A step-by-step procedural methodology for sampling these established rocky sites includes:

1. At each elevation, ten 0.25-m^2 quadrats have previously been randomly located and permanently marked for non-destructive sampling.
2. A 35 m survey tape is laid out along the permanent transect line. Verify location of permanent quadrat markers, and reinstall any missing stakes or markers.
3. As a rule, quadrats on rocky substrate sites are positioned, facing away from the water, with marker or stake in the upper right corner of the quad (this is in contrast to cobble/gravel transects, where quadrats are positioned with the marker or stake in the lower left corner). A photographic guide to quadrat positioning is available.
4. Each quadrat is photographed using color slide film (digital photography may be used in addition but not in place of). A label denoting the site, date, transect elevation, and quadrat number should be included in the photograph. Depending on lighting conditions, a strobe may be necessary for photographing the quadrats.
5. Estimate percent algal cover, to lowest possible taxonomic category.
6. Enumeration of all invertebrates within quadrat. This may be accomplished through actual counts or through alternative methods such as point contact. Species too numerous to conveniently count may be subsampled by counting only those individuals in a roughly representative section of the quadrat and extrapolating to the entire quadrat. Sessile and colonial species (e.g., barnacles, mussels, tunicates, sponges, bryozoans) may be enumerated by estimation of percent cover or other means. It may be appropriate to measure both abundance and cover for both barnacles and mussels. Representative specimens of questionable species of both flora and fauna should be collected for taxonomic resolution in the laboratory.
7. A subjective description of oiling and other physical conditions (e.g., water cover, snow) in each quadrat will be recorded with an estimated percentage of the quadrat containing surface oil.
8. Epibiota enumerations will be recorded in the field on waterproof data forms. Original data sheets will be retained by NOAA.

Biology: Cobble/Gravel/Mud Substrates

Lower intertidal transects in cobble/gravel/mud substrates will be sampled for infauna using a 0.009 m^2 corer. The core sampler is a modified "clam gun", which is readily available on the Pacific coast. The clam gun has been shortened so that its length is 15 cm, thus yielding a sample volume of 1.1 liter.

Standard sampling protocols for cobble/gravel/mud sites are described below:

1. Establish transects as described for rocky substrates. Quadrats are oriented so that the marker or stake lies in the lower left corner of the quadrat as the observer faces away from the water.
2. Infaunal cores will be collected at cobble/gravel/mud transects located at lower tidal elevations. At a consistent and predetermined location relative to each of the five permanent quadrats (e.g., outside the quadrat itself, near the lower right corner), a core sample is taken. Past sampling records should be consulted to ensure that the predetermined coring location has not been used before. The coring device should be driven into the substrate until the top of the corer is level with the beach surface. Before extracting, the sampler should be rotated rapidly and worked back and forth to break the core sample loose. Preferably, a cap should be fitted to the end of the device to prevent sample loss during extraction and transfer. The sample is carefully transferred to a previously labeled container (e.g., large ziplock-type bag or other container).
3. Infaunal core samples will be pre-sieved in the field (not necessarily on-site) to remove larger substrate materials. Samples will be sieved through 1.0 mm sieves using a low-pressure seawater wash. Seawater source should preferably be filtered to remove potential contamination by organisms in the water column. Sieved infaunal samples are then preserved in 10 percent (in seawater) buffered formalin and packed for shipment to the laboratory, where detailed examination and enumeration will take place.
4. On cobble/gravel/mud substrates, up to four of the non-permanent 0.25-m^2 quadrats will be sampled to a depth of approximately 20 cm (or until a biologically inert substrate is reached), screened or sieved to ensure quantitative collections, and hand-sorted to remove infauna.

Chemistry: Sediment & Tissues

Selected sediment and tissue samples, at the option of NOAA, may be collected at sites in order to characterize existing environmental conditions, and potential exposure and uptake mechanisms. Chemical analyses will be performed under contract (currently by the Institute for Environmental Studies at Louisiana State University, LSU). NOAA personnel or contracted chemists will direct the hydrocarbon sample collection effort. Past experience has shown that the field time allocated for biological sampling of epibiota and infauna, as detailed above, is more than sufficient to permit chemical sampling. As chemistry samples are typically stored frozen, freezer space aboard the vessel must be allocated as well.

A brief description of field sampling protocols for chemistry follows:

Sediment Samples

Sediment samples may be collected at selected sites, although the overall decline in residual oiling at most of the monitored sites has reduced the usefulness of these results. However, selected sediment samples will continue to be collected and analyzed to provide information on weathering patterns and hydrocarbon sources.

Previously, sediment sample composites at cobble/gravel/mud sites have been collected from excavations resulting from the infaunal core collections. Surface sediment material from the upper 5 cm of the excavations were collected and composited to yield one sample for each transect elevation.

Field sampling will be accomplished using techniques to ensure no hydrocarbon contamination will occur during collection. Samplers wear new disposable surgical gloves for each sample, and will use noncontaminating scoops to place the sediment samples in EPA-certified glass containers. Sample containers must be labeled with unique field ID numbers to facilitate tracking and prevent subsequent confusion in the lab. Samples will be kept frozen until analysis.

Analysis of the sediment samples will take place at LSU or the currently contracted facility.

Tissue Samples

Tissue samples of certain representative species will be collected at most monitoring sites. Target species for collections typically include the bivalves *Mytilus trossulus* and *Protothaca staminea*, and these organisms will typically be collected whenever available at an established monitoring transect area.

Standard sampling procedure will involve the collection of a sufficient number of organisms to provide a composite laboratory sample and replicate, generally 50 g of soft tissue material. Generally, this is satisfied by a sample consisting of 25-40 organisms, dependent on size. Samplers wear disposable gloves to prevent hydrocarbon contamination of the organisms. Gloves are changed between samples. The composite will be double wrapped in aluminum foil, labeled, sealed in a labeled ziplock-type plastic bag, and kept frozen until analysis.

Analysis of the tissue samples will take place at LSU or the currently contracted facility.

Ancillary Site Characterization

In addition to the biological and chemical collections described above, ancillary information about each site will also gathered. This information will include, at a minimum, ambient water salinity and temperature; and where substrate-appropriate, total organic carbon, total Kjeldahl nitrogen, and grain size characteristics for sediments.

Data analysis

Data from epibiota, infauna, ancillary site characterization activities, and chemical analyses will be entered into the reference database in Seattle, and biological data will also be entered into a satellite database in California. Summary statistics will be prepared for the annual project report, time series analysis will be updated to incorporate results for the most recent field sampling, and the implications of those results (including any new, anomalous, or significant trends) will be discussed. Suggestions for further work to augment or target research effort will be included. If data from targeted experimental studies are available, these will be presented in manuscript form and submitted for publication in the literature.

A separate report will be prepared for chemistry, with the intent of summarizing current status of residual hydrocarbons primarily in the target species of bivalves. Some discussion of trends in oil weathering and source identification for selected sediment samples will also be incorporated.

Monitoring guidance

For FY 2001, our intent is to prepare a monitoring guidance document based on the long-term lessons of this program. Although actual content has not yet been determined, examples of

material that could be represented include philosophy of impact assessment, the statistical basis of field monitoring design criteria, randomization, stratification, pseudoreplication, field methods, etc.

Personnel and project management

The project will be implemented by an experienced team of scientists who have been directly involved in intertidal research and monitoring studies both in Prince William Sound and elsewhere. The work will be coordinated by NOAA/Office of Response & Restoration, with Gary Shigenaka and Rebecca Hoff as the project leaders.

Responsibilities for each of the participants is as follows:

NOAA/Office of Response & Restoration—Seattle, WA (Shigenaka & Hoff))
- Overall project management
- Logistical support for field sampling efforts
- Assist in sampling and data analysis
- Assist in manuscript preparation

Marine Research Specialists—Ventura, CA (Imamura & Coats)
- Lead contractor for biological team
  - Fiscal management & personnel assignments for biology
- Lead for data analysis
- Lead author(s) on manuscripts

University of Washington—Seattle, WA (Skalski, Klinger, & Fukuyama)
- Subcontracted statistical (Skalski) & biological (Klinger, Fukuyama) support
- Lead field scientist (Fukuyama)
- Lead for infauna analysis (Fukuyama)
- Lead phycologist (Klinger)

Tenera Environmental—Avila Beach, CA (Kimura, Steinbeck, Blecha, Caroll)
- Subcontracted biological support
- Lead for epibiota analysis

Louisiana State University—Baton Rouge, LA (Miles)
- Contracted chemistry support

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Since 1998, we have supported the participation of other scientists with an intent of (*inter alia*) fostering ties to other Trustee research programs. For example, between 1998 and 2000, Ms. Susan Saupe (Cook Inlet Regional Citizens Advisory Council) and Ms. Mandy Lindeberg (NOAA/NMFS Auke Bay) have accompanied us into the field in both Lower Cook Inlet and in Prince William Sound. In 1999 and 2000, we are supporting a Trustee project led by Dr. Thomas Dean to study if and how data from the NOAA intertidal monitoring effort can be combined with data from the Coastal Habitats Injury Assessment (CHIA) to increase the utility of the data. We believe that such interactions not only are mutually beneficial for the individuals and agencies involved, but also serve to strengthen the relevance of our work to the larger Trustee effort.

SCHEDULE

A. Measurable Project Tasks for FY 01 (includes FY02 carryover tasks from FY01)

Field sampling will be conducted in May and June 2001; epibiota data will be entered, checked, and partially analyzed by October 1, 2001; infauna data will be entered, checked , and available for analysis by January 2002. A progress report will be prepared at the end of FY01, and two final reports (biology and chemistry) and one manuscript (monitoring guidance) will be completed in FY2002. A description of these is provided under "Publications and Reports" below. A more detailed schedule is presented below.

B. Project Milestones and Endpoints (includes FY02 carryover tasks from FY01)

All field work will be completed by July 2001, and epibiota data will be entered and databases updated by September 30, 2001. Infauna and chemistry data will be available December 31, 2001. Two final reports and one manuscript will be completed by April 2002. It is anticipated that the manuscript will be reviewed, revised and submitted for final acceptance by September 2002.

October 1, 2000:	Project initiation under Trustee sponsorship
February 2, 2001:	Project planning meeting with key scientific personnel
May 23-26, 2001:	Field data collection, Kasitsna Bay
June 18-27, 2001:	Prince William Sound field cruise
July 20, 2001	Cruise report submitted
September 30, 2001:	Epibiota data entry and QA/QC completed
December 31, 2001:	Infauna sorting and taxonomy completed
December 31, 2001:	Chemistry lab analysis completed
April 15, 2002:	Biology & chemistry reports submitted
April 15, 2002:	Monitoring guidance manuscript submitted

C. Completion Date

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

PUBLICATIONS AND REPORTS

Three manuscripts will be prepared and will be intended as final reports for the project. Potential titles, authorship, and journals for submission are as follows:

Status and trends in intertidal communities twelve years after the *Exxon Valdez Oil Spill.* Coats, D.A., E. Imamura, A.K. Fukuyama, J.R. Skalski, S. Kimura, J. Steinbeck, R.Z. Hoff, and G. Shigenaka (possible submission to Mar. Ecol. Progress. Ser.)

Chemical trends in sediments and bivalve tissues twelve years after the *Exxon Valdez Oil Spill.* Miles, S., E.B. Overton, R. East, J. Farr, R.Z. Hoff, and G. Shigenaka. (Possible submission to Mar. Poll. Bull.).

Monitoring guidance for oil spill assessment. Skalski, J.R., D.A. Coats, E. Imamura, A.K. Fukuyama, S. Kimura, J. Steinbeck, R.Z. Hoff, and G. Shigenaka (possible submission to J. Env. Management)

PROFESSIONAL CONFERENCES

No funding is being requested for attendance at professional conferences in FY01. There is potential for members of the scientific team to seek support for presentations at scientific meeting in FY02, when results from the proposed work have been analyzed.

NORMAL AGENCY MANAGEMENT

As this project is fundamentally a disturbance monitoring study, it is an activity that could not have been initiated in the absence of the oil spill. While NOAA/OR&R does fund a certain level of research to produce guidance for spill response and other environmental management applications, the scale and technical complexity of the monitoring as detailed here is far beyond the normal purview of the agency. NOAA's National Status and Trends Program is a nationwide monitoring effort that has been supported by the agency for 16 years, but it is far broader in scope and is not designed as a vehicle for impact assessment and recovery documentation.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

In recent years, we have made a conscious and concerted effort to coordinate our intertidal research with other Trustee restoration projects. For example, we are currently supporting Drs. Thomas Dean, Lyman McDonald, and Michael Stekoll in their active project to study intertidal monitoring approaches and the feasibility of pooling data to maximize benefit. Between 1998 and 2000, we have incorporated two veteran field biologists from the Coastal Habitats project, Susan Saupe and Mandy Lindeberg, into our own research team. In 1998, we worked with Ms. Saupe and Ms. Lindeberg to establish new study sites at two CHIA survey areas (Deer Cove, Lower Herring Bay) in order to directly compare results for epibiota enumeration. Although data for this comparison effort was collected in 1998 only and has not yet been analyzed, the ready possibility exists to repeat field collections and allocate analytical effort to this as a targeted study.

Additionally, in the year 2000 we have provided tissue chemistry data to Dr. James Bodkin in order to help provide context for ongoing sea otter biomarker studies.

A key member of our monitoring team for the past ten years and the lead investigator for infauna, Allan Fukuyama, has also been active in the Nearshore Vertebrate Predator project. This "cross-pollination" has proved beneficial to us at several levels, not the least of which is methodological and taxonomic consistency with the NVP project.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

None

PROPOSED KEY INVESTIGATORS

Gary Shigenaka
NOAA/OR&R/ HAZMAT
7600 Sand Point Way NE
Seattle, WA 98115
(206)-526-6402
Fax (206)-526-6329
shigenaka@hazmat.noaa.gov

Rebecca Z. Hoff
NOAA/OR&R/ HAZMAT
7600 Sand Point Way NE
Seattle, WA 98115
(206)-526-6276
Fax (206)-526-6329
rebecca.hoff@hazmat.noaa.gov

Eiji Imamura
Douglas Coats
Marine Research Specialists
3639 E. Harbor Blvd., Suite 208
Ventura, CA 93001

Allan K. Fukuyama
Fukuyama/Hironaka Taxonomic and Environmental
7019 157th Street S.W.
Edmonds, WA 98026

John R. Skalski
School of Fisheries
University of Washington
1325 Fourth Avenue, Suite 1820
Seattle, WA 98101

Scott Kimura
John Steinbeck
Tenera Environmental
P.O. Box 400
Avila Beach, CA 93424

OTHER KEY PERSONNEL

Terrie Klinger
University of Washington Friday Harbor Laboratories
620 University Road
Friday Harbor, WA 98250

Mandy Lindeberg
Auke Bay Laboratory
11305 Glacier Highway
Juneau, AK 99801

Susan Saupe
Cook Inlet Regional Citizen's Advisory Council
910 Highland Ave.
Kenai, AK. 99611

BIOGRAPHICAL SKETCHES FOR PRINCIPAL INVESTIGATORS

Gary Shigenaka is the proposed principal investigator for this project. A graduate of the University of Washington's School of Oceanography (1976) and Institute for Marine Studies (1987), he was part of NOAA's initial *Exxon Valdez* damage assessment team in 1989 and since 1991 has managed NOAA's long-term monitoring program in Prince William Sound. He has been a field party scientist in every project monitoring visit to the Sound—save one, when his son was born in 1995. He has extensive experience in fisheries biology, oceanography, and environmental monitoring. Prior to joining NOAA/HAZMAT in 1990, Mr. Shigenaka worked on the National Status and Trends Program in Washington, DC and Seattle.

Rebecca Z. Hoff is a NOAA co-principal investigator for the project. She graduated from the University of California Santa Cruz with a B.A. in biology and environmental studies, and received an M.S. in fisheries from the University of Washington. Ms. Hoff is a marine biologist who is currently involved with several research projects, including the NOAA Prince William Sound monitoring study and the U.S. Coral Reef Initiative. She has also worked with HAZMAT's Superfund program, and is experienced in issues related to spills of toxic chemicals as well as oil. Prior to her work with HAZMAT, Rebecca Hoff performed quantitative assessment of commercial fish stocks for NOAA's National Marine Fisheries Service.

Eiji Imamura is President and Manager of Marine Research Specialists in Ventura, CA. He has over 20 years experience in managing applied marine environmental programs. Mr. Imamura specializes in the design and implementation of multidisciplinary marine programs for environmental impact assessment. Prior to establishing Marine Research Specialists, Mr. Imamura was the Director of Battelle Ocean Sciences. He also served as Chief of the Environmental Studies Program for the U.S. Department of Interior's Minerals Management Service Atlantic OCS Region.

Douglas A. Coats, B.S. in physics (1975), California State Polytechnic University at Pomona, M.S. in oceanography (1979), Scripps Institution of Oceanography, Ph.D. in oceanography, Scripps Institution of Oceanography (1982). Dr. Coats has over 20 years experience interpreting oceanographic data to resolve complex marine environmental issues. He has analyzed a wide variety of interdisciplinary oceanographic data sets using multivariate statistical methods to interrelate marine biological, physical, and chemical processes.

John R. Skalski, B.S. in wildlife management/biology (1974), University of Wisconsin Stevens Point, M.S. in wildlife science (1976), Oregon State University, M.S. in biometry (1978), Cornell

University (1982), Ph.D. in biometry (1985), Cornell University, is a professor of biological statistics at the University of Washington's Center for Quantitative Science. Dr. Skalski is an internationally known expert on the development of sampling methodology, field designs, and statistical tests for assessing human-induced and natural effects on organismic and ecological systems. In addition to his skills as a environmental statistician, he is also a certified wildlife biologist (through the Wildlife Society) and a member of the American Fisheries Society.

Allan K. Fukuyama, B.S. in zoology (1973), University of California Davis, M.A. in biology (1985), San Francisco State University Moss Landing Marine Laboratories, is a marine biologist with twelve years uninterrupted intertidal and subtidal experience in the spill-impacted Alaskan environment. Mr. Fukuyama is currently in the final agonizing stages of his Ph.D program at the University of Washington, where he is researching post-Exxon recovery and restoration of intertidal and shallow subtidal ecosystems with an emphasis in infaunal organisms. Since 1993, Mr. Fukuyama has owned Fukuyama/Hironaka Taxonomic & Environmental Services in Edmonds, WA.

Scott Kimura, B.S. in biology (1973), California State University Fresno, M.S. in biology (1980), Moss Landing Marine Laboratories, is a senior scientist with TENERA, Inc. An intertidal specialist, Mr. Kimura has been the task leader for ongoing intertidal and subtidal field studies at the Diablo Canyon Nuclear Power Plant to monitor kelp, surfgrass, invertebrates, and fish potentially at risk from power plant operation. He was an early participant in field studies on effects of the Exxon Valdez oil spill and cleanup techniques in Prince William Sound.

John Steinbeck, B.S. in biology (1980), California Polytechnic University San Luis Obispo, M.S. in biology (1986), California Polytechnic University San Luis Obispo, has 20 years experience as an environmental scientist. He is currently the project manager for environmental monitoring conducted at the Diablo Canyon Nuclear Power Plant, a project which is one of the largest and most comprehensive environmental monitoring programs conducted in the U.S. Mr. Steinbeck combines a broad background in field and laboratory biology with extensive experience in data analysis and data management.

LITERATURE CITED

Coats, D.A., E. Imamura, A.K. Fukuyama, J.R. Skalski, S. Kimura, and J. Steinbeck. 1999. Monitoring of biological recovery of Prince William Sound intertidal sites impacted by the *Exxon Valdez* oil spill. NOAA Technical Memorandum NOS OR&R1. Seattle: NOAA/NOS. 73 pp. + appendices.

Fukuyama, A.K., G. Shigenaka, and R.Z. Hoff. In press. Effects of residual *Exxon Valdez* oil on intertidal *Protothaca staminea*: mortality, growth, and bioaccumulation of hydrocarbons in transplanted clams. Marine Pollution Bulletin.

Peterson, C. H. 2000. Lessons learned from the *Exxon Valdez* oil spill: Are the surprises now predictable? Platform presentation at the Sixth International Conference, Effects of Oil on Wildlife, March 30, 2000, Myrtle Beach SC.

Shigenaka, G., D.A. Coats, A.K. Fukuyama, and P.O. Roberts. 1999. Effects and trends in littleneck clams (*Protothaca staminea*) impacted by the *Exxon Valdez* oil spill. In Proceedings of the 1999 International Oil Spill Conference. Paper ID #326.

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

Budget Category:	Authorized FY 2000	Proposed FY 2001
Personnel		$66.1
Travel		$4.7
Contractual		$36.0
Commodities		$2.5
Equipment		$0.0
Subtotal	$0.0	$109.3
Indirect		$52.0
Project Total	$0.0	$161.3
Full-time Equivalents (FTE)		0.6
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

Comments:

FY01

Prepared:

Project Number: 01528
Project Title: Long-term Monitoring of Intertidal Communities as a Framework for Hypothesis-Driven Research
Agency: NOAA

FORM 4A
Non-Trustee
SUMMARY

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

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2001
	E. Imamura	Project coordinator	1.6	8.0		12.8
	D. Coats	Oceanographer	1.6	6.6		10.6
	A. Fukuyama	Infauna specialist	1.3	5.4		7.0
	S. Kimura	Epibiota specialist	1.3	10.4		13.5
	J. Steinbeck	Biologist	0.6	10.4		6.2
	J. Skalski	Statistical support	1.0	16.0		16.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	7.4	56.8	0.0	
					Personnel Total	$66.1

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2001
	Seattle-Cordova	0.7	1	2	0.3	1.3
	San Luis Obispo-Cordova	0.9	1	2	0.3	1.5
	Seattle-Ventura	0.5	2	2	0.2	1.4
	Avila Beach-Ventura	0.1	1	2	0.2	0.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$4.7

FY01

Prepared:

Project Number:
Project Title: Long-term Monitoring of Intertidal Communities as a Framework for Hypothesis-Driven Research
Agency: NOAA

FORM 4B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed
Description	FY 2001
M/V Auklet vessel charter	10.0
Infaunal enumeration & ID for FY01 samples	13.0
Grain size analysis	7.0
TOC/TKN analysis	6.0
Contractual Total	$36.0

Commodities Costs:	Proposed
Description	FY 2001
Miscellaneous consumable supplies	2.5
Commodities Total	$2.5

FY01

Prepared:

Project Number:
Project Title: Long-term Monitoring of Intertidal Communities as a Framework for Hypothesis-Driven Research
Agency: NOAA

FORM 4B
Contractual & Commodities DETAIL

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

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2001
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	

FY01

Prepared:

Project Number:
Project Title: Long-term Monitoring of Intertidal Communities as a Framework for Hypothesis-Driven Research
Agency: NOAA

FORM 4B
Equipment
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001
Personnel		$63.2
Travel		$9.7
Contractual		$201.3
Commodities		$4.0
Equipment		$1.0
Subtotal	$0.0	$279.2
General Administration		$23.6
Project Total	$0.0	$302.8
Full-time Equivalents (FTE)		0.7
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 2002		

Dollar amounts are shown in thousands of dollars.

Comments:

FY01

Prepared:

Project Number:
Project Title: Long-term Monitoring of Intertidal Communities as a Framework for Hypothesis-Driven Research
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

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

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2001
G. Shigenaka	Oceanographer	GS13/4	6.0	7.6	3.0	48.6
R. Z. Hoff	Marine biologist	GS 12/6	2.0	6.8	1.0	14.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		8.0	14.4	4.0	
					Personnel Total	$63.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2001
NOAA scientist Seattle to Kasitsna Bay 5/01	1.0	1	2	0.3	1.6
2 student interns Seattle to Kasitsna Bay 5/01	1.0	2	2	0.3	2.6
2 NOAA scientists Seattle to Cordova 6/01	1.5	2	2	0.3	3.6
Restoration workshop attendance, Seattle-Anchorage 1/01	1.0	1	3	0.3	1.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$9.7

FY01

Prepared:

Project Number:
Project Title: Long-term Monitoring of Intertidal Communities as a Framework for Hypothesis-Driven Research
Agency: NOAA

FORM 3B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed
Description	FY 2001
Marine Research Specialists, biological support for PWS monitoring work	161.3
Marine Research Specialists, biological support for Kasitsna Bay followup studies	20.0
Louisiana State University, chemistry support for PWS monitoring work	20.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$201.3

Commodities Costs:	Proposed
Description	FY 2001
Field supplies, consumable	2.0
Phycology supplies	0.5
Film & photo processing	1.5
Commodities Total	$4.0

FY01

Prepared:

Project Number:
Project Title: Long-term Monitoring of Intertidal Communities as a Framework for Hypothesis-Driven Research
Agency: NOAA

FORM 3B
Contractual & Commodities DETAIL

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

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 2001
Digital camera	1	1.0	1.0
			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**	$1.0

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency

FY01

Prepared:

Project Number:
Project Title: Long-term Monitoring of Intertidal Communities as a Framework for Hypothesis-Driven Research
Agency: NOAA

FORM 3B
Equipment
DETAIL

Strategy and Technique Development for Monitoring the Ecopathology of 1996-1998 Prince William Sound Herring, Submitted Under the BAA

Project Number:	01531-BAA
Restoration Category:	Research
Proposer:	Prince William Sound Science Center Cordova, Alaska
Lead Trustee Agency:	NOAA
Cooperating Agencies:	
Alaska SeaLife Center:	
Duration:	Year 1, 2-year project
Cost FY 01:	$ 84.147K (exclusive of agency overhead)
Cost FY 02:	$ 56.635K (exclusive of agency overhead)
Cost FY 01:	$ 90.037K (inclusive of agency overhead)
Cost FY 02:	$ 60.599K (inclusive of agency overhead)
Geographic Area:	Prince William Sound
Injured Resource/Service:	Herring and their Injured Consumers, Fisheries: Commercial, Recreational, and Subsistence

ABSTRACT

The distinctive stable isotopic composition of PWS food sources when used to reconstruct recent herring migration could suggest ecological mechanisms that predispose PWS Pacific herring populations to epizootics. This project addresses the need to (1) address integrating PWS herring ecology and pathology studies, and (2) develop a strategy and technique for monitoring the ecopathology of PWS herring populations. The proposed strategy involves (1) including natural stable isotope abundance measurements, a useful ecological parameter, as a part of on-going pathology monitoring and (2) stratifying the stable isotope analysis based upon the pathology monitoring results. Benefits specific to the proposed strategy include (1) a unified sampling approach, (2) rationalized analyses, and 3) pathology-based analysis.

INTRODUCTION

Epizootics may be controlling Prince William Sound (PWS) Pacific herring populations. Acute disease caused by the pathogen viral hemorrhagic septicemia virus (VHSV) and chronic infection and morbidity by the fungal pathogen *Icthyophonus hoferi* (IHF) reduce herring life expectancy effectively cropping stock size (Marty 1999, Marty et al. 2000, Quinn et al. 2000). Support for the importance of pathogens was provided by recent a stock assessment modeling study that incorporated adult herring VHSV infection rate (Quinn et al. 2000). Marty et al. (2000) conjectured that ecological factors may predispose PWS herring populations to pathogens found since the *Exxon Valdez* oil spill such as VHSV and IHF. Since these pathogens are highly contagious, infection is more likely when herring are confined and concentrated (Kocan et al. 1997). Herring undergo movements within the greater PWS region on seasonal and ontogenetic basis. Thus opportunities for infection may shift over time in accordance with the herring behavior.

Kline et al. (1998) demonstrated how naturally-existing gradients of carbon and nitrogen stable isotope ratios can be exploited for reconstructing recent behavioral ecology of fishes that migrate among feeding areas. Furthermore, carbon and nitrogen stable isotope ratios have been shown to serve as effective tracers of energy supply in the oil spill study area because of (1) the conservative transfer of carbon isotope ratios between the lower tropic levels (phytoplankton to zooplankton to forage fishes, etc.) of (PWS) and adjacent Gulf of Alaska (GOA) waters up to the top consumers and (2) the naturally occurring gradient in $^{13}C/^{12}C$ productivity generated in the Gulf compared with the Sound (Kline 1997a, 1997b, 1998, 1999a, 1999b). Organisms such as herring and their prey acquire these isotope ratios in response to the importance of the food in bulk body tissues. Isotope ratio analysis of tissues thus provides insight into both habitat usage and assist in quantifying amounts derived from various areas. For example, during the 1994-1998 period PWS herring had large inter-annual $^{13}C/^{12}C$ shifts, depending on oceanographic conditions, but also consistently increased their $^{13}C/^{12}C$ during winter from feeding on PWS carbon sources (Kline 1999, 2000). Nitrogen isotope ratios, in turn, provide excellent definition of relative trophic level. The heavy isotope of nitrogen is enriched by about 0.3 % with each trophic level and thus can accurately indicate the relative trophic status of species within an ecosystem (Minagawa and Wada 1984, Fry 1988, Kline and Pauly 1998, Kline 2000). Herring undergo an ontogenetic trophic level increase that can be detected from measurement of their stable nitrogen isotope rations (Kline 2000). The consistency in their relative trophic level and ontogenetic trophic level shift over the long term is unknown but if either did occur, it would provide another line of evidence for ecological change.

Herring form dense aggregations when over-wintering in confined bays, when spawning in the spring, and otherwise when schooling. The possibility of infection thus exists at various times. However, herring are

also most stressed in winter when somatic energetic levels decline from lack of forage (Paul and Paul 1998). Over-wintering stress in combination with their contagious distribution (Stokesbury 1999, 2000) are likely factors to increase rate of infection. Herring up ~ 20 cm may over-winter in protected bays where they undergo measurable isotopic shifts from feeding on ^{13}C-enriched foods while those feeding offshore are ^{13}C-depleted (Kline 1999, 2000). Therefore it could be discerned from stable isotope analysis whether over-wintering location is a factor contributing to the epizootics. A possibly is that preferred over-wintering locations shift over time as food resources shift (e.g., Brodeur and Ware 1992). For example, when more food is available on the continental shelf, sub-adult herring might preferentially over-winter near or in outer waters where they would also be less susceptible to infection since they would have the opportunity to be less contagiously distributed. Epizootic occurrences may thus be determined by large scale oceanographic cycles presently postulated to control north Pacific fish populations (Ware and McFarlane 1989, Francis and Hare 1994). Stable isotope measurements appear to shift systematically in a given area reflecting long-term shifts in oceanographic conditions (Kline 1999, Schell 2000) suggesting their potential use as a tool to increase our understanding of how of epizootics might be related to environmental conditions. While GEM will provide an opportunity for assessing these changes, data from which a sampling strategy could be based and adopted does not exist. Because of the short time-frame until the anticipated startup of GEM, there is a need to expedite a design that would mesh with the anticipated monitoring. Given the success of the present pathology sampling strategy (e.g., Marty et al. 1999), it is likely that it will be continued in GEM and thus a test for a complementary isotopic sampling strategy is axiomatic.

Prior stable isotope research focused on juveniles stages, principally ages 0 and 1 (Kline 1999). These results were derived from samples for which various ecological parameters were collected, though no information was collected on pathology, so that an ecological synthesis could be derived (Norcross et al. 2000). A similar approach will be needed for integrating pathology and ecology studies in the future. However, it is the mature life history stages that appear to be critical for pathology-related population control (Marty 1999, Quinn et al. 2000). Therefore a different sampling strategy from that used for juveniles is needed. Mature herring are presently being sampled for pathology analysis in the fall and spring, respectively, October and April, in time series for VHSV or IHF (Marty et al. 1999). This timing may also confer success for isotopic analysis as significant measurable differences have been found among herring in the fall reflecting feeding shifts of the prior summer while spring samples reflect over-winter changes. The deduced over-wintering shift will be a good indicator of where herring had been feeding during winter. The strategy will be to compare among pathology states (i.e., the presence or absence of each pathogen) with the anticipation of finding differences in winter feeding habit among them. It will be necessary to have measurements both at the start and at the end of the winter period to

assess isotopic shifts thus the pathology sampling is already ideal. The degree of GOA carbon in the fall (cf. Kline 1999) may also be important and so will be secondary goal.

NEED FOR THE PROJECT

A. Statement of Problem

We need to determine whether a simple sampling strategy can be used to couple our understanding of fundamental ecological processes with the pathological condition of PWS herring. Because of the contagious nature of herring pathogens it is postulated that aggregated feeding behavior and related feeding on enriched carbon during the winter enables epizootics and that this behavior can be assessed by isotopic shifts. Present pathology sampling allows for this conjecture to be tested since samples are collected in October and April. This test would be conducted on a judicious sub-sample of herring samples collected from 1996 to 1998. Results would be incorporated into a rational GEM implementation plan.

B. Rationale/Link to Restoration

Acute disease caused by the pathogen viral hemorrhagic septicemia virus (VHSV) and chronic infection and morbidity by the fungal pathogen *Icthyophonus hoferi* (IHF) reduce life expectancy thus cropping herring stocks in PWS (Marty et al. 1999). Recent modeling suggest that stock size to be related to VHSV infections of adult herring. Ecological factors may predispose PWS herring populations to two pathogens found since the *Exxon Valdez* oil spill (Marty et al. 1999). These pathogens are transmitted when herring a confined into small volumes such as when over-wintering in protected bays. It may be possible to tell whether those infected were more likely to have over-wintered in a bay from their isotopic composition. If so, this will provide evidence that their behavior has contributed to the disease. Furthermore shifts in their behavior could be monitored over time and compared with occurences of epizootic outbreaks to determine long-term trends in the relationship of pathology with ecological processes.

Prince William Sound herring populations undergo inter-annual shifts in food source dependency and seasonal shifts in trophic level (Kline 1999a, 1999b, 2000). These shifts in PWS herring population ecology were determined using the natural abundance of the stable isotopes of carbon and nitrogen $^{13}C/^{12}C$ and $^{15}N/^{14}N$, respectively. Shifts in carbon flow occurring as a result in variations in the physical environment represent fundamental changes in the way the PWS ecosystem supports commercially important species. The availability of macro-zooplankton forage for fishes varies in space and time because of changes in physical processes in PWS. The stable isotope approach is unique in its ability to integrate time and spatial scales at meso-scale levels. No other technique currently available can generate such results. The natural tracer aspects

of the approach emulates artificial tracer experiments without the burden of needing to generate signals or experimental artifacts. Tracking the effect of Gulf carbon inflow on pelagic production that appears to vary between years will be used to resolve the question of how oceanographic process affect fisheries populations and thier pathogens.

C. Location

Prince William Sound

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

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

Anchorage; Steve Ranney, Fishing and Flying, Cordova; Gayle Ranney, Fishing and Flying, Cordova; Ken Roemhildt, Superintendent, North Pacific Processors, Cordova; Jerry Sanger, Charter operator, Whittier; Dan Sharp, Alaska Dept. of Fish & Game, Valdez; Dorothy Shepard, Cordova Coordinator, PWS Community College, Cordova; Stan Stephens, Stan Stephens Charters, Valdez; Paul Swartzbart, Cordova; Chuck Totemoff, President, Chenega Bay Corporation, Anchorage; Bill Webber, Jr., Cordova; Mark Willette, Alaska Dept. of Fish & Game, Cordova; Ed Zeine, Mayor, City of Cordova, Cordova. Additionally, community involvement and traditional ecological knowledge was incorporated in the sampling since local fishers were used.

PROJECT DESIGN

A. Objectives

To isotopically analyze a subset of samples collected for assessment of pathology because natural stable isotope abundances reflect (1) trophic level and (2) source of assimilated matter and are thus a proxy for the change in diet. Stable isotope ratios will thus be used as a indicator of production and shifts as tests of the hypothesis that behavioral ecology predispose herring to epizootics. It is therefore expected that those herring found to be positive for either or both VHSV and IHF will have different isotopic composition and that the composition of those infected will reflect having fed in protected bays where they will have shifted to more positive $\delta^{13}C$ (conventional expression for carbon stable isotopes) values compared to hose that are pathogen free.

B. Methods

Sampling:

Conceptual model of sample flow

1. Collection of herring from PWS by ADF&G each spring and fall.

Collections products and their destination:
A. Pathology samples for Marty et al. ---> separate project
B. Muscle Plugs for this project ---> samples for this project
C. Herring descriptors (length, sex) ---> data used by managers
D. Otoliths or scales for aging ---> data used by managers

2. Pathology assessment by Dr. G. Marty (separate project) using A from above

Pathology products:
Samples will be categorized by pathology assessment as either
A. pathogen free

B. positive for VHSV only
C. positive for IHF only (subsets: i. none to weak lesions to ii. severe lesions)
or, D, positive for both pathogens

Isotopic analysis:

1. The sample inventory includes herring muscle plugs from spring of 1996, 1997, 1998 and from fall of 1996 and 1997.

2. Stable isotopic ecology assessment by Dr. T. Kline (this project)

A. For each sampling period, analyze N = 25 herring muscle plugs for each pathology category, A to D, above
B. Therefore the goal will be to analyze 100 muscle samples (500 total) from each sampling period listed in the sample inventory, above.
C. Laboratory and modeling methods used for the isotopic analysis will be as described by Kline 1999.
D.Isotopic data anlysis will use 4-way ANOVA comparing similarity of $\delta^{15}N$ and $\delta^{13}C$ among A to D, with the inventory samples as well as data from previous studies (Kline 2000). The comparisons are listed below-
Within sample inventory comparisons
Fall vs. spring, falls compared, springs compared using a correlation matrix between carbon source and trophic level with pathologies which will be used to infer relationships of A to D with isotopically-measurable PWS ecological parameters
Comparison with existing data
The sample inventory coincides with the timing of previous isotopic sampling for herring juveniles. Therefore the isotopic shifts previously measured for juveniles in projects \320 and \311 (Kline 2000) will be compared to adults (over-all comparison of adults vs. juveniles) and the pathology state (A to D, above) of the adults. Note: the existing pathology data used to determine (A to D, above) will also be incorporated into these analyses.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

N/A

SCHEDULE

A. MEASURABLE PROJECT TASKS for FY01 (October 1, 2000 - September 30, 2001)

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

B. Project Milestones and Endpoints

30 Jun. 2001:	Preparation of samples for mass spectrometry complete
Jan. 2001, 2002:	Attend Annual Restoration Workshop
31 Dec. 2001:	Isotope data processed
Dec. 2001 - Jan. 2002:	Preparation for and dissemination of results at EVOS and other Symposia
Jan. - Apr. 2002:	Draft final report preparation
Sept. 30 2002:	Final Report revisions

C. Completion Date

September 2002 (Final Report)

PUBLICATIONS AND REPORTS

PROFESSIONAL CONFERENCES

Travel to present project results at national meetings are essential but will be not requested until year 2 of the project. Travel is requested for the P.I. to present results and attend workshops with collaborators.

NORMAL AGENCY MANAGEMENT

N/A

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The PI expects to continue collaborating with other EVOS investigators, which in the past has facilitated relating stable isotope data with e.g., somatic energy content (A.J. Paul) and trophic level (D. Pauly). In the case

of this proposal the collaboration will be primarily with Dr. Gary Marty, University of California, Davis. Dr. Marty provided T. Kline with the tissue samples. T. Kline will work with Dr. Marty during selection of samples for analysis and during data anlysis and publication of the results.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

N/A

PROPOSED PRINCIPAL INVESTIGATOR

Thomas C. Kline Jr., Ph.D.
Prince William Sound Science Center
P. O. Box 705
Cordova, AK 99574
907-424-5800 (t)
907-424-5820 (f)
tkline@grizzly.pwssc.gen.ak.us

PRINCIPAL INVESTIGATOR

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

OTHER KEY PERSONNEL

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

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2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized *'FY 2000	Proposed FY 2001	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$0.0						
Travel		$0.0						
Contractual		$84,146.8						
Commodities		$0.0						
Equipment		$0.0						
Subtotal		$84,146.8	Estimated					
General Administration		$5,890.3	FY 2002					
Project Total		$90,037.1	*60.6					
Full-time Equivalents (FTE)		0.6						
			*'Dollar amounts are shown in thousands of dollars.					
Other Resources Agency cost exclusive								

FY01

Prepared:

Project Number: 01531
Project Title: Strategy and Technique Development for Monitoring the Ecopathology of 1996-1998 Prince William Sound Herring, Submiited Under the BAA
Name: Prince William Sound Science Center
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized *'FY 2000	Proposed FY 2001						
Personnel		$41,589.0						
Travel		$2,394.0						
Contractual		$16,650.0						
Commodities		$4,800.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$65,433.0	Estimated FY 2002					
Indirect		$18,713.8						
Project Total		$84,146.8	$127.7					
Full-time Equivalents (FTE)		0.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY01

Prepared:

Project Number: 01___
Project Title: Strategy and Technique Development for Monitoring the Ecopathology of 1996-1998 Prince William Sound Herring, Submiited Under the BAA
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
	T. Kline	Principal Investigator	3.0	8734.6		26,203.8
	J. Williams	Technician	4.0	3846.3		15,385.2
	TBN	Technician	0.0	5385.3		0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	7.0	17966.2	0.0	
					Personnel Total	$41,589.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 2000
	National meeting	1000.0	0	0	121.0	0.0
	registration and car rental	300.0	0	0	55.0	0.0
	EVOS and collaborative workshops	225.0	3	9	141.0	1,944.0
	car rental	50.0	9	0	0.0	450.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$2,394.0

FY01

Prepared:

Project Number: 01___
Project Title: Strategy and Technique Development for Monitoring the Ecopathology of 1996-1998 Prince William Sound Herring, Submiited Under the BAA
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:				Proposed
Description		cost per unit		FY 2000
PWSSC network charge by computer-months	computer months	8	100	800.0
Stable Isotope Analysis	number:	500	25	12,500.0
Freeze drier charge	number:	500	3	1,500.0
photocopying				500.0
shipping				750.0
communications (fax and phone)				600.0
page charges				0.0
			Contractual Total	$16,650.0

Commodities Costs:	Proposed
Description	FY 2000
Lab supplies miscl	1,500.0
Lab supplies: chemicals, vials, knives	1,000.0
Office supplies miscl	800.0
Computer supplies and upgrades	1,000.0
Dyesub, photog. (presentation materials)	500.0
Commodities Total	$4,800.0

FY01

Prepared:

Project Number: 01___
Project Title: Strategy and Technique Development for Monitoring the Ecopathology of 1996-1998 Prince William Sound Herring, Submiited Under the BAA
Name: Prince William Sound Science Center

FORM 4B
Contractual & Commodities DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

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

Existing Equipment Usage: Description	Number of Units	

FY01

Prepared:

Project Number: 01___
Project Title: Strategy and Technique Development for Monitoring the Ecopathology of 1996-1998 Prince William Sound Herring, Submiited Under the BAA
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Coupling of Oceanic and Nearshore: The Search for Indicator Species

Project Number: 01532

Restoration Category: Research/Monitoring

Proposer: Dr. Gail Irvine
USGS-BRD
Alaska Biological Science Center
1011 E. Tudor Rd.
Anchorage, AK 99503

Lead Trustee Agency: DOI
Cooperating Agencies:

Alaska SeaLife Center: Yes

Duration: 3 years

Cost FY 01: $291.0

Cost FY 02: $275.0

Cost FY 03: $275.0

Geographic Area: Gulf of Alaska

Injured Resource/Service: Intertidal and subtidal communities, clams, subsistence, commercial fishing, sport fishing

ABSTRACT

The primary purposes of this proposal are to: 1) identify nearshore species whose abundances are coupled with low-frequency dynamic processes (e.g., regime shifts) occurring in the oceanic realm, and that could serve as sentinels of change for the Gulf Ecosystem Monitoring program, 2) investigate mechanisms that are responsible for such coupling, identifying processes that could also be monitored, and 3) investigate long-term (7,000 year) patterns of productivity and relative species abundances in nearshore, intertidal communities via retrospective analyses.

INTRODUCTION

A significant portion of the Gulf Ecosystem Monitoring (GEM) plan addresses the relationships between patterns of long-term, low-frequency change in oceanographic parameters and the abundances of species. Certainly one of the lessons from the *Exxon Valdez* oil spill was that it is difficult to decipher the effects of a perturbation against other shifting patterns in abundances of species. Additionally, it is difficult to manage oceanic, nearshore, and coastal ecosystems when we do not understand how marine climate influences changes in community structure. With potentially significant alterations in climate possible due to global warming, it is imperative that we elucidate the relationships between ocean climate and species abundances and distributions, and that we identify key species and processes that may be indicators of changing conditions. A first step in evaluating long-term patterns is examination of historical records (near-term history) and retrospective analyses that may illustrate how ocean productivity and species shifts may have changed in the recent past and over millenia.

Evidence supporting the link between changing ocean conditions (e.g., regime shifts) and species abundances comes primarily from offshore oceanic species, though some of those, like salmon, spend only part of their lives in the oceanic realm. The coupling of nearshore species with longer-term changes in ocean conditions is more poorly known (but see Anderson and Piatt, 1999). Nearshore invertebrate species with planktonic larvae may be linked through the exposure of larvae to offshore conditions and the transport of larvae. Effects on larvae may translate into effects on settlement and recruitment into the adult population. Additionally, nearshore species may be affected by changing ocean conditions through effects on their food, competitors, predators, or habitat.

Although the patterns of species abundances through time, especially as related to regime shifts (e.g, Pacific Decadal Oscillation [PDO], North Pacific Oscillation, 18.6 lunar nodal cycles, etc.; see GEM plan; Francis et al., 1998; Hare and Mantua, 2000) and other types of ocean conditions (e.g. El Niño Southern Oscillation or ENSO), are becoming clearer (e.g., Hare and Mantua, 2000), there is little understanding of the mechanisms that underly the patterns (Anderson and Piatt, 1999; Francis et al., 1998). Analysis of patterns of species abundances through time, especially as related to known patterns of alterations in oceanic state, may provide clues as to which mechanisms are likely to be important. Additionally, analysis of life history patterns may also provide clues to the relative importance of different mechanisms or processes. Neither all species nor all locations are expected to have similar responses. The inverse inshore-offshore production regime proposed in the GEM model may apply to only some species, and to more protected nearshore areas rather than more exposed areas.

As stated above, cyclic patterns in species abundances that may be brought about by cyclic, low-frequency changes in ocean conditions driven by atmospheric alterations, must be understood against the broader spectrum of truly long-term (century to millenial) changes and more directional climate change (global warming). Retrospective analyses of archeological sites may allow development of such a perspective.

In this project, we propose to create a long-term historical perspective against which to examine the evidence for coupling of nearshore species and communities to oceanic conditions. The goals are to understand long-term patterns in productivity, relative species abundances, and the influence of broad-scale ocean conditions on nearshore communities.

NEED FOR THE PROJECT

A. Statement of Problem

In order to effectively manage coastal ecosystems, it is necessary that we acquire an increased understanding of the processes that shape the distributions, abundances and interactions of species through time. There is an emerging awareness of the extensive influence of changing ocean conditions on the abundances of oceanic species and their linked interactions. However, much less is known about the influence of offshore and nearshore oceanic parameters on nearshore species and communities. Within this pattern of low-frequency cyclic change, longer-term changes are occurring that reflect climate changes. When large-scale perturbations, such as the *Exxon Valdez* oil spill occur, we need to know what the general state of nearshore communities is in order to be able to evaluate the extent of the perturbation, and to be able to plan restoration options. We are proposing to identify sentinel nearshore species that are reflect changing ocean conditions, investigate the mechanisms underlying the patterns, and develop a long-term view of changing ocean productivity and nearshore species abundances. Within the context of the GEM plan, the information developed will help detect change, understand the processes, and help predict trends in species abundances.

B. Rationale/Link to Restoration

As stated above, in order to understand both the effects of the *Exxon Valdez* oil spill and other perturbations, we need to have an increased understanding of how species are changing through time. This project focuses on the nearshore environment, an area that was heavily injured by the *Exxon Valdez* oil spill. Data on a number of nearshore (both intertidal and subtidal) species will be considered. Some of the species for whom historical data are likely to be most abundant include species that are harvested commercially, recreationally (sport fishing), or by subsistence users. Developing an understanding of the influence of changing ocean conditions on some of these species will enable better management of these species and communities, and fuller understanding of the effects of the *Exxon Valdez* oil spill.

C. Location

Nearshore environments along the Gulf of Alaska, from Sitka to Kodiak and the Alaska Peninsula

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

This project will involve tapping into both traditional and historical knowledge of changing patterns of abundances of nearshore species (e.g., clams, shrimp). In particular, communities such as Cordova, Kodiak and Tatitlek will be queried for information in the early stages of the project. Additionally, we propose to establish areas of more intensive study combined with an array of recruitment sites. The anticipated locations include: Sitka, Juneau/Glacier Bay, Cordova, PWS Aquaculture hatcheries, Seward, Homer and Kodiak. Contacts have already been made in some of these locations, but this network will be developed with the project. Use of community volunteers, Youth Area Watch folks, and teachers/students will be explored. We will work to apply for funds through the Alaska Technology Foundation in order to fund supplies and equipment for the network.

PROJECT DESIGN

A. Objectives

Phase I: Evaluation of Species and Patterns for Evidence of Coupling and Long-term Change

1. Evaluate historical data on species' abundances and population structure, and life history patterns of invertebrates to identify nearshore species that are apparently coupled with cyclic oceanic conditions or climate change, and that could act as sentinels of such change.

2. Evaluate the potential for recruitment studies of coupled nearshore invertebrate species to serve as early indicators of changing ocean conditions and long-term climate change. (e.g., through modelling of life histories, plankton patterns, recruitment; isotopic analysis of recruiting individuals and larvae).

3. Examine long-term trends in marine productivity and relative species abundances through examination of historical samples and paleoarcheological/ecological studies of nearshore marine communities.

Phase II: Technique Development, Initiate Experimental Studies

4. Initiate linked plankton (larval abundance) and recruitment studies, combined with nearshore oceanographic sampling (SST, CTD, chlorophyll-a or fluorescence measurements) in order to assess patterns and relationships.

5. Investigate whether genetic probes are available for target species; develop, if necessary for several highest ranked target species in order to be able to rapidly assess plankton samples for the presence and abundance of these target species.

Phase III: Test Recruitment Monitoring on Broad-scale and Initiate Experimental Studies

6. Initiate recruitment monitoring on broader physical scale across the Gulf of Alaska (Sitka, Juneau/Glacier Bay, PWS (hatcheries), Seward, Homer, Kodiak), with linked oceanographic measurements. Contrast patterns of more exposed (underlined) and more protected sites to test whether the inshore-offshore inverse production regime (GEM) applies similarly to both.

7. Coordinate recruitment studies with similar studies being conducted from Oregon to southern California in order to be able to address whether nearshore recruitment patterns are inverse to those for offshore patterns, and whether there is a switch in patterns north and south of where the West Wind Drift bifurcates as it reaches the coast of North America.

8. Initiate experimental studies at the Alaska SeaLife Center, with assistance from Qutekak Shellfish Hatchery; other studies at NMFS lab in Kodiak, to address relationships of settlement/recruitment with SST, algal blooms, zooplankton. Possibly raise larvae for identification or experimental purposes.

This project will evolve along adaptive management lines, with the evaluation phases providing necessary input to focus other stages of the project. As such, the study plan must be viewed as a template which we expect to revise.

B. Methods

This project includes a variety of approaches to address the central focus, which is to identify nearshore species and processes that are coupled to cyclic or changing ocean conditions. Three main approaches are involved: evaluation of available information, testing of new techniques to elucidate appropriate species to focus on or speed the analytical sampling, and experimental (establishing patterns and testing monitoring methods and mechanisms).

The first year is dominated by evaluations of: historical samples, retrospective analyses of archeological samples; available information on life histories and factors that may foster coupling; proposed mechanisms whereby species may be coupled and the available evidence supporting the different mechanisms; and techniques (e.g. isotopic analysis, genetic probes) to determine patterns or clarify whether species are appropriate targets for coupling; and initiation of some experimental work. Isotopic analyses of archeological specimens will begin, to assess patterns of productivity through analysis of annuli of dated clams, after evaluation and testing of techniques. Additionally, analyses of a subset of previously collected and saved nearshore plankton samples from PWSAC hatcheries will be analyzed for abundance of the larval forms of benthic invertebrates. The second year will include additional development of techniques (e.g., development of genetic

probes, if they don't exist for species that have been identified in the evaluation period as target species, utilization of isotopic analysis to examine target species), and expanded experimental work, including establishing a network of recruitment study sites. The third year will involve analysis of broad recruitment patterns, continued broad sampling at multiple stations across the Gulf of Alaska, more detailed measuring of oceanographic conditions, and more extensive experimental work.

The following hypotheses are addressed by this project:

H1: Nearshore invertebrate species can be "coupled" to oceanic conditions by productivity (timing, composition, intensity of blooms), temperature, advection/transport, effects on their planktonic larvae, competitors, and/or predators.

H2: Nearshore invertebrate species with coupling to broad-scale oceanic conditions through their planktonic larval stages should show:

a. Under positive PDO (via inshore-offshore inverse production regime, GEM model): decreased larval abundance, decreased settlement/recruitment, and increased post-settlement mortality (due to poorer condition of the larvae) after correcting for density-dependent effects.

b. Under negative PDO: increased larval abundance, increased settlement, and increased post-settlement mortality.

c. Within Prince William Sound varying patterns of success based on the patterning of primary production.

    1. When phytoplankton blooms are short in duration, but of high intensity, carbon is transferred primarily to the benthos, resulting in high growth rates of the invertebrates, but more limited success of larval forms (only those tightly coupled to the bloom are successful).

    2. When phytoplankton blooms set up more gradually, with resetting by wind events, resulting in a bloom of lesser magnitude but longer duration, larval success is increased for species with longer development times and/or periodic production of larvae.

d. Similar patterns of recruitment across the Gulf of Alaska for an individual species, i.e., coupled species are consistently negatively or positively correlated with certain ocean conditions.

e. Similar patterns of recruitment to individuals all along the West coast, from Alaska to southern California, if there is no inshore-offshore opposition of production along the Oregon/California coast. If there is a similar inshore-offshore inverse production regime along that coast, then an inverse pattern of recruitment is projected for individuals south of the West Wind Drift bifurcation.

H4: There has been no change in long-term productivity or relative species abundances in the nearshore marine environment as indicated by stasis of marine nearshore species in archeological sites and fine-scaled isotopic analysis of dated material (e.g., clam shells).

H5: Climate change, e.g. global warming, can be detected via range extensions of species, with more southerly species extending their ranges northward, and more northerly species extending southward. These extensions are more likely to occur for species highly mobile as adults, or via the increasing successful settlement of planktonic larvae. Recruitment studies may provide the first cues for these changes, as well as of invasions by exotic species.

The methods used to test each of these hypotheses are given below, as well as details of the proposed study sites, and data sets.

HO1: Nearshore invertebrate species can be "coupled" to cyclic oceanic conditions by productivity (timing, composition, intensity of blooms), temperature, advection/transport, effects on their planktonic larvae, competitors, and/or predators.

The focus will be on evaluating the available evidence for indications of coupling of nearshore species and oceanic conditions. Historical and long-term retrospective data will be analyzed for cyclical patterns, hypothesized mechanisms collated, and the evidence for/against each mechanism will be evaluated. Additionally, new mechanisms will be proposed based on the patterns and correlative data. Evidence of coupling may be derived from correlations of abundance, growth, or recruitment with 1) known patterns of low-frequency, cyclic oceanographic changes, and 2) responses to oceanographic conditions. Suggestion of coupling may be found in long-term records as cyclical patterns of abundance, growth, or recruitment, or through evaluation of life histories and modelling of life history patterns and oceanographic conditions.

There is growing evidence for correlations of biotic abundances or responses with cyclical atmospheric and ocean conditions (e.g., GEM plan; Francis et al., 1998; Hollowed et al., 1998; Hollowed and Wooster, 1992; Anderson and Piatt, 1999; Hare and Mantua, 2000). In fact, Hare and Mantua (2000) review 100 time series (31 climatic and 69 biological) to ascertain whether there is a consistent signal of another regime shift since the widely accepted one that occurred in the winter of 1976-1977. They found evidence of a 1989 shift in some components of the North Pacific ecosystem, but the changes were not as pervasive as the 1977 changes and apparently did not signal a simple

return to pre-1977 conditions. Notably, biological time series showed more consistent patterns than did the physical time series, suggesting that biota integrate the stochasticity of the physical parameters. One of the first steps in this project will be delineation of the various periodicities of different types of ocean conditions (e.g., Pacific Decadal Oscillation [PDO], 18.6-year lunar nodal cycle; El Niño Southern Oscillation [ENSO]; etc.). One of the complications in expecting consistent repeating cycles is that at least two cycles having differing periodicities can overlap, resulting in increased amplitude of the signal or a dampening of effect (Minobe, 1999). Various researchers have proposed climate shifts in the Northeast Pacific in the early 1920s and mid 1940s (e.g., Kondo, 1988; Manuta et al, 1997; Zhang et al., 1997; Minobe, 1997; Ingraham et al., 1999), based on analyses of temperature, tree ring, and salmon catch data. One of the most striking aspects of Hare and Mantua's (2000) analysis is the delineation of two major patterns in the time series, based on principal components analysis. Given the comprehensive nature of the time series they examined, these are likely to be the most commonly observed recent patterns. It has been acknowledged by a variety of authors (e.g., Anderson and Piatt, 1999; Francis et al., 1998; GEM; Hare and Mantua, 2000) that although cyclical patterns are more commonly being recognized, the mechanisms giving rise to the patterns are vague or poorly known. A mechanistic interpretation of abundances of different crab species relative to ocean conditions has suggested how different species-specific mechanisms could be operating (Zeng and Kruse, in press).

The major sources of historical data include: a) small mesh trawl surveys from the Kodiak/ Alaska Peninsula area (Anderson and Piatt, 1999); b) benthic clam sampling from the NVP project, which includes data gathered over several years, as well as samples from a dramatically different, much denser multi-species clam assemblage of unknown age, c) harvest data for razor clams at sites along the Alaska Peninsula, Cook Inlet (east and west sides), and Cordova. We will investigate with ADFG and NOAA/NMFS other sources of data for nearshore benthic or pelagic species. Consideration will be given to species from multiple taxa, however, we acknowledge that species with hard parts (e.g., bivalves, echinoderms) may be better candidates for a full complement of retrospective studies that could include size-frequency data, chemical dating, and isotopic analysis.

A few additional details concerning the data above are warranted. From the Anderson and Piatt (1999) analyses, it is apparent that there are a variety of nearshore species that are coupled with ocean conditions (e.g., shrimp, starfish, jellyfish, octopus, various fishes). Investigating the life history parameters of these species should help formulate hypotheses regarding mechanisms producing these patterns.

Analysis of the PWS subtidal benthic clam assemblages sampled by Van Blaricom and Fukuyama during the NVP project indicated a sharp dichotomy between surface/shallow subsurface clam assemblages, and a deeper, much denser clam assemblage. It is possible that the deeper clam assemblage represented clams that died as a result of the 1964 earthquake, or represent another time period. We propose to date these clams (using a radiometric analysis; Nevissi et al., 1995) in order to evaluate their significance. Isotopic analyses of the annuli of the dated shells could then provide data on the productivity

patterns that occurred during the life of the clam. For long-lived clam species, this might yield productivity patterns in excess of 15 years linked to a specific date.

We also propose to analyze the age/size structure for a collection of dead clam shells collected by Glenn Van Blaricom in areas that had been uplifted by the 1964 earthquake. Approximately 200 0.25m^2 quadrats were sampled. Data were gathered between 1978 and 1984 at Gibbon Anchorage on Green Island; some data were also collected near Cordova during the same time period. Although this is not pre-otter (Lensink, 1962), it is probably before the peak abundance of otters, which may have occurred in the middle or late 1970s (Estes et al., 1981; A. Johnson, pers comm; as cited by VanBlaricom, 1988). These clams will provide a pre-spill reference for aspects of clam population structure. Although patchy in their distribution, these clams, when encountered, had densities well in excess of 10 clams/m^2, compared to the NVP subtidal densities from 1995 of approximately 2.7-3.2/m^2. Almost every quadrat contained members of the genera *Saxidomus*, *Protothaca*, and *Macoma*. Occasional individuals of *Mya, Tresus,* and *Hiatella* occurred. The 1995 suction-dredge samples also included some of these same genera (*Saxidomus, Protothaca, Macoma,* and *Mya*), but in much reduced abundances.

Razor clams are/were dense at four major sites in Alaska: Swikshak (Alaska Peninsula), Polly Creek (west side of Cook Inlet), the east side of Cook Inlet, and Cordova. Harvest data and population estimates (Szarzi, 1991) for eastside of Cook Inlet will be compared to harvest and biological data for the other areas to see if these long-lived (up to 18 years in Alaska) bivalves show evidence of coupling to ocean conditions. Historical/traditional information will also be gathered on patterns of abundance.

H2: Nearshore invertebrate species with coupling to broad-scale oceanic conditions through their planktonic larval stages should show:

- **a. Under positive PDO (via inshore-offshore inverse production regime, GEM model): decreased larval abundance, decreased settlement/recruitment, and increased post-settlement mortality (due to poorer condition of the larvae) after correcting for density-dependent effects.**
- **b. Under negative PDO: increased larval abundance, increased settlement, and increased post-settlement mortality.**
- c. **Within PWS varying patterns of success based on primary production patterns.**
    1. **When phytoplankton blooms are short in duration, but of high intensity, carbon is transferred primarily to the benthos, resulting in high growth rates of the invertebrates, but more limited success of larval forms (only those tightly coupled to the bloom are successful).**
    2. **When phytoplankton blooms set up more gradually, with resetting by wind events, resulting in a bloom of lesser magnitude but longer duration, larval success is increased for species with longer development times and/or periodic production of larvae.**

These specific hypotheses will be examined by comparing larval abundances in nearshore plankton samples, with the patterning of plankton blooms, and successful settlement/recruitment.

Under H2.c1., carbon gets transferred to the benthos because the bloom is established quickly and intensely, may get shut off by nutrient limitation (although grazing may also be a factor), and much of the planktonic biomass cannot be efficiently used. Therefore, considerable production gets shunted to the benthic environments (T. Cooney, pers. comm.). There is some evidence that the spawning of some invertebrate species has been triggered or correlated with dense algal suspensions, although temperature has also been implicated as a spawning trigger (Strathmann, 1987). In order for the triggering of spawning by phytoplankton blooms to be effective for reproductive success, larval development times have to be short enough for the larvae to be able to take advantage of the bloom. Thorson (1946) gives examples of several species that produce free-swimming veligers within a few hours to several days following fertilization of the gametes. Thus, it is quite likely that some species, including clams, might show a tight coupling of spawning and rapidly increasing larval abundances with an intense phytoplankton bloom. Further selection for tight coupling to intense phytoplankton blooms might derive from the potential "rain" of unconsumed carbon to the substrate, which could enrich the environment for newly settling larvae. Food-limitation has been suggested as a potentially limiting factor for new recruits or juveniles in soft-bottom habitats (see review by Olafsson et al., 1994).

The relative success of species with different patterns of larval development and timing with respect to the patterning of the phytoplankton bloom, will be examined for a variety of invertebrates (e.g., clams, mussels, echinoderms, shrimp, crabs).

The relationship between growth rates of benthic invertebrates and the patterning of the phytoplankton bloom (predicted effect: greater growth in years with an intense phytoplankton bloom), can be examined retrospectively by comparing periods of greater growth as recorded in the shells of bivalves and tests of echinoids, with historical knowledge of patterns of phytoplankton productivity, and information gathered by SEA.

Since 1995, I have had previous nearshore plankton samples taken by PWSAC for the purposes of settling volume at all four of their hatcheries, preserved, and in 1995 and 1996 had a subset of these samples from the AFK hatchery sorted and analyzed for the numerical abundance of invertebrate larval forms. At the same time (1995-1996), I had put out larval settling tubes (passive collectors of near-bottom larvae; Yund et al., 1991) in conjunction with subtidal studies of the NVP project in order to look at larval abundances at oiled and unoiled study areas. Lack of funding for this project limited the extent of additional larval identification necessary to tie larval abundances to recruitment patterns. I am proposing that a subset of the previously collected nearshore plankton samples (e.g., for one site, the AFK hatchery) be sorted and analyzed in order to develop an understanding of seasonal variation in the abundance of different larval taxa through time. Since it is time intensive (and therefore costly) to analyze the samples, and it can be difficult to identify a number of taxa beyond the genus, family or order, I am

proposing that future samples (or a split of the samples, or a second sample) be preserved in 100% ethanol so that they can be analyzed by genetic probes. I am also proposing the development of genetic probes for target species, if they do not currently exist, in order to facilitate rapid analysis of samples that would cumulatively be cheaper, and allow samples from all of the hatcheries, plus samples from other locales to be easily analyzed for the target species. These target species should be defined by the evaluation phases outlined above, under both H1 and H2.

Central to the testing of the hypotheses listed above is the ability to tie larval abundance and settlement/recruitment patterns to ocean parameters, including temperature and productivity patterns. Therefore, I propose that a fluorescing CTD be used to sample for a subset of these parameters at the AFK hatchery. Further discussions with Dr. Peter McRoy and Dr. Dave Eslinger will help define the options for most cost-effectively monitoring ocean state and the pattern of the phyto- and zooplankton blooms in PWS. The coupled model that Dave Eslinger developed as part of the SEA project should facilitate characterization of the water column production patterns.

d. Similar patterns of recruitment across the Gulf of Alaska for an individual species, i.e., coupled species are consistently negatively or positively correlated with certain ocean conditions.

e. **Similar patterns of recruitment to individuals along the West coast, from Oregon to southern California, if there is no inshore-offshore opposition of production along the Oregon/California coast. If there is a similar inshore-offshore inverse production regime along that coast, then an inverse pattern of recruitment is projected for individuals south of the West Wind Drift bifurcation.**

These hypotheses will be examined starting in Year 2 of the project.

H4: There has been no change in long-term productivity or relative species abundances in the nearshore marine environment as indicated by stasis of marine nearshore species in archeological sites and fine-scaled isotopic analysis of dated material (e.g., clam shells).

A very rich (replete with invertebrate remains, primarily clams) archeological site along the Katmai National Park and Preserve coast has been excavated by the NPS. This site is the oldest site identified along the northern Alaska Peninsula, is the most extensively excavated site on the Alaska peninsula, and has great organic preservation. It is also unusual in its well defined stratigraphy, which allows layers to be related to dated house floors. Dating has indicated that the site was occupied from 7,000 calendar years (BP) to approximately 500 years AD. The invertebrate fauna have been identified taxonomically by Nora Foster of the UAF Museum. I am proposing to analyze the relative species abundances from a paleoecological standpoint. Although there are certain caveats that must be acknowledged in dealing with/interpreting the remains of human collections, these samples provide a tremendous opportunity to extend our perspective regarding

species occurrences and productivity in the nearshore community into the past. In order to establish a long-term perspective with the finest resolution possible, I am proposing to isotopically analyze annuli of individual, dated clams to assess nearshore productivity as revealed by stable isotope signatures. I will be evaluating the best methodology with Tom Kline. The site data may also provide information on biogeographic shifts in species distributions that may be related to different climate shifts.

> **H5: Climate change, e.g. global warming, can be detected via range extensions of species, with more southerly species extending their ranges northward, and more northerly species southward. These extensions are more likely to occur for species highly mobile as adults, or via the increasing successful settlement of planktonic larvae. Recruitment studies may provide the first cues for these changes, as well as of invasions by exotic species.**

This hypothesis will be examined starting in Year 2 of the project after a suite of settlement/recruitment sites is established across the Gulf of Alaska (from Sitka to Kodiak). Coordination with other settlement/recruitment studies being conducted along the West coast of North America, from southern California through Oregon should facilitate detection of such species shifts. I have been in contact with several of these researchers, discussing use of similar methods over the last few years. Monitoring of intertidal communities at Sitka and Glacier Bay National Parks that I have designed and implemented for the National Park Service, can be used in conjunction with settlement/recruitment studies to increase the likelihood of detecting species shifts. A more proximal gain may be the detection of invading species, such as the green crab, which has rapidly been extending its range northward from San Francisco Bay.

Cooperating Agencies, Contracts, and Other Agency Assistance

A variety of important cooperators will be involved in this project. Drs. Paul Anderson (NMFS) and Dr. Gordon Kruse (ADFG) and other agency staff will be involved in assessing the sources of biological information and interpretation of patterns and mechanisms. Experimental work in the later stages of the project is anticipated to be done in conjunction with Paul Anderson. We will be collaborating closely with Dr. Glenn Van Blaricom in aging and assessments of older clam assemblages in Prince William Sound. Other important collaborators include Dr. Tom Kline of the PWS Science Center, who will help evaluate the appropriateness and methodologies of different isotopic techniques; Dr. Jeanne Schaaf, an archeologist with the National Park Service who has managed the excavation of the Katmai site that will be a focus of this project; Nora Foster of the University of Alaska Museum;; continued cooperation of the PWS Aquaculture Association in collection of plankton samples, and with future assistance in field studies; and collaborators in California ,Oregon, and Alaska for broad recruitment studies (Drs. Steve Gaines, Steve Schroeter, Steve Morgan, Bruce Menge, and Ginny Eckert). Contracts are expected to be employed with the Institute of Marine Science, University of Alaska, Fairbanks and an Institute in Germany for radiometric dating of clams.

SCHEDULE

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

Oct. 1– March 31:	Setting up contracts
Oct – Dec.:	Collecting historical data, initiating discussion for local knowledge
November – Jan.:	Evaluate isotopic techniques
January 16-26:	Attend Annual Restoration Workshop
Jan – Feb:	Coordinate collection, preservation of plankton samples at PWSAC hatcheries, plan other sampling
Feb – July/Sept:	Linked plankton, CTD, recruitment studies

B. Project Milestones and Endpoints

Year 01: Evaluation Phase

- Collection of historical data; analyses of time series data
- Aging of historic clam samples from PWS
- Productivity of paleoarcheological samples via isotopic analysis
- Plankton analyses
- Initiation of integrated plankton, CTD, recruitment studies
- Synthesis of existing information to make recommendations regarding target coupled species

Year 02: Technique Evaluation/Development, Field Studies, Data analysis

- Further paleoarcheological analyses/faunal analyses
- Initiate genetic probe development, if needed
- Linked plankton, CTD, recruitment studies; plankton analyses
- Isotopic analyses
- Creation of broader recruitment sampling network
- Data analysis; Annual Report

Year 03: *Note: Plans for year 03 will be re-evaluated in year 02 to determine if additional years are necessary to complete the work outlined and develop the groundwork for a GEM component

- Data analysis, synthesis, continued field studies; more experimental studies; Annual Report

Year 04: Final report

C. Completion Date

A Final Report will be produced April 15, 2004.

PUBLICATIONS AND REPORTS

In FY01, there are no publications expected for this project, as most of the efforts will be evaluative. Reports and manuscript(s) will be generated in FY02. Publications are expected to be produced for other EVOS funded projects that the PI is currently involved with.

PROFESSIONAL CONFERENCES

No attendance is currently planned.

NORMAL AGENCY MANAGEMENT

The work involved in this project is not part of normal agency management, however, the results are expected to be useful for management purposes of a variety of agencies.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The type of work outlined in this proposal needs to be integrated within the larger context of what is happening in the near-coastal and offshore ocean; thus the intent is to collaborate and integrate to the maximum extent possible. The proposal has detailed extensive collaboration with other agency, science center and university staff, as well as PWSAC staff. Additionally, we will be having extensive contact with local communities in order to gather information on the historical presence and abundance of nearshore species of importance to them. We will make every effort to coordinate and integrate our efforts with those of other restoration projects.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

N/A

PROPOSED PRINCIPAL INVESTIGATOR

Dr. Gail V. Irvine
USGS-BRD
Alaska Biological Science Center
1011 E. Tudor Rd.
Anchorage, AK 99503
Phone: 907-786-3653
Fax: 907-786-3636
E-mail: gail_Irvine@usgs.gov

PRINCIPAL INVESTIGATOR

Dr. Irvine is a Marine Ecologist with the Alaska Biological Science Center. She has extensive experience in coastal ecosystems in Alaska, the Pacific Northwest and the tropics. Her primary research interests have been in plant-herbivore interactions, succession, life history dynamics, oil effects, and the design of long-term monitoring programs and associated research. She has been a Principal Investigator on several EVOS-funded studies involving oiled mussel beds and the residual oiling of coastlines. Recently she was invited to author a chapter on "Persistence of Spilled Oil on Shores and its Effects on Biota" for The Seas at the Millenium, a three-volume assessment of the state of the world's oceans being published by Elsevier. Over the last 4 years, she has also been involved in the designing protocols for broad-scale, inferential monitoring of intertidal assemblages in Glacier Bay National Park and Preserve, then adapting the design for the small coastline of Sitka National Historical Park.

OTHER KEY PERSONNEL

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

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$115.2
Travel		$18.1
Contractual		$109.9
Commodities		$5.0
Equipment		$17.8
Subtotal	$0.0	$266.0
General Administration		$25.0
Project Total	$0.0	$291.0
Full-time Equivalents (FTE)		1.7
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

		Estimated FY 2001	Estimated FY 2002		
		$275.0	$275.0		

Dollar amounts are shown in thousands of dollars.

Comments:

FY01

Prepared:

Project Number: 01532
Project Title: Coupling of Oceanic and Nearshore: The Search for Indicator Species
Agency: DOI-USGS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
Gail Irvine	Marine Ecologist	GS/12/8	8.0	7.8		62.4
Vacant	Biologist	GS9/1	12.0	4.4		52.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		20.0	12.2	0.0	
					Personnel Total	$115.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
RT Anchorage to Santa Barbara, Moss Landing, Calif	0.8	1	8	0.2	2.4
RT Anchorage / Corvallis, Ore	0.8	1	6	0.2	2.0
RT Anchorage / Juneau	0.6	2	3	0.2	1.8
RT Anchorage/ Sitka	0.7	1	3	0.2	1.3
RT Anchorage/ Seward	0.2	2	4	0.2	1.2
RT Anchorage/ Kodiak	0.3	2	4	0.2	1.4
RT Anchorage/Homer	0.2	1	3	0.2	0.8
RT Anchorage/Cordova	0.6	1	3	0.2	1.2
RT Anchorag/PWS	0.6	6	12	0.2	6.0
					0.0
					0.0
					0.0
				Travel Total	$18.1

FY01

Prepared:

Project Number:
Project Title: Coupling of Oceanic and Nearshore: The Search for Indicator Species
Agency: DOI-USGS

FORM 3B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed FY 2000
Description	
4A Linkage: Statistical Analysis (WEST)	12.2
Stable isotope analyses; 2,300 samples@ estimated $25/sample	57.5
Radionuclide analysis (dating) of subtidal clams- 33 samples @estimated $400/sample	13.2
Plankton analyses - 120 samples @ estimated $225/sample	27.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$109.9

Commodities Costs:	Proposed FY 2000
Description	
Lab Supplies	2.0
Field Supplies (settlement substrates, buoys, lines, raingear, etc.)	3.0
Commodities Total	$5.0

FY01

Prepared:

Project Number:
Project Title: Coupling of Oceanic and Nearshore: The Search for Indicator Species
Agency: DOI-USGS

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
			0.0
CTD, fluorescing			17.0
Folsom Plankton Splitter			0.8
			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**	$17.8

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Dissecting Microscope, Compound Scope		

FY01

Prepared:

Project Number:
Project Title: Coupling of Oceanic and Nearshore: The Search for Indicator Species
Agency: DOI-USGS

FORM 3B
Equipment
DETAIL

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

Budget Category:	Authorized FY 1999	Proposed FY 2000						
Personnel		$6.1						
Travel		$0.0						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$6.1			Estimated FY 2001	Estimated FY 2002		
Indirect		$6.1						
Project Total	$0.0	$12.2						
Full-time Equivalents (FTE)		0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY01

Prepared:

Project Number:
Project Title: Coupling of Oceanic and Nearshore: The Search for Indicator Species
Name: Western Ecosystems Technologies, Inc., contract to USGS

FORM 4A
Non-Trustee
SUMMARY

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

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
	L. McDonald	Senior Scientist	0.2	8.1		1.6
	M. Bourassa	Biometrician I	1.0	4.5		4.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	1.2	12.6	0.0	
					Personnel Total	$6.1

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

FY01

Prepared:

Project Number:
Project Title: Coupling of Oceanic and Nearshore: The Search for Indicator Species
Name: Western Ecosystems Technologies, Inc., contract to USGS

FORM 4B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed FY 2000
Description	
Contractual Total	$0.0

Commodities Costs:	Proposed FY 2000
Description	
Commodities Total	$0.0

FY01

Prepared:

Project Number:
Project Title: Coupling of Oceanic and Nearshore: The Search for Indicator Species
Name: Western Ecosystems Technologies, Inc., contract to USGS

FORM 4B
Contractual & Commodities
DETAIL

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

Existing Equipment Usage: Description	Number of Units

FY01

Project Number:
Project Title: Coupling of Oceanic and Nearshore: The Search for Indicator Species
Name: Western Ecosystems Technologies, Inc., contract to USGS

FORM 4B
Equipment
DETAIL

Prepared:

FORM DI-1

UNITED STATES
DEPARTMENT OF INTERIOR
REQUISITION

TO:	REQUESTING OFFICE:	REQUISITION NUMBER:
ALASKA SCIENCE CENTER	MFEB/ JAMES FINN **PHONE:** (907)786-3450	0-3403-0539

APPROPRIATION/ALLOTMENT NO.

0/1	3403	30K16 211C	486.80
0/1	3403	30K16 261A	2,367.43

DATE: 14-APR-00

CHARGE SHIPPING COSTS TO:

VENDOR (NAME & ADDRESS):

BANK OF AMERICA
P.O. BOX 650782

DALLAS, TX 75265-0782

DELIVER TO:

U.S. GEOLOGICAL SURVEY, BIOLOGICAL RESOURCE DIV
ALASKA SCIENCE CENTER
1011 EAST TUDOR ROAD
ANCHORAGE,, AK 99503

LINE	DESCRIPTION	QTY	UNIT	UNIT PRICE	EXTENDED AMT
	BANK OF AMERICA MARCH 27 STATEMENT JAMES FINN				
0001	Bank Card Charges	1	EACH	2,854.23	2,854.23

To Be Completed by Fiscal Authority Only

FUND CERTIFICATION: Funds in the amount shown are available and chargeable to the cost authorities shown above.

TOTAL COST: **$2,854.23**

Signature	**Approved by (Signature)**
Title: **Date**	**Title** **Dat**
Requisitioned by (Signature)	**Bureau/Regional Officer (Sig. if Necessary)** **Dat**
Title: **Date**	**Title**

Project Title: Comparison of Cytochrome P450 1A Induction in Blood and Liver Cells of Sea Otters

Project Number:	01534
Restoration Category:	Research and Monitoring
Proposer:	Brenda E. Ballachey and Paul W. Snyder
Lead Trustee Agency:	DOI: U.S. Geological Survey
Cooperating Agencies:	
Alaska SeaLife Center:	No
Project Duration:	1st year, 1-year project
Cost FY 01:	$19,900.
Geographic Area:	WPWS
Injured Resource/Service:	Sea otter

ABSTRACT

Sea otters in oiled areas of western PWS had elevated levels of cytochrome P450 1A (CYP1A), a biomarker of hydrocarbon exposure, measured in blood samples collected from otters in 1996-98. In summer 2001, as part of project 01423, we have proposed to resample CYP1A in blood from sea otters in oiled and unoiled areas of PWS. Herein we describe a complementary effort to project 01423. We propose also to sample liver from the captured sea otters, for assays of CYP1A, and for examination of histopathological changes. Liver CYP1A levels will be compared to those measured in blood from the same individuals. We will also assay for CYP1A in archived frozen liver samples from sea otters that were oiled and died in 1989, to enable comparison of current levels of CYP1A induction with levels in sea otters that had a known high degree of oil exposure. The results of this study will provide a basis for comparison of cytochrome P4501A induction in sea otters in 1989, in 1996-98, and in 2001, and will help determine if there is a decline in CYP1A levels over time.

INTRODUCTION

In the NVP project (/025), sea otters were evaluated for increased levels of cytochrome P450 1A (CYP1A) in blood (peripheral blood mononuclear cells), as a biomarker of exposure to environmental hydrocarbons. Data from 1996-98 show elevations of CYP1A in otters from oiled areas, compared to those from unoiled areas.

We do not have archived blood samples from previous years that are suitable for assays of CYP1A, and so cannot compare CYP1A levels currently observed to levels that would have been present in sea otters exposed to oil in the months immediately after the 1989 oil spill. We do, however, have archived liver samples from 1989, which are suitable for the assay of CYP1A; most of those samples also have data on tissue hydrocarbon concentrations, collected as part of NRDA studies. During 1999, we have verified that RNA can be isolated from the archived liver samples (see below).

Further monitoring of CYP1A in sea otters in WPWS, in the summer of 2001, is currently proposed as part of Project 01423. Our goal herein is to supplement measurement of CYP1A in blood from those otters with assays on liver biopsies from the same individuals, to establish the relation between CYP1A in the two tissue types. We further propose to assay archived liver samples collected from sea otters that died in the summer of 1989. The comparison of liver levels from 1989 and 2001 would give an indication of the relative levels of exposure, 12 years after the spill.

NEED FOR THE PROJECT

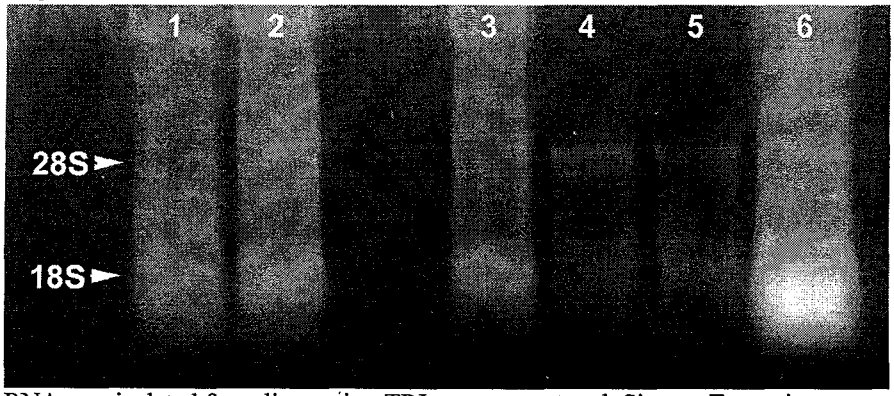
A. Statement of Problem

Sea otters in the most heavily oiled areas of western Prince William Sound (WPWS) have not yet recovered from the *Exxon Valdez* oil spill, based on several lines of evidence from studies conducted as part of the NVP project (/025) and the continuing sea otter work as part of project /423. Significant results on sea otters include lack of population growth in the oiled study area (Bodkin et al. 1999, Dean et al. 2000, USGS unpub. data), evidence of relatively poor survival rates of sea otters from the oiled area (Bodkin et al. 1999, Monson et al. 2000), and increased induction of CYP1A in the oiled area (Ballachey et al. 1999). Elevations in CYP1A do not appear to be due to background or natural hydrocarbon sources, as these were found to be negligible in intertidal areas of PWS (Short and Babcock 1996), nor to differential contamination of areas by PCBs (Trust et al. 2000; USGS unpub. data). Continued exposure to residual *Exxon Valdez* oil is the most plausible explanation of elevated CYP1A. Residual oil is still stranded in intertidal areas of PWS (Babcock et al. 1996, Harris et al. 2000, Hayes and Michel 1999), providing a continuing potential source of contamination. However, the extent to which continuing exposure to residual oil may be constraining sea otter population recovery is not known (Project 01423 contains objectives designed to address this question).

The NVP CYP1A data cover the period from 1996-98. At this time, comparable data on CYP1A induction in sea otters are not available from earlier post-spill years (1989-95). However, such data would be valuable as they would provide a benchmark for evaluation of degree of exposure seen in samples collected presently to samples collected in the months post-spill, and thus a measure of the relative continuing exposure.

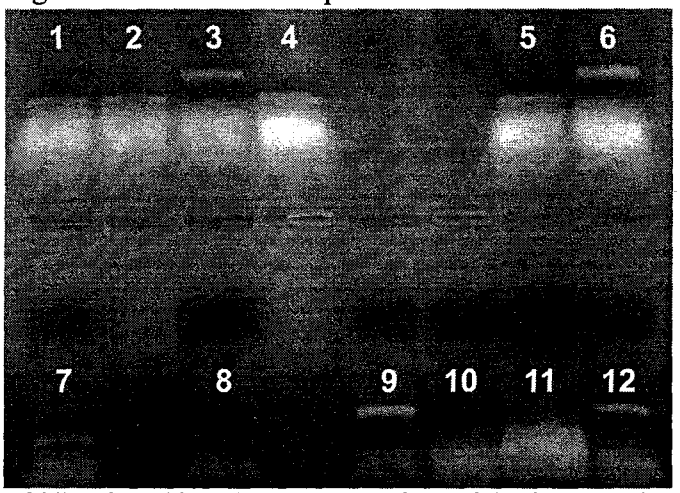
Measurement of CYP1A in sea otters in the NVP project used a quantitative RT-PCR technique on peripheral blood mononuclear cells (Vanden Heuvel et al. 1993, 1994; Snyder et al. 1999). Although there are no archived samples of blood cells that would be suitable for the RT-PCR assay, the assay can also be applied to liver or other tissue samples, and archived frozen liver samples are available. These liver samples were collected from sea otters that died in 1989 subsequent to the spill, and time of death and extent of oiling on the pelage are known. Many of these otters were exposed to large quantities of oil, and showed histopathological changes (Lipscomb et al. 1993); CYP1A levels likely were greatly elevated. Further, hydrocarbon concentrations were measured on aliquots of the same samples (Ballachey and Kloecker 1997a, b), and in many cases (where otters were heavily oiled), concentrations were well above method detection limits. Preliminary assays of archived liver samples during the last year have demonstrated that we are able to isolate RNA (Figure 1) and obtain P4501A PCR products (Figure 2) on the archived liver samples.

Figure 1. Total RNA extracted from frozen sea otter liver tissue



RNA was isolated from liver using TRI reagent protocol, Sigma. Two micrograms of each RNA sample was analyzed by electrophoresis in a 1% MOPS-EDTA-formaldehyde agarose gel and visualized by staining for 5 minutes with 100 µg/ml ethidium bromide in deionized water.
Lane 1 – VZ 081
Lane 2 - VZ 135
Lane 3 – SW 050
Lane 4 – VZ 060
Lane 5 – VZ 111
Lane 6 – VD 123

Figure 2. P450 1A PCR product from frozen sea otter liver tissue



Ethidium bromide-stained agarose gel containing PCR products resulting from amplification of sea otter liver P450 1A cDNA.
Lane 1 – VZ 081
Lane 2 – VZ 135
Lane 3 – VZ 081 positive control (glyceraldehyde-3-phosphate degydrogenase)
Lane 4 – SW 050
Lane 5 – VZ 060
Lane 6 – VZ 060 positive control
Lane 7 – VZ 111
Lane 8 – VD 123
Lane 9 – VD 123 positive control
Lane 10 – VZ 109
Lane 11 – SW 149
Lane 12 – SW 149 positive control

We propose to work in conjunction with the sea otter capture and CYP1A monitoring effort being proposed for the summer of 2001 in Project 01423. As part of that project, sea otters will be captured and blood samples taken for CYP1A evaluation. In this project, we propose to supplement the blood sampling/CYP1A effort with collection of liver biopsies from the same otters, also for analysis of CYP1A using the RT-PCR assay. This will enable us to establish the relation between CYP1A induction in blood and liver cells. We further propose to analyze 30 archived liver samples, including samples from heavily oiled otters.

The results of this study will provide a basis for comparison of cytochrome P4501A induction in sea otters in 1989, in 1996-98, and in 2001, and will help determine if there is a decline over time in CYP1A levels.

B. Rationale/Link to Restoration

This research will provide a means for us to relate present levels of CYP1A induction, measured in sea otters from oiled areas of PWS and other locations, with levels of CYP1A induction in

oiled sea otters collected in 1989, after the spill, thus providing insight into the degree of exposure currently being experienced by sea otters. It also gives an opportunity for histological examination of liver tissues from sea otters in oiled areas, which may be informative in terms of understanding apparent differences in survival rates between areas. Additionally, adaptation of the assay for liver tissues will allow us to obtain samples from other sources (e.g., natural mortalities, subsistence hunters), for monitoring of CYP1A and comparison of oiled and unoiled levels.

C. Location

The samples will be collected in western PWS. Assays of CYP1A and histopathology will be done at Purdue University.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

We will interact with local communities in meetings to explain and discuss ongoing restoration projects (this effort coordinated with similar activities for project 01423).

PROJECT DESIGN

A. Objectives

1. Measure and compare CYP1A in blood (PBMC) and liver samples from sea otters captured in summer 2001.

2. Measure CYP1A in archived liver samples of oiled sea otters from 1989; compare liver CYP1A values from 2001 to 1989 samples.

3. Do histopathological examination of liver biopsies from 2001, to assess relation between CYP1A levels and histological change in the liver.

4. Relate CYP1A levels in 1989 liver samples with hydrocarbon concentrations measured previously, and histopathology collected previously on those samples.

B. Methods

In the NVP study, the RT-PCR assay (quantitative reverse transcriptase PCR assay; Vanden Heuvel et al. 1993, 1994; Snyder et al. 1999) was adapted to measure CYP1A levels in sea otters. This assay quantifies the messenger RNA (m-RNA) that codes for the CYP1A protein, and results are reported as molecules of mRNA per 100 ng of RNA. For sea otters, the assay has been applied only to peripheral blood mononuclear cells; we will adapt it for measurement of CYP1A in liver cells.

In summers of 2001, we have proposed (project 01423) to capture 30 sea otters (15 per area) in the same areas (Knight and Montague islands) that were sampled in the NVP project, so that additional data collected can be directly compared to previous (1996-98) results. Capture and handling methods will be similar to those employed previously (Bodkin et al. 1999). Sea otters will be sedated, body measurements taken, a tooth collected for age determination, and a blood sample taken by jugular venipuncture. In addition, a liver biopsy weighing approximately 0.5 gm will be surgically collected from 10 otters per area, by a qualified veterinarian. One portion will be frozen in LN2 and a second portion fixed in formalin. Following reversal, sea otters will be released in the same vicinity as captured.

Samples (liver, blood cells, and frozen archived liver) will be shipped to Purdue University for analysis in the laboratory of Dr. Paul Snyder. CYP1A will be measured by the RT-PCR assay, and liver samples in formalin will be examined for evidence of histological change.

The data will be used to determine the relation between CYP1A in blood and liver. We will compare mean CYP1A values in liver samples from 2001 and 1989. We will look for a correlation between CYP1A in liver and histopathological change in hepatic cells. We will also relate liver histopathology and CYP1A levels to serum chemistry, including serum enzymes, measured as part of work outlined in Project 01423. Finally, for the 1989 liver samples, we will correlate total hydrocarbons in liver (data from NRDA studies) and histopathology (Lipscomb et al. 1993) with CYP1A induction.

SCHEDULE

A. Measurable Project Tasks for FY 01

July:	Capture and sampling of sea otters.
August-Sept.:	CYP1A analyses on liver samples from 2001 and from 1989, data analyses.

B. Project Milestones and Endpoints

1. July 2001: Collection of liver samples from live otters.
2. Aug-Sept: Analyses of new (year 2001) and old (year 1989) liver samples for CYP1A. Data analyses.
3. April 2001: Report submission - April 15, 2001.

C. Completion Date

This is a one year project. Sample collections and laboratory assays will be completed in FY2001 and a final report submitted by April 15, 2002.

PUBLICATIONS AND REPORTS

We will provide a final report to the EVOSTC office by April 15, 2002. We anticipate a manuscript on the results to be submitted to a scientific journal in the year 2002.

PROFESSIONAL CONFERENCES

None planned for FY2001.

NORMAL AGENCY MANAGEMENT

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

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is dependent on funding of sea otter capture for monitoring cytochrome P450 as part of Project 01423; otherwise we cannot complete the stated objectives.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This is a new project proposal.

PRINCIPLE INVESTIGATORS

Dr. Brenda Ballachey, B.S., M.S. 1980 Colorado State University, Ph.D. 1985 Oregon State University, is a Research Physiologist at the Alaska Biological Science Center of USGS, Biological Resources Division. She was Project Leader for sea otter NRDA studies from 1990 through 1996, and has been involved in all aspects of post-spill research on sea otters. She has authored or coauthored over 25 peer-reviewed publications, and is currently a co-principal investigator for the Nearshore Vertebrate Predator (NVP) project, examining effects of residual oil on health and recovery of sea otters and other NVP study species.

Dr. Paul Snyder is an Assistant Professor of Pathology and Immunotoxicology and Director of the Clinical Immunology Laboratory of the Department of Veterinary Pathobiology, Purdue University. He is also a Diplomate of the American College of Veterinary Pathologists. His research interests are in the area of mechanism-based studies on the pathology and immunology

of xenobiotics on biological systems. He has been a PI on the Nearshore Vertebrate Predator project since 1995.

OTHER KEY PERSONNEL

LITERATURE CITED

Babcock, M. M., G. V. Irvine, P. M. Harris, J. A. Cusick, and S. D. Rice. 1996. Persistence of oiling in mussel beds three and four years after the *Exxon Valdez* oil spill. Am. Fish. Soc. Symp. 18:286-297.

Ballachey, B.E. and K.A. Kloecker. 1997a. Hydrocarbon residues in tissues of sea otters (*Enhydra lutris*) collected following the *Exxon Valdez* oil spill, *Exxon Valdez* Oil Spill State/Federal Natural Resource Damage Assessment Final Report (Marine Mammal Study 6), U.S. Fish and Wildlife Service, Anchorage, Alaska.

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Ballachey, B.E., J.J. Stegeman, P.W. Snyder, G.M. Blundell, J.L. Bodkin, T.A. Dean, L. Duffy, D. Esler, G. Golet, S. Jewett, L. Holland-Bartels, A.H. Rebar, P.A. Seiser, and K.A. Trust. 1999b. Oil exposure and health of nearshore vertebrate predators in Prince William Sound following the *Exxon Valdez* oil spill. Chapter 2 *in* NVP Draft Final Report (Project 95025-99025).

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2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001
Personnel		$9.0
Travel		$2.2
Contractual		$6.3
Commodities		$0.6
Equipment		$0.0
Subtotal	$0.0	$18.1
General Administration		$1.8
Project Total	$0.0	$19.9
Full-time Equivalents (FTE)		0.1

LONG RANGE FUNDING REQUIREMENTS	
Estimated FY 2002	Estimated FY 2003
$0.0	$0.0

Dollar amounts are shown in thousands of dollars.

Other Resources

Comments:

No costs are included for NEPA compliance, technical review session attendance, restoration workshop attendance, report writing, publications, professional conferences, or community involvement.

FY01

Prepared: 14 April 2000

Project Number: 01534
Project Title: Comparison of Cytochrome P450 1A Induction in Blood and Liver Cells of Sea Otters
Agency: DOI

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2001
B. Ballachey	Research Physiologist	GS 12 / 04	1.0	7.0		7.0
Technical support	Biologist	GS 7	0.5	4.0		2.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.5	11.0	0.0	
					Personnel Total	$9.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2001
Airfare & per diem, Indiana - Alaska RT (Snyder)	0.7	1	15	0.1	2.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.2

FY01

Prepared: 14 April 2000

Project Number:
Project Title: Comparison of Cytochrome P450 1A Induction in Blood and Liver Cells of Sea Otters
Agency: DOI

FORM 3B
Personnel
& Travel
DETAIL

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

Contractual Costs:		Proposed FY 2001
Description		
4A Linkage		0.0
Assays of liver for cytochrome P450 1A, histopathology 50 @ $125		6.3
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$6.3

Commodities Costs:		Proposed FY 2001
Description		
Veterinary supplies		0.6
	Commodities Total	$0.6

FY01

Prepared: 14 April 2000

Project Number:
Project Title: Comparison of Cytochrome P450 1A Induction in Blood and Liver Cells of Sea Otters
Agency: DOI

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2001
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY01

Prepared: 14 April 2000

Project Number:
Project Title: Comparison of Cytochrome P450 1A Induction in Blood and Liver Cells of Sea Otters
Agency: DOI

FORM 3B
Equipment
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FY 2000	Proposed FY 2001						
Personnel		$0.0						
Travel		$0.0						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$0.0			Estimated FY 2002	Estimated FY 2003		
Indirect								
Project Total	$0.0	$0.0						
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY00

Prepared:

Project Number:
Project Title:
Name:

FORM 4A
Non-Trustee
SUMMARY

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 2000
						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 2000
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$0.0

FY00

Prepared:

Project Number:
Project Title:
Name:

FORM 4B
Personnel
& Travel
DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Contractual Costs:	Proposed FY 2000
Description	
Contractual Total	$0.0

Commodities Costs:	Proposed FY 2000
Description	
Commodities Total	$0.0

FY00

Prepared:

Project Number:
Project Title:
Name:

FORM 4B
Contractual & Commodities DETAIL

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 2000
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:	Number of Units
Description	

FY00

Project Number:
Project Title:
Name:

FORM 4B
Equipment
DETAIL

Prepared: