19.08.01 (2 of 16)

Community Involvement/Traditional Ecological Knowledge

Project Number:	00052
Restoration Category:	General Restoration
Proposer:	Chugach Regional Resources Commission
Lead Trustee Agency:	Alaska Department of Fish & Game
Cooperating Agencies:	None
Duration:	6 Years
Cost FY00:	219,400.00
Cost FY01:	219,400.00
Cost FY02:	219,400.00
Geographic Area:	Spill Area Wide
Injured Resource/Service:	Subsistence

ABSTRACT:

This project will increase community involvement in the restoration process. The Spill Area-Wide Community Involvement Coordinator's work will continue through a contract with the Chugach Regional Resources Commission (CRRC). Through direct communication with a network of local facilitators, the Spill Area-Wide Coordinator will continue to actively involve local residents in the restoration program. (Local facilitators are located in Tatitlek, Chenega Bay, Port Graham, Nanwalek, Cordova, Seward, Seldovia, Valdez, Kodiak, and the Alaska Peninsula).

The project will initiate the process of integrating the duties of the Community Facilitator into the Tribal Natural Resource Management Programs. As the role of the Community Facilitator decreases, CRRC will be working with five pilot project communities (Eyak, Tatitlek, Ouzinkie, Port Graham and Nanwalek) to initiate a Stewardship program that will assist in the recovery of injured resources and services. This will be accomplished through: 1) A workshop to be held that will bring Natural Resource Specialists and Community Facilitators to Anchorage and focus on presenters from around the state and nation regarding their existing programs. Additionally, facilitated discussion will take place on how to institute a natural resource program in each of the communities, 2) the initiation of a Science Committee to work with local Natural Resource Specialists to create a monitoring program throughout the spill area. This will include bringing together interested EVOS scientists to give direction and advice to Natural Resource Specialist on species and areas that need to be monitored and techniques for monitoring, and 3) a long-term plan to organize and institute a Natural Resource Program in each pilot project community that will complement the existing Trustee Council mission and become stewards of injured resources, services and land.

INTRODUCTION

Ten local facilitators were hired in FY99 through cooperative agreements with the village councils of Tatitlek, Chenega Bay, Port Graham, Nanwalek, Eyak (Cordova), Ouzinkie, Qutekcak (Seward), Valdez, and the Chignik Lake Tribal Council. Hugh Short, the full time Spill Area Wide Community Involvement Coordinator, will continue his employment with CRRC to coordinate the project out of the Restoration office, to accomplish the following tasks:

1. Increase involvement of community members and local tribal traditional natural resource programs throughout the spill region in restoration projects. This community process will require a Community Facilitator and Natural Resource Specialist, whose duties are described below.

2. Serve as contact point for the Community Facilitator and Natural Resource Specialist in each of ten participating communities (Tatitlek, Chenega Bay, Port Graham, Nanwalek, Cordova, Seward, Seldovia, Valdez, Ouzinkie, and Chignik Lake - the Community Facilitators will be subcontractors to CRRC). The tasks for the Spill Area Wide Community Involvement Coordinator in relation to the Community Facilitators will be to:

    a. Once a month, fax a brief activities report to the Community Facilitators and Tribal Natural Resource Management Programs to keep them informed of Trustee Council actions, Restoration Office activities, upcoming events, new research finding, and all other pertinent information. The report could take the form of bullets or a newsletter with contact information on each issue.

    b. Update the local resources inventories for each community (lodging and meeting space available for rent, boats and people available for hire, etc.) This information will be consolidated and distributed to all PIs. The Spill Area Wide Community Involvement Coordinator and Community Facilitators will then assist PIs in arranging use of these local resources.

    c. Coordinate the participation of the Community Facilitators in the annual Restoration Workshop, as well as two additional workshops. These workshops, titled "Stewardship Workshop," and "Traditional Knowledge and Monitoring" will take place separately. The Stewardship Workshop will take place in November 1999 in Anchorage. The Traditional Knowledge and Monitoring Workshop will take place during the annual Restoration Workshop in January.

    d. Work with the TEK Specialist to coordinate an annual review by Community Facilitators and village councils of restoration project proposals involving indigenous knowledge, and develop recommendations for the Executive Director.

3. Annually review the community involvement component of all restoration project proposals. Inform the Community Facilitators and/or Natural Resource Specialists of proposals that would involve their communities. Make recommendations to the Executive Director on the adequacy of, and ways to strengthen, the community involvement components of specific proposals. Once funding decisions are made by the Trustee Council, initiate contact with the PIs to offer assistance in implementing their community involvement components.

4. Provide input at the Restoration Work Force meetings.

5. Provide input to the Restoration Update newsletter editorial board.

6. Provide a "community report" to the PAG at each of its meetings.

7. Assist in organizing Trustee council/Restoration Office community meetings held in conjunction with the Invitation/Draft Work Plan. This may include arranging presentations in specific communities by PIs.

8. Attend (in person or by teleconference) all Trustee Council meetings and report to the Community Facilitators on actions taken.

9. Work with the Science Coordinator, Communications Specialist, and TEK Specialist to get research results to communities.

10. Coordinate the provision of technical assistance to the villages by the Trustee Council staff and agency personnel to develop project proposals.

11. Prepare quarterly project status reports and ensure all annual/final reports are submitted on a timely basis by the affected communities.

The cooperative agreement signed in FY96 between the Alaska Department of Fish & Game, Subsistence Division, and the Chugach Regional Resources Commission would be extended to include FY00. Under this agreement, all parties to the agreement would jointly and cooperatively:

1. Identify suites of injured resources that could be incorporated into the Traditional Ecological Knowledge (TEK) approach. This would also be done in consultation with the Chief Scientist.

2. Through the development of a training manual in FY96, the Community Facilitators and Natural Resource Specialists will utilize their training to assist the PIs in their research projects by adding the traditional knowledge to the research information through interviews with local community members.

3. ADF&G will provide training for and assistance to EVOS researchers/scientists on the interpretation and potential application of TEK to their restoration projects. This might include a separate workshop and/or ongoing involvement with select researchers.

The specific tasks the local Community Facilitators are expected to undertake include the following:

1. Inform the Spill Area Wide Coordinator of community issues, concerns or questions regarding the oil spill. These issues could be identified through community meetings conducted by the Community Facilitators or through other means and could include ideas for new projects.

2. Assist the Spill Area-Wide Coordinator in increasing community involvement in restoration projects. This will include maintaining the list of a community labor database, listing the names, telephone numbers, area of expertise, and compensation requirements of specific community members who are interested and able to work on the EVOS Trustee Council funded projects. Areas of expertise range anywhere from skiff and other equipment availability, general laborers, and interviewers, to research assistants, guides, and traditional wisdom holders.

3. Work with the Spill Area-Wide Coordinator in coordinating the annual round of Trustee Council community meetings as well as community visits from project PIs. The Community Facilitator will also serve as the initial contact in the village for any project conducted in the traditional use areas of the communities.

4. The Community Facilitators are responsible for ensuring that the protocols and guidelines developed in FY96 are strictly adhered to by all parties involved in the Trustee Council funded project.

5. Work closely with the village council's tribal traditional natural resource program to coordinate all activities that have a direct impact the local community resources and any research projects that will complement the tribe's traditional knowledge of the traditional use areas.

6. Disseminate to community members the monthly update from the Spill Area-Wide Coordinator.

7. All Community Facilitators shall attend the annual Restoration Workshop and

associated meetings, including certain scientific review sessions (on SEA, persisting oil, marine mammal projects, etc.)

8. Assist in identifying injured species on which TEK should be collected.

9. Conduct interviews with local traditional wisdom holders under the supervision of the Spill Area-Wide Coordinator and the TEK Specialist.

10. Provide a quarterly report to the Spill Area-Wide Community Involvement Coordinator identifying community issues, concerns, or questions regarding restoration. These issues could be identified through community meetings or other means and should include relevant issues discussed at village council meetings. Ideas for new projects should also be included.

The specific tasks for Natural Resource Specialist in Pilot Project communities (Eyak, Tatitlek, Port Graham, Nanwalek, and Ouzinkie) will include all Community Facilitator duties, in addition to the following:

1. Participate in the Stewardship Workshop in November in Anchorage to discuss the formation or integration of a Natural Resource program with their tribal councils. This includes how to organize and implement programs, funding, and mentoring opportunities. Presentations will be given by representatives of tribes that have existing programs.

2. Collaborate with the TEK Specialist and Community Involvement Coordinator to hold a Traditional Knowledge and Monitoring workshop in January during the annual Restoration Workshop. Analyze the possibility of setting up a Science Committee to provide advice, training, and direction in monitoring specific injured resources.

3. Continue to formulate a stewardship and monitoring program for FY01 workplan.

NEED FOR THE PROJECT

A. Statement of Problem

The *Exxon Valdez* oil spill caused severe disruption of the lives of many people living in the spill impacted area. The spill also caused residents of the area to be concerned about the safety of their wild food sources, and the integrity of the surrounding natural environment. While scientific studies aimed at restoring the resources and services damaged by the oil spill have occurred throughout the spill area, most of the researchers work for agencies or institutions based in Anchorage, Fairbanks, or outside Alaska. Residents have voiced concern over a lack of involvement by spill area communities in the restoration efforts, and incomplete communication to spill area inhabitants of study proposals and results. While the past several years have facilitated an increasing amount of communication between the scientists and the communities, there still exists a void for meaningful involvement in the restoration process by the community members at the grass roots level. At the same time, researchers have recognized that local residents have traditional knowledge that could help them answer questions they have not been able to answer through conventional scientific means.

Additionally, resources and services injured by the oil spill are currently not cared for adequately by local, state and federal governments. The development of Natural Resource program would facilitate the formation of stewardship programs that are in need regarding injured resources recovering from the oil spill.

B. Rationale

This project furthers the Trustee Council's goals of facilitating the involvement of spill area residents and resource users in the restoration process. It also reaffirms the Trustee Council's dedication to the involvement of people living in the oil spill affected areas in the restoration process. In addition, people living in the spill area have detailed knowledge about the condition of resources, which can significantly add to data collected as part of scientific studies, and possibly even enhance the success of restoration efforts. Local people have expressed a desire to be involved in all aspects of restoration projects, and a willingness to work with researchers.

Tribes are eager to work with state and federal agencies to implement long-term monitoring programs that will benefit recovering resources. Workshops and training held in this proposal would allow tribes to work with a Science Committee to set up a long-term monitoring program that will satisfy all involved parties. Additionally, the formation of stewardship programs will benefit all injured resources by facilitating a healthy ecosystem with wise management.

C. Location

This project will be spill area wide. All communities will have a Community Facilitator within their community, with the exception of the Alaska Peninsula and Kodiak, which will be covered by a region-wide Community Facilitator.

The project's benefits will be realized both in the communities involved and in the restoration of the injured resources. Better communication among the Trustee Council staff, researchers, and residents of the communities impacted by the spill should improve the effectiveness of restoration efforts.

COMMUNITY INVOLVEMENT

The core of this project is community involvement.

PROJECT DESIGN

A. Objectives

The objectives of the project will be to:

1. Increase the meaningful involvement of spill area communities in the restoration efforts of the Trustee Council;

2. Improve the communication of findings and results of restoration efforts to spill area village councils and inhabitants and the appropriate regional organizations. It is expected that by doing so, this project will increase the effectiveness of overall restoration efforts; and

3. Develop a means by which western science and traditional wisdom can be compiled and utilized in a cooperative manner with the intent of furthering the restoration process in a way that is sensitive to the needs of the affected communities.

4. Hold a Stewardship Workshop in Anchorage. Invite tribal representatives from existing Natural Resource Programs to assisting in developing similar programs in the spill area. This would facilitate the healthy recovery and management of injured resources services in the spill area.

5. Hold a Traditional Knowledge and Monitoring Workshop during the annual Restoration Workshop in January. EVOS scientists and Natural Resource Specialists/Community Facilitators will discuss a cooperative effort to monitor specific resources in the spill area.

B. Methods

The project will be implemented by a Spill Area-Wide Coordinator hired through a contract with the Chugach Regional Resources Commission, the local Community Facilitators, in close coordination with the Tribal Natural Resource Programs and Natural Resource Specialist in pilot project communities.

The objectives will be achieved using the following methods:

A contract will be renewed by ADF&G Subsistence Division to CRRC for overall coordination of the Community Facilitators and Spill Area-Wide Coordinator. The contractor will be expected to arrange for the hiring (where applicable) and coordination of local facilitators in the communities of Chenega Bay, Tatitlek, Port Graham, Nanwalek, Cordova, Seward, Valdez, Seldovia, and regional coordinators for the Kodiak Island and Alaska Peninsula regions.

Working with the Community Facilitators, the Spill Area-Wide Coordinator will identify those projects funded by the Trustee Council for which a community outreach component would be appropriate, and will work with the principal investigators of those projects to design and implement community outreach components. The goal of community outreach will be to continue the partnership begun under 95052 between the people of the oil spill region and scientific researchers. Outreach will include communication of traditional knowledge and local interests, as well as communication of research proposals and study results.

A new initiative for this program will be the integration of the Tribal Natural Resource Programs into the Community Involvement Program through the support of Pilot Stewardship Programs in five communities (Tatitlek, Nanwalek, Ouzinkie, Port Graham, and Eyak). These communities have existing Tribal Natural Resource Programs in place and are willing to integrate the community facilitator responsibilities into this program. The remaining communities will continue their normal functions, but at a reduced level. They will be encouraged to develop Tribal natural resource programs in their individual communities and be asked to participate in the training provided through this and other projects.

Increased responsibilities on the pilot stewardship programs will be to assist in the development of a natural resource curriculum, develop working relationships with the land management agencies in and around their traditional use areas (including the village and regional corporations), attend two natural resource management workshops, work to identify target injured species that their community would like to focus on in FY00, and take advantage of the TEK that is available in each community to accomplish these responsibilities.

The effectiveness of the project will be evaluated on an annual basis, by the Trustee Council staff working in cooperation with the Spill Area-Wide Coordinator, and the communities in the oil spill region.

C. Contracts and Other Agency Assistance

A contract will be let to CRRC for overall coordination of a facilitator network through a Spill Area-Wide Coordinator. The contractor will be expected to arrange for the hiring and coordination of local facilitators in the communities of Chenega Bay, Tatitlek, Port Graham, Nanwalek, Cordova, Seward, Valdez, Seldovia, and regional coordinators for the Kodiak Island and Alaska Peninsula regions. However, all other communities in the oil spill impacted area will also be included in outreach efforts, even though a local facilitator will not be hired in each community.

These tasks are being contracted out for the following reasons:

1. The use of a regional organization as opposed to a state agency would better serve the needs of the local community members.

2. The Trustee Council has encouraged contracting tasks out to the private sector as

much as possible, and as appropriate.

3. The state procurement systems makes it difficult to contract directly with the communities in the oil spill region. It has proven to be simpler to contract out the coordination of the facilitator network on a sole source basis with CRRC, who has an established working relationship with the communities.

D. Completion Date

Since the objective of this project is to integrate the local communities into the restoration program, we see a need to continue this program until the spill restoration project is complete. The project should be evaluated on a yearly basis to determine how it can best serve the needs of the Trustee Council and the local communities.

SCHEDULE

A. Measurable Project Tasks for FY97

October 1, 1999	Contract with CRRC and ADF&G Renewed
October 1, 1999	SAWCIC continues CRRC employment
October 1, 1999	Subcontracts with Communities for Community Facilitators developed or renewed and contracts with Natural Resources Specialist developed and completed
October 1-31, 1999	MOU renewed between ADF&G & CRRC
Ongoing	Identification of Species for TEK
November, 1999	Stewardship Workshop for Community Facilitators/Natural Resource Specialists
Nov. 1 - Dec. 31, 1999	Preparation for Annual Restoration Workshop
Nov., 1999	Coordinate development of new projects w/ communities
January, 2000	Participate in Annual Restoration Workshop
January, 2000	Traditional Knowledge and Monitoring Workshop for Community Facilitators/Natural Resource Specialists
March-April, 2000	Work with communities to develop and/or write proposals for FY98 work plan
March-April, 2000	Work with communities to compile final reports
Ongoing	Provide ongoing technical assistance to Facilitators
Ongoing	Work with communities who are not under the pilot program to encourage them to develop natural resource programs at the tribal level

B. Project Milestone and Endpoints

The project should be continued as long as there are significant restoration efforts underway. The project should be evaluated on a yearly basis to determine the most efficient way to continue to keep the communities involved in the Trustee Council Restoration Program.

C. Project Reports

Annual reports will be compiled in coordination with the ADF&G and provided each year by CRRC on April 15th, describing and summarizing the progress made during the previous federal fiscal year. In addition, monthly reports will be provided to the participating communities by the Spill Area-Wide Coordinator.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This community outreach effort is in fact a novel effort to coordinate the Restoration Program with the local residents and builds on the established relationship between CRRC and the communities in Prince William Sound. Under this project, CRRC will work to establish new relationships with Seldovia, Kodiak Island and Alaska Peninsula area residents.

CRRC is contributing a considerable amount of in-kind services to the project. CRRC's tribal traditional natural resource program development project has been operating for the past two years in four of the villages in the Chugach Region, and Ouzinkie. CRRC, through a BIA contract, is providing a total of $36,800 in salaries and fringe for five natural resource specialists to be hired at the local level. Technical assistance is being provided by CRRC as well as the Native American Fish & Wildlife Society to provide training and technical assistance at the local level. Part of the normal duties of the Natural Resource Specialists will be to collect traditional harvest and other baseline data (such as population assessments) on the resources in their traditional use areas. This information can then be incorporated into the TEK portion of the project. It has been suggested to the communities that the Community Facilitators also serve as the Natural Resource Specialists to aid in maximizing the available funds.

ENVIRONMENTAL COMPLIANCE

This project is categorically excluded under NEPA guidelines.

PERSONNEL

Patty Brown-Schwalenberg: Ms Brown is the Executive Director of the Chugach Regional Resources Commission (CRRC). She has worked for the past 17 years in such positions as Tribal Administrator for her tribe, the Lac du Flambeau Band of Lake Superior Chippewa Indians, Society Administrator for the Native American Fish & Wildlife Society, Office Manager of the Bering Sea Fisheries Development Fund, and as a private consultant, assisting Alaska Native communities in obtaining funding for natural resource management programs, and setting up their natural resource program administrative systems. CRRC and the previous organizations that Ms Brown has operated have consistently met all standards of proper management, including annual program and financial audits.

Hugh Short: CRRC will renew the subcontract with Hugh Short to be the Spill Area-Wide Community Involvement Coordinator for this project. Hugh has been active in spill area issues for the past 1 1/2 years and has developed an excellent working relationship with people at the community level and the principal investigators. He will be instrumental in working with the communities at developing the training workshops as well as assisting the villages in developing their own natural resource stewardship programs.

Dr. Henry Huntington: CRRC will continue to contract with Henry Huntington as the TEK Specialist. He has been active on the TEK project for 4 years. He has worked extensively with Chugach and Arctic Native communities and received his doctorate in the integration of traditional knowledge with western science.

Proposed Project Leader: Patty Brown-Schwalenberg
Chugach Regional Resources Commission
4201 Tudor Centre Drive, Suite 300
Anchorage, Alaska 99508
phone number: 907/562-6647
fax number: 907/562-4939
e-mail: crrcomm@alaska.net

FY97 BUDGET

Budget Line Items	CRRC	ADF&G	In-Kind	Total Budget
Personnel (incl. Fringe)	$ 0.00	$0	38,000.00	$38,000.00
Division Project Coordinator	*0.00*	*0*	*0.00*	*0*
TEK Data Compilation/Input	*0.00*	*0*	*0.00*	*0*
CRRC Executive Director	*0.00*	*0.00*	*9,500.00*	*9,500.00*
Natural Resource Specialists`	*0.00*	*0.00*	*28,500.00*	*18,500.00*
Travel	35,000.00	0	2,500.00	37,250.00
Contractual	97,000.00	0.00	17,000.00	114,000.00
Community Facilitators	*75,000.00*	*0.00*	*0.00*	*75,000.00*
Spill Area Wide Coordinator	*50,000.00*	*0.00*	*0.00*	*50,000.00*
Technical Assistance	*4,000.00*	*0.00*	*0.00*	*4,000.00*
Alaska Inter-Tribal Council	*0.00*	*0.00*	*12,000.00*	*12,000.00*
Native American Fish & Wildlife Society	*0.00*	*0.00*	*5,000.00*	*5,000.00*
Commodities	2,500.00	0	2,500.00	5,000.00
Equipment	2,500.00	0	0.00	2,500.00
Capital Outlay	0.00	0.00	0.00	0.00
Subtotal	$186,500.00	$0	60,000.00	$196,750.00
General Administration	18,500.00	14,400	5,000.00	19,600.00
Project Total	$205,000.00	$219,400.00	$65,000.00	$219,400.00

2000 EXXON VALDEZ TF :E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000						
Personnel		$0.0						
Travel		$0.0						
Contractual		$205.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$205.0			Estimated FY 2001	Estimated FY 2002		
General Administration		$14.4						
Project Total	$0.0	$219.4			$220.0	$220.0		
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY00

Prepared: 4-12-99

Project Number: 00052
Project Title: Community Involvement/Traditional Ecological Knowledge
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TR :E COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
						0.0
						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	
					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: 4-12-99

Project Number: 00052
Project Title: Community Involvement/Traditional Ecological Knowledge
Agency: Alaska Department of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

2000 EXXON VALDEZ TR :E COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

Contractual Costs:	Proposed
Description	FY 2000
Contract with Chugach Regional Resources Commission	205.0
	0.0
	0.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$205.0

Commodities Costs:	Proposed
Description	FY 2000
Commodities Total	$0.0

FY00

Prepared: 4-12-99

Project Number: 00052
Project Title: Community Involvement/Traditional Ecological Knowledge
Agency: Alaska Department of Fish and Game

FORM 3B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TR :E COUNCIL PROJECT BUDGET
October 1, 1999 - September 30, 2000

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

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY00

Prepared: 4-12-99

Project Number: 00052
Project Title: Community Involvement/Traditional Ecological Knowledge
Agency: Alaska Department of Fish and Game

FORM 3B
Equipment
DETAIL

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

Budget Category:	Authorized FY 1999	Proposed FY 2000						
Personnel		$50.0						
Travel		$35.0						
Contractual		$97.0						
Commodities		$2.0						
Equipment		$2.5	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$186.5			Estimated FY 2001	Estimated FY 2002		
Indirect		$18.5						
Project Total	$0.0	$205.0			$205.0	$205.0		
Full-time Equivalents (FTE)		1.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY00

Prepared: 4-12-99

Project Number: 00052
Project Title: Community Involvement/Traditional Ecological Knowledge
Name: Chugach Regional Resources Commission

FORM 4A
Non-Trustee
SUMMARY

2000 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2000
Hugh Short	Community Involvement Coordinator		12.0	4.1	0.0	50.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		12.0	4.1	0.0	
					Personnel Total	$50.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2000
Port Graham - Anchorage		0.2	2	8	0.1	1.2
Tatitlek - Anchorage		0.5	2	8	0.1	1.8
Chenega Bay - Anchorage		0.5	2	8	0.1	1.8
Seldovia - Anchorage		0.3	2	8	0.1	1.4
Nanwalek - Anchorage		0.2	2	8	1.0	8.4
Seward - Anchorage		0.2	2	8	1.0	8.4
Cordova - Anchorage		0.3	2	8	0.1	1.4
Valdez - Anchorage		0.2	2	8	0.1	1.2
Ouzinkie - Anchorage		0.7	2	8	0.1	2.2
Chignik Lake - Anchorage		0.7	2	8	0.1	2.2
TEK Specialist/Community Involvement Coordinator travel throughout						5.0
spill area						0.0
					Travel Total	$35.0

FY00

Prepared: 4-12-99

Project Number: 00052
Project Title: Community Involvement/Traditional Ecological Knowledge
Name: Chugach Regional Resources Commission

FORM 4B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed
Description	FY 2000
TEK Specialist	18.0
Sub-contracts with tribal councils (5 councils at $9,000 and 5 councils at $6,000) to provide facilitator and stewardship services	75.0
Contracts with four speakers for services at Stewardship Conference	4.0
Contractual Total	$97.0

Commodities Costs:	Proposed
Description	FY 2000
Incidental costs for Stewardship Conference (meeting space rental, supplies, food, etc.)	2.5
Commodities Total	$2.0

FY00

Prepared: 4-12-99

Project Number: 00052
Project Title: Community Involvement/Traditional Ecological Knowledge
Name: Chugach Regional Resources Commission

FORM 4B
Contractual & Commodities DETAIL

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

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
Communication and computer equipment			2.5
			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**	$2.5

Existing Equipment Usage: Description	Number of Units	

FY00

Project Number: 00052
Project Title: Community Involvement/Traditional Ecological Knowledge
Name: Chugach Regional Resources Commission

FORM 4B
Equipment
DETAIL

Prepared: 4-12-99

Monitoring, Habitat Use, and Trophic Interactions of Harbor Seals in PWS

Project Number:	00064
Restoration Category:	Research, Monitoring
Proposer:	Kathryn J. Frost, ADF&G
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	none
Alaska Sea Life Center:	
Duration:	3rd year, 3-year project
Cost FY 00:	$131,000
Geographic Area:	Prince William Sound
Injured Resource:	Harbor Seals

ABSTRACT

This project is the final year of a project to monitor the status of harbor seals in Prince William Sound and investigate the hypothesis that food limitation to pups and juveniles has caused the ongoing decline. Aerial surveys will be conducted during molting to determine whether the population continues to decline, stabilizes, or increases. Trend analysis using Bayesian statistics will be completed and a manuscript submitted for publication. No additional field work other than the aerial surveys will be conducted as part of this project. Fatty acids analysis will be conducted on blubber samples collected during summer 1999, and development of mathematical models continued to estimate seal diets and whether they have changed both within the 90s and since the 1970s. Special emphasis will be on pups and juveniles, the age groups most likely to be affected by food limitation. Emphasis will be placed on write-up of final results and preparation of manuscripts for publication.

INTRODUCTION

The *Exxon Valdez* oil spill (EVOS) occurred in Prince William Sound (PWS) in March 1989. Because harbor seals (*Phoca vitulina richardsi*) and their haulouts became oiled by the spill, harbor seal studies began almost immediately as part of the Natural Resources Damage Assessment (NRDA) program. These NRDA studies were conducted by the Alaska Department of Fish and Game (ADF&G), and included aerial surveys to quantify mortality and necropsies to document levels of hydrocarbons and tissue damage in oiled seals. Based on these investigations, it was estimated that more than 300 harbor seals (36% of the seals in oiled areas) died in PWS following the EVOS. As NRDA studies progressed, it also became clear that the harbor seal population throughout PWS was declining and had been doing so since at least 1984. Therefore, beginning in 1991 as NRDA studies neared completion, the Trustee Council funded a harbor seal restoration study in which ADF&G continued to monitor the trend of harbor seals in PWS and began to investigate the causes of the ongoing decline. These early restoration studies addressed a broad array of possible causes for the decline including disease, predation, human-caused mortality, reproduction, and food limitation.

Marine mammals and seabirds are apex predators in ecosystems in which fishes and cephalopods are important prey. As such, a strong relationship would be expected between predator populations and the abundance of fish stocks. This relationship is likely to be influenced by factors such as commercial fisheries and ecosystem changes (e.g., Beddington, et al. 1985; Springer 1993). In many parts of the world pinniped populations have increased as predicted after protection from over-exploitation (e.g., Olesiuk, et al. 1990; Shelton et al. 1995). However, large declines in populations of harbor seals and Steller sea lions (*Eumetopias jubatus*) have been documented in the Bering Sea and the GOA, including PWS (Pitcher 1990; Loughlin, et al. 1992). These declines occurred despite implementation of the 1972 Marine Mammal Protection Act (MMPA) which ended commercial hunting for pups and bounty payments for adults. Likewise, since the 1970's numerous species of seabirds have also declined in PWS. These unanticipated declines have prompted monitoring and assessment of marine mammal, seabird, and fish population trends, and perhaps most importantly, have furthered the idea of using predators as samplers of forage fish abundance (Duffy 1996; Roseneau and Byrd 1996). The latter aspect may provide the most useful information towards addressing the question of "Is it food?", since the mean abundance of prey at large spatial scales, as determined from fisheries surveys, may not be relevant to the scale at which seals and seabirds forage (e.g., Duffy 1996; NRC 1996).

In PWS, harbor seals are one of the most abundant and widely distributed marine mammals, hauling out and/or breeding at more than 50 sites. Since 1984 harbor seal numbers in PWS have declined by about 60%, with only part of this decline attributable to the 1989 *Exxon Valdez* oil spill (EVOS) (Frost and Lowry 1994a, Frost et al. 1994). The decline in harbor seals has not been limited to PWS, but has also occurred in adjacent parts of the GOA (Pitcher 1990). A change in the trophic structure of the ecosystem, and hence the availability of prey, is among the hypothesized causes for this observed decline, as well as that of other apex predators. Thus, understanding the diet of harbor seals and how they may depend on seasonal or area-specific concentrations of prey is not only needed in the management of harbor seals as a resource, but because harbor seals may also act as important indicators of other marine resources.

Recently, the use of fatty acid signature analysis (Iverson 1993) has been proposed to study marine food webs and pinniped diets (Iverson 1995). Fatty acids are the largest constituent of lipids and those of carbon chain length 14 or greater are often deposited in animal tissue with minimal modification from diet. Lipids in the marine food web are exceptionally complex and diverse. Owing to various restrictions and specificities in the biosynthesis and modification of fatty acids among different taxonomic groups (e.g., Paradis & Ackman 1976; Ackman 1980; Cook 1985; Fraser et al. 1989), many components appear which can be traced to a general or even specific ecological origin. Certain "indicator" fatty acids (Iverson 1993) exist which are particularly useful in food web studies since they can arise only or mostly from the diet. Although methods of fatty acid signature analysis are still being developed, the technique has been used both to identify general trophic level of diets and to detect major and minor shifts in diet within populations (Iverson, Arnould & Boyd 1997; Smith, Iverson & Bowen 1997).

This harbor seal restoration study conducted in PWS during 1994-1998 is one of the two most comprehensive ecosystem studies ever conducted using fatty acids signature analysis (Iverson, Frost & Lowry, 1997; Iverson, Bowen & Ackman, unpublished data), and has come the farthest in advancing the development of this method. In the first four years of study in PWS, fatty acid signatures have indicated that fine-scale structure of foraging distribution of harbor seals can be discerned, and that this is due not only to localized feeding patterns in seals, but also to specific differences in prey species with size and location or habitat within PWS (Iverson, Frost & Lowry, 1997). From this initial work, it was also possible to make inferences about predominant prey species in the diet of individual seals. Since harbor seals are likely to adjust their foraging patterns to changes in abundance of local prey (Olesiuk 1993; Tollit & Thompson 1996), this suggests that determining diets or changes in diets of harbor seals over time using fatty acid signatures may provide clues not only to changes in foraging patterns, but also to differences in local prey availability, predominant species size classes, and species abundance at the spatial and temporal scales that are essential to the nutrition of individual animals. It has been proposed that one cause for the decline in some Alaskan pinniped populations may have been a change in community structure over time that resulted in an ecosystem dominated by large predatory pollock, thus making small forage fish less available to pinnipeds, especially juveniles (NRC 1996). Thus, the ability to detect relationships between and within predators and prey on a small spatial scale indicates that fatty acid signature analysis could begin to address such hypotheses.

Since the inception of this restoration study, the focus has continued to narrow and tighten. As other possible causes for the decline (for example disease and poor pup production) appear less likely, the focus has shifted increasingly to the question "Is it food?" Initially we addressed this question relative to adult and subadult segments of the population. More recently, we have begun to focus on pups.

Since 1994, we have collected samples from 224 PWS harbor seals for stable isotope, blubber energy, blood chemistry, genetics, and fatty acids analyses. Morphometric measurements, ultrasound, and measurements of bioimpedence were also obtained from many of these seals. This included 36 seals in 1994, 42 in 1995, 39 in 1996,50 in 1997, and 57 in 1999. In addition, more than 60 blubber samples have been obtained from subsistence hunters as part of an EVOS-funded biosampling program. These samples have been analyzed by a variety of investigators in a multi-disciplinary approach to the question of whether food is limiting the recovery of harbor

seals. Stable isotope results are reported by Schell and Hirons as part of EVOS Restoration Project 170 and blood chemistry and blubber energy results by Castellini et al. as part of EVOS Restoration Project 001. As part of our study, we have addressed the food limitation hypothesis through satellite-tagging and fatty acids analysis. New methods for both of these approaches were developed by this restoration project.

Satellite-tags have provided information about locations, movements, and diving of seals, which is helping us to identify feeding areas and understand feeding behavior (Frost et al. 1996, 1997, 1998). To date, 71 harbor seals have been successfully instrumented with satellite-linked depth recorders (SDRs), including 26 adults (11 males, 15 females), 23 subadults (12 males, 11 females), and 22 pups (15 females, 7 males) (Table 1). Twenty-two of these were tagged in April- May, 29 in September, and 20 of the 22 pups immediately following weaning in late June-early July.

Satellite-tagging data clearly indicate substantial individual variation in the way seals make their livings (Frost and Lowry 1994b; Frost et al. 1995, 1996, 1997, 1998). Some tagged seals used only a few haulouts and made only short trips away from them to feed. Others made longer trips of several days to almost two weeks. Some of these feeding trips were apparently entirely within PWS and others were in the GOA. Movements between terrestrial haulouts in central PWS and glaciers in northern PWS were not uncommon. Analysis of data from newly weaned pups tagged in 1997 and 1998 suggests that their movements are generally similar to those of adults. Contrary to expectations, pups did not appear to move farther or show less site fidelity than adults. Analysis of diving behavior of adults and subadults indicated that some seals made consistently shallow dives, while others fed in deeper waters and dove to greater depths. The deepest dive by a tagged seal was 404 m, but most dives were to less than 200 m. In general, seals dove more and hauled out less in the winter. They spent a greater proportion of days hauled out in summer, and used more haulout sites during this period. This is the period when pupping, breeding, and molting occur.

Over the six years of this study, there appears to have been a change in the feeding behavior of seals during winter. None of 6 seals tagged in September 1993 and only 2 of 8 tagged in September 1994 left PWS. All three adult females tagged in fall 1994 spent the entire winter in PWS. In contrast, 12 of 15 seals tagged in September 1995-1996 made winter-spring feeding trips outside PWS. Of the 5 adult females, 4 moved to the Copper River Delta in March, suggesting that food resources found there in spring may be important to pregnant females. These feeding trips outside PWS occurred primarily during winter and spring, and most were to the Copper River Delta. Only 3 of 22 seals tagged in April/May left PWS. Two of these were adults that went to the GOA in May and returned to PWS by June. One small subadult spent parts of May-July in the Copper River Delta. None of the pups we tagged made trips to the Copper River Delta/ Fatty acids data also show a change in the diets of PWS harbor seals between 1994-1995 and 1996-1997. Diets of both adults and subadults in 1998 appeared to more similar to 1994-1995 than to 1996-1997.

The SDR data set for 71 harbor seals from PWS is one of the largest of its kind. It is especially valuable because ADF&G has similar SDR data from an additional 70 harbor seals instrumented in SEAK and near Kodiak as part of the NOAA-funded harbor seal study (Swain et al. 1996).

When the information from these two data sets are synthesized, it will represent the most complete body of information about harbor seal movements and diving/feeding behavior anywhere in the world.

The sample size of satellite-tagged adult and subadult males and females in PWS is now sufficient to generally characterize the movements and diving behavior of these age groups of seals. Additionally, after the 1999 field season we will have tagged 29 seal pups. Small 0.25-watt SDRs developed and tested in 1996-1997 now allow us to safely instrument small seals. Consequently, our emphasis in 1997-1999 shifted to the tagging of newly-weaned pups. Additionally, in 1999, we will have the opportunity to tag approximately 10 yearling harbor seals with prototype location-only tags provided to this project at no cost. This will provide us with a well-rounded picture of overall movement patterns of all age groups of PWS harbor seals.

Fatty acids analysis in PWS harbor seals and their prey was initially funded by the EVOS Trustee Council starting in 1994 as a pilot project. Early results were published in Marine Ecology Progress Series (Iverson, Frost & Lowry, 1997). In that initial study, fatty acid signatures were used to investigate the diet and spatial scales of foraging in harbor seals and selected prey in PWS and the GOA (Iverson, Frost & Lowry, 1997). Since then, many additional blubber samples and prey have been analyzed. To date, blubber samples collected from 381 harbor seals from PWS, Kodiak Island, and SEAK in the mid to late 1990s have been analyzed for fatty acid composition. In addition, during 1998 we analyzed archived blubber from an additional 286 harbor seals sampled in the 1970s in PWS and the GOA, bringing the total to 667 seals. A total of 1052 potential prey samples representing 22 taxa have also been analyzed for total fat content and fatty acid composition. Classification and regression tree analysis was used to classify seals and prey according to their fatty acid signatures. We continue to find large differences in the fatty acid composition of blubber from seals sampled at Kodiak, SEAK and PWS. Annual differences in diet are evident, as are age and gender-related differences. Diets in the 1970s were found to be substantially more diverse than diets in the 1990s. Additionally, fatty acid signatures distinguished seals from different regions within PWS, as well as from haulout sites only a few kilometers apart. These findings suggested that seals forage very site-specifically.

Prey fatty acid patterns also differed on similarly small spatial scales within PWS. Not only could prey species such as herring and pollock be differentiated from one another using fatty acid signatures, but they could also be distinguished by size-class and location within PWS, reflecting differences in diet with age as well as with fine-scale habitat. Fatty acids analysis indicated that juvenile seals sampled in northern PWS fed only on herring from that region, whereas older seals ate herring from a variety of locations. Results from this study were consistent with both satellite data from tagged harbor seals and stomach content analyses of forage fish species in PWS.

Efforts to date to mathematically model the diets of seals suggest that medium and large herring and squid dominate the diets of older seals in southcentral PWS. Pink salmon and squid, fairly common in adult diets, were not eaten by juveniles. This is consistent with information about prey distribution and abundance in PWS and historical information about harbor seal diets. The modeling exercise is still in the developmental phase and will continue to be refined and improved in the future. However, it is already clear that fatty acid signature analysis will be an important contribution to understanding marine food webs in PWS and other marine environments. Perhaps

its greatest potential is that it integrates diet over time and allows us to identify, not every individual prey that was eaten, but instead the key prey species that have contributed most to fat reservoirs, and therefore nutritional status (and probably survival) of these seals.

During FY 99, the objectives of the harbor seal restoration study addressed six hypotheses regarding the status and trends of harbor seals in PWS, possible causes for the ongoing population decline, and the nutritional status of PWS harbor seals. The status of studies relative to these hypotheses is very briefly summarized below.

Hypothesis 1: The PWS harbor seal population has stabilized and/or increased since the EVOS. Annual counts of seals at 25 standardized "trend count" haulout sites in PWS have been made since the oil spill in 1989. From 1990-1998, surveys showed a decline of about 2.5% per year. The rate has slowed in the last few years. Counts that had been adjusted for the effects of tide, date, and time of survey were 13% higher in 1998 than in 1997, 18% lower than in 1990, and 57% lower than in 1984. The results of these analyses will appear in the journal Marine Mammal Science in April 1999 (Frost et al. 1999).

Hypothesis 2: Juvenile harbor seals are particularly sensitive to characteristics of prey abundance such as depth, prey size, and prey type. Prey changes in PWS have resulted in food limitation, poorer body condition, and therefore reduced survival of juvenile seals. During 1997 and 1998, total body composition (fat, protein, lean body mass) of pups, yearlings, and subadults was measured using isotope dilution with deuterium oxide (D_20). Average fat content in 1997 was 43% for pups, 23% for yearlings, and 18%-20% for other subadults. In 1998, pups averaged 3 kg smaller and had 3% less fat. Yearlings and two-year-olds were also smaller in 1998 than in 1997, but their average fat content was 4%-5% greater. In both years, PWS pups averaged 3-7 kg heavier than harbor seal pups form Sable Island, and PWS yearlings had twice the fat content of Sable Island yearlings. This suggests that PWS pups and yearlings were adequately nourished - much better than expected - in 1997 and 1998, but that there were clear annual differences in condition. It is interesting that the diets in 1997 and 1998, as indicated by fatty acids, were different than in the two previous and the following years. We currently have no means of assessing survival of juveniles.

Hypothesis 3: The diets of PWS and other declining populations of harbor seals differ from diets of harbor seals in areas where populations are stable. Fatty acid signature analysis has been conducted on blubber of 381 harbor seals from PWS, southeast Alaska, Yakutat, and the Kodiak area collected in the 1990s. In general, southeast Alaska seals were clearly distinguished from Kodiak and Yakutat seals and most similar to seals from northern PWS. Southern PWS seals were quite similar to those from Kodiak. This was not surprising since satellite tagging data indicated that some southern PWS seals made regular feeding trips to the northern Gulf of Alaska. Diets in southeast and northern PWS were generally more diverse than those in other areas. Although we have been able to identify geographic differences in prey base, we have not yet been able to determine whether and how these differences might affect nutritional status.

Fatty acid signature analysis indicates clear annual differences in diet for all regions. Diets in PWS were quite different in 1994, 1995 and 1998 than they were in 1996 and 1997. Fatty acids

analysis of samples from SEA and Kodiak for 1995 and 1996 indicated a substantial change in diet from one year to the next.

Hypothesis 4: The diets of harbor seals have changed over the past few decades, reflecting a change in the distribution and abundance of important forage fishes. Archived blubber samples from 286 harbor seals collected in the 1970s in PWS and the GOA were analyzed during the last year. Fatty acid signatures of these blubber samples indicated that diets of both adults and subadults in the 1970s were substantially different than diets in the 1990s. Annual differences during 1994-1998 were far less than the interdecadal differences. In general, diets in the 1970s were more diverse, and included more shrimp, octopus, sandlance and squid than diets in the 1990s. A subsample of fatty acids data from Kodiak in the 1970s indicated that flatfish, herring, smelt, sandlance, octopus, shrimp, and squid made up most of the diet. Stomach contents data also indicated that these same species were eaten.

Hypothesis 5: The diet composition of harbor seals in areas of population decline reflect differences or changes in the relative distribution and abundance of prey important to various demographic groups. As part of a Master of Science graduate thesis project, Ms. Tracey Gotthardt is collecting information on recent and historical distribution and abundance of forage fishes in PWS and the northern Gulf of Alaska. She is synthesizing forage fish data layers by compiling a literature/data search of the most recent forage fish studies in PWS. Forage fish distribution data acquired from ADF&G, APEX and SEA have been entered into a GIS database to provide maps for use in spatial analysis of species distribution in PWS. This synthesis of forage fish information will be used to coarsely depict year round distributions of fish and particularly to identify "hot spots" and describe species distribution on a seasonal basis.

Ms. Gotthardt is also analyzing seal diving and movement data for 14 seals satellite-tagged near Montague Island. Location data have been entered into a GIS database and seals tracked through time to determine the range of foraging trips, and any patterns in spatial and temporal distribution. She is currently examining spatial and temporal co-occurrences of seals and fish in an attempt to describe harbor seal distribution and movements in relation to their prey base.

During 1995, large concentrations of young-of-the-year pollock dominated the forage fish complex in central PWS. Fatty acids analysis of blubber from seals sampled in this area in 1995 indicated that pollock was a component of the diet. In 1996, herring replaced these young pollock as the dominant forage fish and, not surprisingly, fatty acid signatures also indicated that herring was a major prey of harbor seals that year.

Ms. Gotthardt is nearing completion of her thesis. She anticipates that her thesis will be completed and defended during FY 99.

Hypothesis 6: Harbor seal pups and juveniles spend more of their time foraging to obtain adequate nutrition than do adults; pups in PWS spend more time foraging than pups in other areas where the population is not declining. Twelve post-weaning harbor seal pups from PWS were instrumented with SDRs in 1997, and an additional 8 in 1998. As of April 1999, three of the pups tagged in 1998 were still transmitting, and all were within PWS. Preliminary analysis of dive data indicates that pups and non-pups spend similar amounts of time diving during, and that

seasonal patterns in amount of time spent diving were generally similar for all ages. Pups did not make obviously more or longer feeding trips, nor did they show less site fidelity than adults. ADF&G, as part of the NOAA-funded harbor seal study, also tagged newly-weaned harbor seal pups on Tugidak Island in the northern GOA in summer 1997 and again in 1998. In the future, comparisons will be made among PWS pups tagged in different years, and between PWS pups and pups tagged on Tugidak.

Proposed work in 1999. During the 1999 field season, satellite tagging, sampling, and monitoring will continue. Research will focus on the hypothesis that the availability of food, particularly to pups and subadults, is limiting the harbor seal population. Aerial surveys will be flown to monitor trends during the molting period in 1999. We plan to attach satellite transmitters to 7 harbor seal pups in 1999 to assist with the interpretation of dietary information provided by fatty acid analysis, and to identify areas used by newly weaned pups for feeding. Satellite-tagging will also provide information about dispersal of pups after weaning, and whether or not they leave PWS. Body fat content of 20-30 pups and yearlings will be determined using D_2O. Blood, blubber, skin, and measurements will be taken from all seals that are caught during tagging operations regardless of age. Similar samples are being collected by ADF&G in SEAK, where harbor seals are not declining, and in the Kodiak region where they have declined more than 90% since the mid-1970s, but may now be increasing, as part of the NOAA-funded harbor seal project. Data will be compared to better understand why seals are doing well in some areas and declining in others. In addition to the above work, it is likely that we will have the opportunity to attach 10 prototype location-only satellite tags to harbor seal yearlings in PWS in 1999. These tags, worth over $20,000, will be provided to the project at no cost in exchange for evaluation of their performance.

Work proposed in 2000 and beyond. The work being proposed for 1999-2000 will focus on analysis of field studies and data analysis undertaken since the inception of this project.

We will conduct aerial surveys to monitor the trend of harbor seals in PWS during 2000. These surveys are relatively inexpensive to conduct, and since the population trend for PWS harbor seals is still unclear, we think it is important to continue a monitoring program. During 2000, we will finalize our analysis of survey data using hierarchical Bayes models that relate observed seal count to a number of covariates (including location). Recommendations regarding future trend monitoring will be made after this hierarchical Bayes analysis has been completed.

Data collected from the 51 adult and subadult seals satellite tagged during 1992-1996, as well as the 27 pups instrumented in 1997 -1999, will be thoroughly analyzed. This project is well underway. A manuscript describing diving behavior of non-pup seals is currently in preparation.

Fatty acid studies will be continued through the next year. Additional samples of a few select prey species will be analyzed to fill in missing locations or age classes and to enable an examination of annual variability in fatty acid signatures. We will analyze blubber samples from seals that we catch in summer 1999, as well as from subsistence caught seals and seals caught by the ADF&G-NOAA harbor seal study. Particular emphasis will be on modeling work to provide actual estimates of diet composition based on fatty acids signature.

NEED FOR THE PROJECT

A. Statement of Problem

From 1984-1988, harbor seal counts at 25 trend sites in PWS declined by 43% due to unknown causes. The decline continued in 1989, aggravated in oiled areas by the EVOS. Counts of seals at oiled trend count sites declined by 45%, compared to 11% at unoiled sites. More than 300 harbor seals (36% of those in oiled areas) were estimated to have died in PWS due to the spill.

Since 1990, numbers have continued to decline. The rate of decline from 1990-1998 was about 2.4% per year. There were 18% fewer seals in 1998 than in 1990, and 57% fewer than in 1984. The reasons for the decline remain unknown, but may relate to food limitation. It appears that the decline has slowed in recent years and the PWS harbor seal population may, in fact, be starting to stabilize. Future surveys will be required to confirm this.

B. Rationale

Harbor seals are important to residents of PWS for subsistence. In 1985-1989, harbor seals made up 13%-27% of the subsistence foods harvested in Tatitlek and Chenega Bay. During 1992-1995, these two villages harvested less than half the number harvested annually before the spill. Native residents have noted the scarcity of seals and the impact this has had on subsistence hunting. Harbor seals are also watched and photographed by tourists and recreational users of PWS, and they interact with and are incidentally killed by commercial fisheries.

Like all marine mammals, harbor seals have special federal protection under the Marine Mammal Protection Act. Because of the ongoing decline, it is essential that current population data be available so that inappropriate restrictions on human activities are not implemented. It is important to understand what factors are limiting the population. We cannot assume, given the ongoing decline, that the number of seals in oiled areas will return naturally to pre-spill levels. It is necessary to continue monitoring trends, identify and appropriately manage areas of particular biological significance, and communicate information on population status to subsistence hunters and fishermen in order to minimize mortality and augment recovery in any way possible. Commercial fisheries in PWS may face greater restrictions designed to reduce incidental take of harbor seals unless something can be done to understand and reverse the population decline.

The ongoing decline of harbor seals began over two decades ago in the Kodiak area, and was detected at least a decade ago in PWS. Although periodic surveys have documented the downward trends and are useful for determining whether the recovery objective of "stable or increasing population trends" has been met, they are not adequate for determining what is causing the seal population to decline, or for designing conservation and management measures to facilitate recovery and ensure the future health of the population. Unless research is specifically designed and conducted to investigate the factors limiting harbor seals, it is likely that little progress will be made in understanding and mitigating the decline. This is a difficult but important topic to investigate. It requires a multidisciplinary approach that incorporates an understanding of

harbor seal behavior, habitat use, and energetic, with data about the distribution, abundance, and biology of prey species and predators.

C. Location

This project will be conducted in PWS. Aerial surveys will be flown over the 25 established trend count sites listed in Table 1. Seal tagging and sampling has taken place at a variety of locations throughout PWS. Pup tagging locations have been chosen based on our ability to catch seals, to represent different habitats, and on the existence of previous tagging data for adult and subadult seals, to facilitate comparisons. Comparative data will be obtained by other ADF&G harbor seal studies near Kodiak and in SEAK.

Communities that harvest harbor seals or engage in commercial fishing activities, and may be affected by or utilize results of this study, include Cordova, Chenega Bay, Tatitlek, and Valdez.

COMMUNITY INVOLVEMENT

"Harbor Seal Updates" have been produced and distributed to PWS subsistence hunters and other interested persons in PWS communities in previous years, depending on the availability of new and pertinent information. The Principal Investigator participated in the Elder Youth Conference in Cordova during August 1998.

Information from this study will be presented at oil spill symposia, planning workshops, conferences, and in the published literature. Information will be provided to the University of Alaska Sea Grant program and ADF&G Division of Subsistence for use in meetings and discussions with PWS subsistence hunters regarding the biosampling program. ADF&G marine mammals staff regularly attend meetings with various public groups (tourism industry, fisheries, conservation groups, subsistence communities) to inform them about status, important conservation issues, and key research needs for harbor seals.

Project investigators will cooperate with personnel from the ADF&G Division of Subsistence in their efforts to inform residents of Chenega Bay, Tatitlek, Valdez, and Cordova about the findings of this study and to incorporate the suggestions of PWS residents in study design. Such an exchange of information will allow biologists to benefit from residents' observations about abundance and behavior of harbor seals in PWS, and will help residents to make informed decisions about their annual harvest of harbor seals.

When invited, investigators will continue to attend meetings of the ANHSC to discuss study results and proposed research. Investigators will assist as requested in developing community-based sampling programs. Biosampling is a cooperative effort of the ANHSC, NMFS, the University of Alaska Sea Grant program, and the ADF&G Division of Subsistence. Personnel from this harbor seal project will facilitate sample analysis and communication of results to community residents.

PROJECT DESIGN

A. Objectives

These are the objectives for this project during the last 2-5 years. During the next fiscal year this project will focus on data analysis and preparation of reports and manuscripts that will address these objectives.

1. Monitor the abundance and trends of harbor seals at trend count sites in oiled and unoiled areas of PWS to determine whether the PWS harbor seal population has declined, stabilized, or increased since the EVOS.

2. Recommend a schedule for continued aerial survey monitoring based on observed trend and statistical characteristics of survey data.

3. Identify important prey species in the diets of harbor seals in PWS, with a particular emphasis on pups and yearlings, and determine whether there are dietary differences among different components of the population.

4. In conjunction with research efforts being done on the Scotian Shelf, develop mathematical models and associated software programs to quantitatively estimate species composition of individual harbor seal diets.

5. Determine whether there are differences in diets and important prey species among populations of harbor seals in areas of the Gulf of Alaska where they are continuing to decline (e.g., PWS and northern GOA) and areas where the population is stable or increasing (SEAK).

6. Determine whether changes in harbor seal diets and important prey species have occurred over the past two decades.

7. Compare estimates of abundance and importance of harbor seal prey to trawl survey data and data obtained from seabird diet studies being conducted concurrently under the APEX program.

8. Determine foraging range and diving behavior of harbor seal pups and juveniles and compare to similar information for other age groups.

9. Provide information to subsistence hunters so they can make informed decisions about the appropriate level of harvest for harbor seals.

B. Methods

The following hypotheses were developed for FY 98 - FY 00 for this harbor seal study to meet the above objectives. (General progress to date relative to these hypotheses was described in the Introduction of this annual report.).

Hypothesis 1: The PWS harbor seal population has stabilized and/or increased since the EVOS.

1. Conduct aerial surveys at PWS trend sites during molting in 2000;
2. Re-analyze survey data using hierarchical Bayes models and develop estimates of the annual number of observed seals.
3. Develop hierarchical Bayes models that relate observed seal count to a number of covariates, including location, calendar day, time, height of low tide, time of low tide, qualitative assessments of wind and sky conditions, and trends for each site.
4. Develop a hierarchical Bayes approach to trend monitoring by combining trends among sites, taking into account the covariates.
5. Reevaluate survey data collected since 1989 using hierarchical Bayes methods to evaluate whether seal numbers are continuing to decline, have stabilized, or are recovering to pre-spill levels.

Hypothesis 2: Juvenile harbor seals are particularly sensitive to characteristics of prey abundance such as depth, prey size, and prey type. Prey changes in PWS have resulted in food limitation, poorer body condition, and therefore reduced survival of juvenile seals.

1. Obtain blood and blubber samples from pups, subadult and adult harbor seals in PWS during two time periods: a) in late June/early July, representing the diets of pups about 2 weeks post-weaning (and therefore of their mothers) and the first over-winter diets for yearling harbor seals, and b) in August/September, a time when pups have lost blubber stores obtained from milk fat consumed during suckling and have begun to forage on their own, and also a time representing the summer diets of other age groups.
2. Analyze blubber samples for fatty acid signatures of individuals and age groups.
3. Measure total body composition (fat, protein, and lean body mass) of pups and juveniles using D_20 equilibration as an indicator of individual nutritional status.
4. Use fatty acids signature analysis to determine whether individual, age-related, and interannual differences in diets occur in harbor seals; use this information to examine whether seals from different areas appear to have different diets because of differing prey intake with location or because of different age-group composition.
5. Continue to assess variation in the fat content and fatty acid composition of prey species in PWS, but with a particular emphasis on characterizing size-class and regional differences in the four prey species that are likely of most importance to harbor seals and especially juveniles: herring (*Clupea pallasi*), pollock (*Theragra chalcogramma*), capelin (*Mallotus villosus*), and sandlance (*Ammodytes hexapterus*).
6. Assemble the entire database being gathered in PWS on the fatty acid signatures of predators and prey and, together with a cooperating Scotian Shelf research program, develop mathematical models and associated software programs to quantitatively estimate species and size-class composition of individual harbor seal diets.
7. Estimate the most important prey items (and size classes) in diets of different demographic groups of harbor seals and determine whether diets of pups and small subadults differ significantly from diets of large subadults and adults and relate this to data obtained previously on characteristics and limits of dive depths in pups, subadults, and adults.

Hypothesis 3: The diets of PWS and other declining populations of harbor seals differ from diets of harbor seals in areas where populations are stable, reflecting differences in the distribution and abundance of important forage fishes at relevant scales.

1. Obtain blood and blubber samples at similar time periods as in Hypothesis 2.1 from similar demographic groups of harbor seal populations, in another area of decline (Kodiak) and an area of stability (SEAK).
2. Analyze blubber samples for fatty acid signatures of individuals and age groups.
3. Determine whether diets of pups, subadults and adult harbor seals differ between PWS, Kodiak, and SEAK using fatty acid signatures.
5. Assess variation in the fat content and fatty acid composition of prey species that are likely to be of importance to harbor seals in Kodiak and SEAK, in cooperation with other ADF&G harbor seal studies.
6. Using mathematical models developed (Hypothesis 2.7), estimate the diet of the differing demographic groups among the differing regions and determine whether juveniles appear to be less constrained by prey availability in SEAK versus Kodiak and PWS.

Hypothesis 4: The diets of harbor seals have changed over the past few decades, reflecting a change in the distribution and abundance of important forage fishes.

1. Archived blubber samples collected in the 1970s from Kodiak and in the late 1980s from PWS are available for analysis and have been successfully tested for their ability to be cleanly analyzed for fatty acid signatures. These samples will be analyzed for fatty acid signatures of individuals and age groups.
2. Using data on prey species fatty acid signatures (and accounting for any annual variability in these signatures), the species composition of diets of archived samples will be estimated using the developed mathematical models.
3. Compare estimated diets of seals collected in the 1970s with diets in the 1990s.

Hypothesis 5: The diet composition of harbor seals in areas of population decline reflect differences or changes in the relative distribution and abundance of prey important to various demographic groups.

1. Target PWS prey collection to areas both where seals are sampled and to where other work is being done on prey and/or seabirds under the APEX program.
2. Compare size-class and regional differences within prey species, especially herring and pollock, to data from stomach content analysis of these prey (APEX).
3. Compare and combine estimates of abundance and importance of harbor seal prey to trawl survey data (APEX).
4. Assess whether fish species important to juvenile seals, such as capelin and sandlance, are limited in areas where harbor seals are declining, as determined through data obtained from seabird diet studies being conducted concurrently under the APEX program.

Hypothesis 6. Harbor seal pups and juveniles spend more of their time foraging to obtain adequate nutrition than do adults; pups in PWS spend more time foraging than pups in other areas where the population is not declining.

1. Compare dive data from seal pups satellite tagged in PWS with data from subadult and adult seals tagged in the PWS.

2. Compare dive data from seal pups satellite tagged in PWS with data from pups tagged in other areas of Alaska (northern GOA and/or SEAK).
3. Assess the annual variability in the foraging behavior of satellite-tagged seal pups.

The final year of field study with take place in 1999, with final data analysis and reporting to take place in 2000. In particular, we expect to prepare reports and manuscripts on the subjects of: 1) movements of satellite-tagged harbor seals in PWS (non-pups); 2) diving behavior of PWS harbor seals (non-pups); 3) fatty acids of the prey base in PWS; 4) modeling fatty acid signatures to estimate diet composition; 4) modeling harbor seal population dynamics to evaluate the role of food limitation in population declines; 5) application of Bayesian statistics to harbor seal monitoring; 6) condition and diet of PWS harbor seal pups.

Aerial Surveys and Analysis (to be done in 2000)

Harbor seal abundance will be monitored by flying aerial surveys during the molting period in mid to late August. A fixed-wing aircraft will be used to survey 25 trend count sites at an altitude of 700-1000 ft. These haulout sites have been used by ADF&G for PWS harbor seal trend counts since 1983, including NRDA and Restoration studies in 1989-1996 (Calkins and Pitcher 1984; Pitcher 1986, 1989; Frost and Lowry 1994a; Frost et al. 1994a; Frost et. al 1995; Frost et. al 1996). The trend count route includes 7 sites that were impacted by the EVOS (Agnes, Storey, Little Smith, Big Smith, Seal, and Green islands, and Applegate Rocks) and 18 unoiled sites (Table 2). The survey methodology and observers will be the same as those used in PWS harbor seal studies conducted in 1989-1998 (Frost et. al. 1996, 1997, 1998), and as summarized below.

Maximum numbers of harbor seals are known to haul out during pupping and molting (Pitcher and Calkins 1979; Calambokidis et al. 1987). Within these periods, more animals are usually hauled out at lower stages of the tide, since availability of many haulout sites is limited by tidal stage. Our surveys will be conducted during mid to late August (molting), and will begin within two hours before daylight low tides and finish within two hours after low tide. Multiple counts will be made at each site to allow statistical analysis of trend. As part of NOAA-funded harbor seal studies, aerial photographs will be taken of harbor seals hauled out on ice near the Columbia Glacier during mid-August in conjunction with our regular surveys. This will be a test program to determine suitability of several photogrametric techniques for counting seals on glacial ice.

Power analysis of data from 1989-1994 indicated that in order to detect a 5% increase per year over a five year period ($p=0.05$) with a greater than 80% probability of being right (using initial population = 767, the number of seals at trend count sites in 1994), it is necessary to fly annual surveys during the molting period, with at least 7 replicates per year, and to adjust them for the effects of time of day, date, and tide. This analysis was based on data collected by ADF&G during 1984-1994, and took advantage of one of the most extensive data sets of its kind. The recommendation of 7 or more replicates is similar to the number of replicates recommended by Pitcher based on analysis of other harbor seal surveys in Alaska (Pitcher 1986, 1989). The number of replicates also may be influenced by weather, which can limit the number of days suitable for flying within a survey period.

Aerial surveys do not estimate the total number of seals present since they do not account for seals that are in the water or seals hauled out at locations not on the trend count route. Surveys provide indices of abundance based on the number of hauled out seals. Interpretation of trend count surveys relies on the assumption that counts of harbor seals on select haulout sites are valid linear indices of local abundance. We assume that within a given biological window, such as the molting period, hauling out behavior remains the same from one year to the next, and counts can thus be compared (e.g., Harvey 1987, Pitcher 1989). Standardization of procedures minimizes, but cannot eliminate, the effects of variables such as tide and weather that could influence the number of seals hauled out on a given day. Consequently, there may be considerable variation in daily counts, despite our attempts to standardize conditions. As part of this project during 1994-1996, we developed multivariate analyses to correct counts for weather, tide, and date (Frost et al. 1999). However, even this approach may not adequately estimate the variance associated with corrected counts.

The current models for trend-monitoring use Poisson regression and linear regression in a two-stage analysis. For the Poisson regression, a separate effect is fit for each site and year. With 10 years of data, and 25 sites, that makes 216 parameter estimates (9x24=216). We have also considered separate covariate effects for time of day (6 levels) and plan to include site-specific effects (but not separately for each year), so that adds more parameters (=5+24=29). In addition, site-specific effects for time relative to low tide (8 levels) (7+24=31), date (1+24=25), and other parameters related to weather are used. If we average 6 replicate flights per year, we have 6x25x10=1500 observations. That makes approximately 300 estimated parameters, and the fraction of parameters estimated to number of data is 1/5. A problem with such an approach is that we are estimating hundreds of parameters, and we may be getting large variances and poor estimation properties under these conditions. For the second stage analysis, the mean effect for year and location are calculated from the Poisson regression parameter estimates for standardized states of the covariates, and then the sites are summed for each year. This sum is then used in linear regression to determine trend across years. This second stage does not formally include estimation variance from the Poisson regression, which is an additional concern.

We have considered variations to our model to get rid of the 2nd stage regression analysis, but they also cause difficulties. For example, we could put the overall trend parameter in Poisson regression. However, this would cause all sites to have a common yearly mean. Another approach would be to allow each site to have a separate intercept with a common trend in the Poisson regression. However, it is clear that not all sites have a common trend. A final approach is to allow each site to have a separate trend slope and intercept in the Poisson regression model, but then it is unclear how to combine all 25 slope estimates into a single estimate of overall trend. Ideally, we would like to weight each slope estimate by the abundance at each site, but computing the variance of such a method may not be possible.

The Poisson regression model has served its purpose as a simple model that, 1) incorporated covariates that allowed us to examine different effects on seal counts, 2) allowed us to adjust our counts to get better trend estimates, and 3) allowed us to do power analysis. However, as we acquire more data, we feel that it is important to model effects separately for each site, and this makes the model much more complicated. For example, how do we summarize an effect for time

of day, with 6 categories, for 25 sites? A natural approach is to combine parameters by giving them a distribution; this is called a hierarchical modeling approach.

Given the problems listed above, one solution is to put more structure on the model. This can be done using a hierarchical model, where all the "parameters" above can be considered "variables" in their own right, coming from one or a few "prior" distributions. For example, rather than having 25 separate trend slope parameters (one for each site), we might consider all 25 slopes as coming from a common prior distribution. These prior distributions have only a few parameters that control their behavior. Thus, we have reduced a large set of hundreds of parameters to a set that contains relatively few. Also, because the 25 slope parameters will have a "distribution," it is conceptually easy to take a weighted sum and obtain the proper variance for an overall trend.

With a hierarchical modeling approach, we will develop a hierarchical Bayes model that relates observed seal counts to a number of covariates. Covariates recorded at each observation include year, spatial coordinates, calendar day, time, height of low tide, time of low tide, and qualitative assessments of wind and sky conditions. Using modern Monte Carlo Markov Chain methods, we will assess the usefulness of any or all of these covariates in explaining and/or predicting the number of seals observed. An integral part of this modeling will be the inclusion of separate trend parameters for each site in the hierarchical Bayes model and then combining trend parameters in an overall approach to trend monitoring. Ultimately, a separate trend may be occurring at each of the 25 haul-out sites in the Prince William Sound. One can consider a trend parameter, such as the slope of a regression through time, for each site. Hierarchical Bayes methods are ideally suited for combining these 25 trend parameters to get an overall trend indicator for all sites.

Catching and Sampling Seals (will be completed in 1999)

Seals will be caught by entanglement in nets placed near the haulouts. Nets will be approximately 100 m long and either 3.7 or 7.4 m deep with standard floats or float line and light lead lines. Mesh openings will be about 30 cm stretched measure. Nets will be deployed from a 6 m boat assisted by one or two other small boats to assist in maneuvering the net and tending it to ensure that all captured seals are quickly detected and removed (see Frost and Lowry 1994b). Some seal pups may be caught using long-handled dipnets.

When seals become entangled, they will be brought into the boats or to shore, cut free from the tangle net, and placed into hoop nets (large stockings made of 1 cm mesh soft nylon webbing). As necessary, seals will be sedated with a mixture of ketamine and diazepam administered intramuscularly at standard doses (Geraci et al. 1981). Each seal will be weighed, measured, and tagged in both hindflippers with individually numbered plastic tags. Field personnel will collect approximately 50 cc of blood from the extradural intervertebral vein. Standard blood chemistry panels and virology screens (phocine distemper virus, herpes, and others as indicated) will be run on these samples. The following samples will also be taken: a 0.5 cm x 2.5 cm blubber biopsy for fatty acid analysis and analysis of energy content, whiskers for stable isotope analysis, and a small piece of skin for genetics studies. Virology screens will be coordinated and paid for by the ADF&G's NOAA-funded harbor seal study, as will all genetics analyses. Seal pups and small juveniles will be selected for instrumentation with satellite tags, as described below.

Total body composition (fat content, protein content, lean body mass) will be measured on a subset of the pups and juveniles that we sample using isotope dilution with deuterium oxide (D_20). D_20 is a stable isotope of water, which is widely used as a non-invasive method to measure body water pool size and the rate of water turnover in mammals and other vertebrates (Nagy & Costa 1980; Oftedal & Iverson 1987; Oftedal, Iverson & Boness 1987; Iverson et al. 1993). After administration of a known amount of D_2O, the isotope completely equilibrates with all body water of the animal. Measurement of the final dilution of D_2O in the body water (dilution space) can then be used to accurately measure total body water content (Oftedal, Bowen & Boness 1993). Body water content is then used to calculate total body fat, protein, and energy stores of the seal, based on the fact that the water and protein contents of lean body mass (fat-free mass) are approximately constant among mammals, particularly among individuals of a given species and age (Pace & Rathbun 1945; Reilly & Fedak 1990; Iverson et al. 1993).

Prior to the onset of the D_20 procedure, seals will be weighed to the nearest 0.5 kg, and a blood sample. Any stomach contents of the animal will be evacuated by gastric intubation using a 3/8 inch veterinary stomach tube. A pre-weighed amount (approximately 1g/kg body mass) of deuterium oxide (99.9% purity), contained in a syringe with a three-way stopcock, will be delivered by gastric intubation using a small 12 French stomach tube (to reduce total surface area during delivery). The syringe and stomach tube will then be rinsed with 2 x 5 ml quantities of water, and air blown through the tube as it is withdrawn to ensure complete delivery. The animal will then be held for approximately two hours to permit isotope equilibration. After that, two sequential blood samples, separated by about 20 minutes, will be taken to ensure that equilibration has occurred. Bloods will be centrifuged and sera collected and frozen in airtight cryovials until the time of analysis. Laboratory analyses will be done at Dalhousie University. Total free water will be collected from blood sera by heat distillation, and D_2O concentration will be determined by quantitative infrared spectrophotometry according to Oftedal & Iverson (1987) and Oftedal, Iverson & Boness (1987) on a Perkin Elmer Fourier Transfor Infrared Spectrophotometer with integrated data station (Paragon 1000).

Seals will be caught in two regions of PWS to coincide with sampling areas used is previous years. These will be: southern PWS near Montague, Green, and Little Green islands; and central PWS near Agnes, Smith, and Seal islands. We will try to catch and sample approximately 40-50 seals total per year in PWS.

Seals will be caught from other areas (Kodiak and SEAK) during similar time periods, to the extent possible, as part of the NOAA-funded harbor seal study. We hope to obtain about 20 blubber biopsy samples per year from each area. Additionally, wherever possible, blubber samples from harvested seals will be obtained from subsistence hunters in SEAK and Kodiak. Archived samples are available from both of these areas (10-20 per year since 1995).

Fatty Acids Analysis (analysis ongoing in 2000)

Recently, a method has been developed for understanding marine food webs through the use of fatty acid signatures (Iverson 1993). Fatty acids are essentially the building blocks of lipid. Organisms are able to biosynthesize and modify fatty acids, but there are biochemical limitations and differences in these processes depending on the organism. Specific fatty acids cannot be

synthesized by animals and therefore can only originate from diet. Because of this, some fatty acids in the food chain can be attributed to specific origins (Cook 1985). Lipids from marine organisms are characterized by a very complex array of fatty acids. There are substantial differences in fatty acid composition among species and prey types, as well as within species by geographic region (e.g., Ackman et al. 1975, Iverson 1993). In marine mammals, dietary fatty acids are often deposited in body tissue without modification (Iverson and Oftedal 1992, Iverson et al. submitted). Consequently, it is possible to trace fatty acids obtained from the diet and to compare arrays in the tissues of the predator to those in the prey consumed.

The use of specific lipids as biological markers has been demonstrated in a number of studies on fish and copepods (Lee, Nevenzel & Paffenhofer 1971; Sargent et al. 1988; Fraser et al. 1989; Klungsoyr et al. 1989; Graeve, Kattner & Hagen 1994; St. John & Lund 1996). Relative proportions of dietary fatty acids have also been shown to be reflected in the fatty acid composition of storage lipids in both captive and free-ranging carnivores (e.g., Reidinger et al. 1985; Rouvinen & Kiiskinen 1989; Colby, Mattacks & Pond 1993; Pond et al. 1995). In seals, ingested fatty acids can be deposited directly into adipose tissue, such that blubber may be a mirror of current diet when a seal is rapidly fattening on a high fat diet (Iverson et al. 1995), or may reflect a longer-term integration of dietary fatty acids and possibly biosynthesized fatty acids at times of reduced intake (Kirsch, Iverson & Bowen 1995).

This concept of fatty acids as trophodynamic indicators can be applied to harbor seals. In general, lipid transfer from prey to deposition in tissue is extremely efficient (Iverson 1988, Iverson et al. 1995). Because certain fatty acids cannot be biosynthesized by seals, these can be identified as being of dietary origin. Since most seals undergo seasonal periods of fasting and depletion of fat stores (e.g., during the breeding season or the molt) followed by intensive blubber deposition (prior to the subsequent breeding season), blubber fatty acids usually reflect the integration of diet over a period of several months. Thus, fatty acids in blubber provide information on dietary history of the animal. Since many seals tend to feed on only a single or few selected prey species at a given time or season (e.g., Bowen 1990), this facilitates the use of fatty acid signatures.

In the initial study funded by the EVOS Trustee Council, we used fatty acid signatures to investigate the diet and spatial scales of foraging in harbor seals and selected prey in PWS and the Gulf of Alaska (Iverson, Frost and Lowry, in press). We found large differences in the fatty acid composition of blubber from seals sampled in geographic regions several hundred kilometers apart. Within PWS, fatty acid signatures distinguished seals from haulouts only a few kilometers apart, suggesting that seals forage very site-specifically. Prey fatty acid patterns also differed on similarly small spatial scales within PWS.

The next step is to advance fatty acid signature analysis so that we can use it to quantitatively estimate the composition of the diet. This means not only determining the species composition, but also the size classes of species eaten and possible area from which the prey were fed upon. Then, it will be critical to apply this technique to evaluating possible problems in recruitment of the population by better understanding the foraging ecology of juvenile harbor seals and perhaps pregnant females. It will be important to document diet differences among age-groups in the declining PWS harbor seal population, as well as differences which occur in the same age-groups but in areas where the population is stable. It will also be important to compare this information

with data available from time periods of lesser declines (1970's and 1980's). Juveniles in particular are thought to be significantly affected by reduced prey availability at scales relevant to the nutrition of individuals (NRC 1996). Thus, there could be several indications about stresses on juveniles through understanding diets. Small forage fish species such as capelin and sandlance have long been an important part of pinniped diets and a decline in these prey species may have affected the seal populations which depend upon them. If reductions in these prey are apparent in the diets of adult seals in areas of decline, this would suggest a lower abundance of these prey in general. If indeed juveniles are found to be dependent on and limited to smaller size prey, this would coincide with the above finding. If juveniles are feeding on smaller but different prey than the small prey in adult diets, this might indicate competition with large animals for available food and further indication of low abundance of important forage fish species.

Blubber samples will be taken from seals of the various demographic groups using routine biopsies (sterile 6 mm biopsy punches). Samples will initially be collected in late June-early July to coincide with initial summer foraging period. Samples will be placed in chloroform and methanol with BHT as an antioxidant, and kept frozen until analyzed. Samples will be collected from all seals that are caught during tagging operations. Blood will be collected from the same animals and centrifuged in the field. In addition, some samples may be available through the biosampling program being conducted by the Alaska Native Harbor Seal Commission.

Blubber samples archived by ADF&G from harbor seals collected in the 1970s will be subsampled, placed in BHT and sent to Dalhousie University for analysis. Several of these archived samples were analyzed on a test basis during 1997 to determine whether the blubber was still in suitable condition. The analyses were successful, indicating that some or all of the remaining archived specimens will be useful for this study. There are 365 total archived specimens from 1976-1978, of which approximately 200 are from areas where recent samples have also been collected (southeast Alaska, n = 16; Kodiak, n = 193; Middleton Island, n = 5; and miscellaneous others from the northern GOA). Samples will be prioritized based on age and specific location, to facilitate comparisons with samples from the 1990s. Some of these same samples have been analyzed for lipid and water content, as well as total caloric density, by Castellini et al. (EVOS project 001). This will enable a comparison of the energy content of the blubber and diet in recent and 20-yr-old samples from areas that have and have not declined.

By 2000, few additional prey items will be collected. We will focus on several key prey species which are readily available from several locations without large-scale fish sampling programs. We plan to continue to assess annual variation in the fat content and fatty acid composition of prey species. Particular emphasis will be on characterizing size-class and regional differences in the four prey species that are likely of most importance to harbor seals and especially juveniles: herring, pollock, capelin, and sandlance. Prey species from the other areas of harbor seal sampling (Kodiak and SEAK) will be obtained as possible through other studies and sources of funding, including in cooperation with the National Marine Mammal Laboratory as part of sea lion studies.

Laboratory analysis and evaluation of data will be conducted by Dr. Sara Iverson at Dalhousie University, Nova Scotia. Fatty acids will be extracted from seal blubber and prey according to methods described in Iverson (1988). Fatty acid methyl esters will be prepared directly from

aliquots of the chloroform extract, then extracted and purified in hexane. Analysis of fatty acid methyl esters will be performed according to Iverson et al. (1992) using temperature programmed capillary gas liquid chromatography and linked to a computerized integration system (Turbochrom, PE Nelson). Identifications of rare isomers will be performed using techniques described in Iverson, Frost and Lowry (in press). Approximately 70 fatty acids and isomers can be separated and quantified in most marine lipids. The proper isolation of all components in any sample is critical in assessing diets and prey items; these methods are currently set up and routinely used in the Dalhousie University laboratory of Dr. Iverson.

Data will initially be analyzed using a multivariate model called classification and regression tree (CART) analysis (Clark and Pregibon 1992). This model has recently been applied and modified for fatty acid signature analysis (Iverson et al. 1997; Smith et al. 1997). CART is a non-parametric technique which considers all 70 component fatty acids in each sample and uses the fatty acid arrays of species to determine classification rules for types of signatures. CART proceeds by recursively partitioning data into two or more groups based upon a series of dichotomous splits, hence building complex trees through which observations (predators or prey) may subsequently be sent for classification. This method will allow us to differentiate individual seals and groups of seals by such factors as age-group, pregnancy status, or haulout location. These differences in turn are a function of differing fatty acid signatures resulting from differences in diets. We will also use CART to determine characteristics and differences among prey by species and within species by size class, time period, and geographical location. We will also account for differences in fatty acid classes in the use of CART. In other words, in the analysis and interpretation of data, fatty acids will be grouped as: 1) components which could readily be biosynthesized by the seal; 2) components that could be biosynthesized but at the measured levels are likely mostly of dietary origin; and 3) components that could only come from the diet. Categories 2 and 3 represent the important "indicator" fatty acids (Iverson 1993). The latter two categories will be most heavily relied upon in interpreting CART results.

Modeling of Seal Diet Composition using Fatty acid Signatures (ongoing in 2000)

The use of fatty acids to elucidate diet and trophic relationships has proceeded considerably in its developmental stages and now requires a mathematical modeling component in order to use it quantitatively. Using fatty acids to determine the diet of seals is facilitated by the fact that seals go through biannual periods of extensive blubber fat depletion followed by intensive fattening and that 2-4 prey species often account for most of the diet. Nevertheless, in free-ranging seals, fatty acid composition of lipid stores will rarely, if ever, match that of their prey because dietary fatty acids will be integrated into the seal's fatty acid signature. The time course of these changes will depend on the rate of food intake and the extent to which lipids are stored seasonally. Finally, biosynthesis of some fatty acids will take place, thus altering their representation in the signature. Thus, the next stage in using fatty acids to estimate diet composition, must be the development of a statistical model which takes possible prey species signatures and computes the most-likely mixture of signatures (species and levels) to create the closest signature (a maximum-likelihood estimate) to that of the predator. Such a statistical program must incorporate information on a wide range of potential prey signatures, and the variability in these signatures with size-class and geographical location, as well as season if applicable. The mathematical model must also incorporate a relative weighting of prey signatures that reflects the proximate fat content of each

prey and size class, and finally, weighting on individual fatty acids as a function of their ability to be biosynthesized by the predator. We expect to start out from a basis of an optimization problem with a simple least square error assumption (R. Myers, pers. comm.). Given the constraints listed above, standard optimization methods cannot be used. The inequality (of fatty acids) is more difficult to deal with analytically and hence also the estimation of standard errors. However, software can be written and developed to handle these. This work will be done in the laboratory of Dr. S. Iverson as a cooperative effort between Alaska and Scotian Shelf research and with partial support from NSERC.

Fatty acid signature analysis has not to date been a stand-alone method, but neither has any other currently available method for examining marine mammal diets. Stomach contents analysis is limited by our ability to obtain large enough samples, the digestive state of contents, and by the fact that food in a stomach represents a single meal. In PWS, large tidal fluctuations every 6 hours make it virtually impossible to collect scats from areas where seals haul out. Stable isotopes indicate the trophic level at which seals feed and temporal variations in prey type, but provide little information on specific prey. Studies of prey availability (e.g. from trawl surveys) are necessary to establish the "menu" from which seals may choose, but they do not reflect the availability of prey to seals on relevant scales or the energetic costs of capturing different prey. Progress towards answering the question of "Is food limiting harbor seals?" will most likely come through the combination and integration of a variety of approaches, but it is clear from our previous work that fatty acids may be a particularly valuable tool in achieving a better understanding of trophic dynamics, dietary differences and demography of harbor seal populations in PWS and the Gulf of Alaska.

Satellite-tagging (tagging will be completed in 1999; analysis ongoing in 2000)

Satellite-linked telemetry can be used to gather information about habitat use, including site fidelity, movements between haulouts and in and out of PWS, seasonal changes in hauling out patterns, feeding habitats, and feeding and diving behavior. Satellite-linked time-depth recorders (SDRs) have provided researchers with the ability to monitor location and diving behavior of marine mammals (Mate 1986, 1989, Hill et al. 1987, Stewart et al. 1989, Lowry et al. 1994, Frost and Lowry 1994b). The SDRs transmit to a satellite-based Doppler positioning system that calculates locations and tracks movements of animals with considerable accuracy. When combined with appropriate environmental sensors and microprocessor hardware and software, other information about an animal's environment and behavior can be transmitted to the satellite.

This study has demonstrated that SDRs are an effective means of monitoring the movements and haulout locations of harbor seals in PWS. During 1992-1998, significant data were received from SDRs attached to 71 harbor seals in PWS, including 30 males and 41 females (Table 1). Twenty-six were adults, 23 were subadults, and 22 were pups. SDRs were attached to 28 seals from areas in central PWS that were oiled by the EVOS (Seal Island, Herring Bay, Bay of Isles, Applegate Rocks); four from eastern PWS (Olsen Bay, Gravina Island); one from northwestern PWS (the Dutch Group); and 38 from unoiled sites in southcentral PWS (Port Chalmers, Stockdale Harbor, Little Green Island, and Channel Island). SDRs were operational for up to 10 months, and provided locations for about 80% of those days.

During 1999, SDRs will be attached to 7 harbor seal pups at locations chosen to complement data from 20 pups tagged in 1997-1998 and from adults and subadults tagged during 1992-1996. These will include southern PWS near Montague, Green, and Little Green islands (herring and fish data from here, and a large number of seals); and central PWS near Applegate Rocks and Seal Island (APEX fish data available, and significant seal haulouts with pups). Actual tagging locations will depend on where seals are present and can be caught.

One-quarter-watt transmitters (10 cm x 5 cm x 3 cm and weighing 170 g) will be attached to the mid-dorsal surface of seal pups by gluing with epoxy resin (Fedak et al. 1984; Stewart et al. 1989). SDRs attached after weaning should remain attached until the next molt, but will not operate that long. A prototype 0.25-watt SDR attached to a harbor seal pup in September 1996 operated until the end of December and sent approximately 12,000 transmissions. Through duty cycling and by limiting the number of daily transmissions, four of twelve SDRs deployed on pups in PWS and seven of the ten deployed at Tugidak during 1997 were still transmitting in March. It is likely that new, more powerful batteries will be available by 1999, and perhaps as early as the 1998 field season.

Data will be acquired from the ARGOS satellite receiving system and formatted using software provided by the manufacturer of the transmitters. Each SDR will transmit signals to polar-orbiting satellites whenever the seal is hauled out or when it surfaces sufficiently long for a transmission to occur. An uplink occurs when a satellite is positioned to receive the signal. Information transmitted by the SDR is used by Service ARGOS to calculate the geographic location of the seal. Units will be equipped with built-in programmable microprocessors to collect and summarize data for periods when animals are diving and store it for later transmission, as has been done for crabeater seals, Steller sea lions, and spotted seals (Hill et al. 1987; R. Merrick, personal communication; Lowry et al. 1994a). These data will be stored in six hour blocks and transmitted to the satellite once the six hour data collection period is complete. Sensor information from a pressure transducer and a conductivity switch will be used to indicate when the animal is hauled out. Data from four periods will be stored in memory, providing at least a 24 hour window for transmission before the data are lost. Dive data will be summarized as histograms in depth bins of 4-20 m, 21-50 m, 51-100 m, 101-150 m, 151-200 m, 201-250 m, 251-300 m, 301-350 m, and over 350 m, and duration bins of 0-120 seconds, 121-240 seconds, 241-360 seconds, 361-480 seconds, 481-600 seconds, 601-720 seconds, 721-840 seconds, 841-960 seconds, 961-1080 seconds, and over 1080 seconds. In addition, SDRs will store and transmit the amount of time spent in each depth bin and the total time spent at the surface.

Each SDR broadcasts a unique identification code so that data can be assigned to a particular seal. Position accuracy for all geographical location information is rated by Service ARGOS to reflect the predicted accuracy of the calculated locations (Fancy et al. 1988, Stewart et al. 1989). Locations calculated by ARGOS will be screened for accuracy and plotted on charts of PWS.

Data on the haulout patterns of tagged seal pups will be examined for indications of daily or seasonal variations, for example to determine whether there is a change in the frequency of haulout by season, or whether the amount of time spent hauled out changes. Plots of locations where continuous signals are received will be used to determine the degree and regularity of use of particular haulout sites. We expect to receive fewer locations of seals while at sea, because the

transmitter antenna will frequently be submerged. At-sea locations will be plotted as an indication of areas used for feeding. Information on depth and pattern of diving will be compiled, and will provide additional information on the general areas used for feeding.

Dive data will be presented as graphs and histograms which indicate the range in individual behavior as well as summary data for all seals combined. Dive data histograms will present the number of dives at different depth increments and by duration of dive. Means and standard deviations for dive depth and duration will be calculated and compared for seals in different locations or habitats and at different times of day and year. Compilation of data on time and location of feeding dives will be used to identify feeding areas near different haulouts, if possible. If sensors indicating whether the seal is on land or at sea become more reliable and the necessary SDR software is developed to provide a continuous record of this information, then diving and hauling out cycles will be examined relative to time of day, tide, and season. These data will be compared for different age groups. Summaries of the number and quality of uplink data and at-sea position data will be presented in tabular form.

Tabular summaries will also be prepared for use of different haulouts by individual seal pups, and frequency of haulout and amount of time spent feeding by season. These data will be used to evaluate site fidelity of seal pups, to quantify the amount of interchange among haulouts within and outside of the area impacted by the EVOS and within and outside of PWS, to determine seasonal importance of particular haulouts, to identify areas used for feeding, and to examine differences in movements and feeding behavior of pups, subadult and adult seals.

C. Contracts and Other Agency Assistance

Survey aircraft will be chartered from the private sector. Charter aircraft for surveys will not require contracts. ADF&G maintains a list of qualified air charter operators. Aircraft for surveys will be chosen from this list according to state procedures. Vessels will also be chartered from the private sector. Vessel support for tagging work will use small vessels contracts that will be completed by the Principal Investigator according the state SOP manual.

Costs of acquiring SDR data from Service ARGOS are paid for through a contract with NOAA. This contract covers all ADF&G Division of Wildlife Conservation satellite tagging projects, not just this harbor seal restoration project, and is processed by the Division of Wildlife Conservation. Funds for data acquisition must be encumbered and guaranteed to NOAA in early February. Actual contract processing occurs later in the spring.

Satellite SDRs will be purchased under contract award from Wildlife Computers, a private company in Seattle, Washington. The contract award is valid through the proposal period. Wildlife Computers is the only company in the United States which manufacturers SDRs with the capabilities necessary to acquire the data we require about diving behavior of seals.

Fatty acid analyses and interpretation will be done by Dr. Sara Iverson at Dalhousie University through a Cooperative Agreement between ADF&G and Dalhousie. Dr. Iverson is the only person in North America with specific experience in analysis of fatty acids in seal blubber, and

particularly with the sophisticated statistical analyses necessary to infer diet from the relative abundance of these fatty acids.

Hierarchical Bayes analysis will be conducted as a cooperative effort between Jay Ver Hoef, ADF&G, and Dr. Ron Barry, Professor of Statistics at University of Alaska Fairbanks. This work will be undertaken through a Reimbursable Services Agreement between ADF&G and UAF. Drs. Ver Hoef and Barry have co-taught Bayesian statistics at UAF, and their experience with hierarchical Bayes model will speed the process of obtaining results.

SCHEDULE

A. Measurable Project Tasks for FY 00 (October 1, 1990 - September 30, 2000)

Aerial surveys, data analysis and final report writing will take place during 2000. A schedule of field activities, data analysis, and report preparation is shown in Table 3 and below.

FY 00: October 1, 1999- September 30, 2000 (00064)

October:	Analyze 99 aerial survey data (preliminary)
October-March:	Retrieve 1999 Argos SDR data
October-September:	Analyze SDR tag data
October-March:	Analyze 1999 seal/prey fatty acids samples
October-March:	Fatty acids model development continued
January (3-4 days)	Attend Annual Restoration Workshop
February (2-3 days)	Coordination meeting for ADF&G and NOAA harbor seal studies
January-June:	Final SDR tag data analysis
January-June:	Final trend analysis 1989-1999
January-June:	Final fatty acid analysis and interpretation
April-September	Final report and manuscript preparation
31 December:	Submit final report

B. Project Milestones and Endpoints

Objective 1

June 2000:	Submit manuscript describing 1989-99 PWS harbor seal trend analysis using hierarchical Bayes methods
August 15-30, 2000:	Conduct aerial surveys at 25 sites in PWS

Objective 2

June 2000:	Submit ms describing 1989-99 PWS harbor seal trend analysis using hierarchical Bayes methods
December 30, 2000:	Submit final report with recommended monitoring scheme

Objectives 3 -7

June-August, 1999:	Sample 30-50 harbor seals for blubber fatty acids
June-August, 1999:	Sample 30 seal pups and juveniles using D_20 for body composition
October-March, 1999-00:	Analyze 50-80 harbor seal samples for fatty acids
October-December, 1999:	Analyze D_20 samples
November 1999:	Paper on fatty acids work at 13th Biennial Marine Mammal Conf.
September 2000:	Submit manuscript describing fatty acids work

Objective 8

June-July 1999:	Attach SDRs to 6-8 seal pups in PWS
November 1999:	Paper at 13th Biennial Marine Mammal Conf. on PWS seal diving
February 2000:	Submit manuscript on PWS seal movements
August 2000:	Submit manuscript on diving and movements of seal pups in PWS

Objective 9

November? 1999-2000:	Attend ANHSC meetings to discuss status and studies with hunters, or provide input to staff as requested

C. Completion Date

This project will continue for one more fiscal year, FY 00. Field work and laboratory analyses will be conducted during FY 99. Final data analyses will be conducted and a final report prepared in FY 00.

PUBLICATIONS AND REPORTS IN FY

1. Oral/poster presentations at 13th Biennial Conference on the Biology of Marine Mammals; papers to include harbor seal diving behavior, fatty acids analysis, and Bayesian trend count analysis (November 1999)
2. Oral/poster presentations at EVOS Restoration Annual Workshop (January 2000)
3. Submit manuscript on PWS seal movements and diving (February-August 2000)
4. Annual report for FY 1999 studies; will include results and/or draft manuscripts of molting surveys including progress of hierarchical Bayes covariate and trend analyses; analysis of data for SDRs deployed on pups in June-July 1998; status report on 1999 fatty acid analyses (April 2000)
5. Manuscript describing hierarchical Bayes approach to trend analysis (June 2000)
6. Manuscript describing fatty acids work (September 2000)
7. Report of field activities for August surveys (September 2000)
8. Final report for project 064 (September 2000)

Manuscript titles and journals to which they will be submitted have not been determined. Topics include: 1) results of hierarchical Bayes modeling of the harbor seal trend count data (Ver Hoef and Barry); 2) age, sex, and location related differences in harbor seal diets in Prince William Sound and the Gulf of Alaska using fatty acid signature analysis (Iverson, Frost, et al); and 3) seasonal movements and distribution of satellite-tagged seals in PWS (Lowry and Frost). It is

possible that a fourth manuscript will be prepared describing the use of population modeling to evaluate the role of carrying capacity in the ongoing harbor seal decline (Small, Frost, et al.).

PROFESSIONAL CONFERENCES

Project investigators plan to attend the 13th Biennial Conference on the Biology of Marine Mammals in Hawaii in November 1999. This conference is sponsored by the Society for Marine Mammalogy and is the largest marine mammals conference in the world. Abstracts will be submitted and it is anticipated that oral or poster presentations will describe the results of fatty acids (Iverson), genetics (O'Corry-Crowe), satellite-tagging studies (Frost or Lowry), and Bayesian statistical analysis (Ver Hoef). Results of other studies using samples from PWS provided by this restoration study are also likely to be reported but travel will not be funded by this grant.

NORMAL AGENCY MANAGEMENT

This project is funded entirely by the Trustee Council as a restoration project. ADF&G conducts no other studies of harbor seals in PWS that are not a part of the restoration program. ADF&G has no management responsibility for harbor seals. ADF&G biologists are conducting this research as principal investigators because of their many years of experience investigating the biology of seals and other marine mammals in Alaska. The Subsistence Division of ADF&G has been funded by the Trustee Council to monitor the harvest of harbor seals in PWS (Project 244) and to conduct food safety testing (Project 279). Subsistence Division also collects and reports harbor seal harvest data for other parts of the State with funding from NOAA.

ADF&G is conducting studies of harbor seals in SEAK and near Kodiak with funding from NOAA/NMFS. Those studies contain similar components to the PWS study and are closely coordinated to ensure that data are collected and analyzed in a similar manner. This will facilitate comparisons of data from declining populations (PWS and Kodiak) and a stable population (SEA) of harbor seals. Equipment is shared by the two projects. Consequently, it has not been necessary for the PWS project to purchase many equipment items and supplies solely for the use of this study. Because of these other ongoing projects, the PWS harbor seal project has had access to a GIS system with which to analyze tagging data.

Without this project, information on the status and trend of harbor seals in PWS will not be regularly available. There will be no systematic documentation of trend, and whether or not the decline continues will be unknown for a much longer time than if regular monitoring continues. Power analysis of data collected through this study has indicated that a minimum of five consecutive surveys is required to reliably detect a trend. If surveys do not occur on a regular basis, it will be a very long time before a trend can be correctly identified.

Because of Trustee Council-funded projects, progress is being made on communicating information about the decline to the public, in particular to fishermen who may incidentally take harbor seals while fishing and to subsistence hunters from PWS villages. This transfer of

information is making local residents more aware of the factors that may affect the decline, and has resulted in the initiation of a village-based biosampling program that may provide important samples to researchers. One of the significant long-term benefits of this and other harbor seal studies will be the involvement of local hunters in the research and management of harbor seals and the formation of the Alaska Native Harbor Seal Commission.

The statistical methods developed to analyze survey data from PWS will be applicable to harbor seal surveys in other regions of Alaska and elsewhere. Other investigators should be able to design more reliable and cost-effective surveys using methodology developed through this Trustee Council-funded project. Similarly, the application of fatty acids analysis to investigations of diet and changes in diet is likely to have significant and far-reaching effects on our ability to investigate the trophic dependencies and interactions of many other species, not only marine mammals. Already, techniques developed as part of this project appear to have application for studies of fish movements and stock identity.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Other EVOS-funded marine mammal studies have included: Recovery of Harbor Seals from EVOS: Condition and Health Status (Project 001); Harbor Seals and EVOS: Blubber and Lipids as Indices of Food Limitation (Project 117-BAA, UAF); and Isotope Tracers - Food Web Dependencies in PWS (Project 170, UAF). Investigators from the three projects regularly communicate and discuss these projects, and will continue to do so in the future.

Project 064 is a multidisciplinary, inter-agency undertaking. Surveys and satellite tagging will be conducted by ADF&G; lipid analyses and interpretation by Dalhousie University; blood chemistry analyses at UAF; and hierarchical Bayes modeling by ADF&G and UAF. Inclusion of interdisciplinary components within the same project will ensure that data are shared and interpreted in an interdisciplinary manner.

Project 064 (this project) will provide logistics, the MMPA permit to conduct sampling, and access to seals and samples for this study and for a study proposed by Dr. Jennifer Burns (Moss Landing Marine Laboratory, California) regarding pup physiology. Archived harbor seal data and blubber samples have been provided to Castellini/UAF for use in analyses of body condition and blubber. Subsamples of these same archived ADF&G harbor seal blubber samples have been sent to Dalhousie University for fatty acids analysis. It will be very useful to have historical fatty acids and blubber quality results from the same individuals. Harbor seal investigators at ADF&G and UAF have been working successfully together for the last five years on harbor seals in PWS and elsewhere, and future collaborations should be equally productive. Regular meetings and seminars are held by marine mammal investigators at UAF and ADF&G Fairbanks to exchange information and ideas.

This study will continue to directly interface with the study entitled "Isotope Ratio Studies of Marine Mammals" (Project 170, UAF) as long as it continues to be funded. Samples of seal whiskers and seal prey have been and will continue to be provided to that study. Investigators of the two projects (Frost and Schell/Hirons) discuss stable isotope results at regular intervals and

are pursuing preparation and publication of a joint manuscript describing preliminary findings of this study.

Prey samples for fatty acid analysis have been obtained through PWS System Investigation studies, the APEX study, and from ongoing ADF&G work. In the future, as large scale fisheries surveys receive less funding, we expect most of our samples to come from routine ADF&G operations. Information on distribution and movements of harbor seals, and diving behavior, will be shared with PWS Sound Investigation modeling studies to look at energy flow within PWS, and with forage fish investigators who may examine the effects of predation on fish population dynamics.

Statistical modeling to assign quantitative values to seal diets based on fatty acids signatures will be done as a cooperative effort between this restoration study and Scotian Shelf research project, with partial support from NSERC.

This harbor seal study has obtained samples of prey and incorporated results from Herring (ADF&G) and SEA studies being submitted under the PWS System Investigation, and from the study Apex Predator Ecosystem Experiment. In the next year, prey samples from the GOA and SEAK will be obtained on an opportunistic basis, in cooperation with other ADF&G harbor seal studies and with National Marine Mammal Laboratory (NMML) sea lion projects. These samples will be analyzed with non-EVOS funding, but analyses will be included in the results of the project. Fatty acids analysis in the future will emphasize pollock, herring, capelin, and sand lance. These species are important to seabirds and to harbor seals. The NMFS Auke Bay laboratory has been funded to investigate fatty acid profiles and lipid class analysis of herring and other forage fishes. That study plans to conduct detailed sampling and fatty acids analysis of herring (and perhaps others) in northeastern (Port Fidalgo) and southwestern PWS. Investigators of that project and this harbor seal study will coordinate to eliminate overlap in sample analysis. Project 064 will also share some harbor samples with Auke Bay personnel for duplicate analysis. This will provide a basis through which to ensure that results of analyses conducted by different laboratories are the same and can therefore be compared and combined. This is especially important as fatty acids studies become more prevalent and are conducted by a variety of laboratories.

ADF&G harbor seal investigators are currently and will continue to participate in interactive discussions with subsistence hunters in PWS and the GOA the Alaska Native Harbor Seal Commission. These discussions include the ongoing harbor seal decline, communication of results of Restoration-funded studies, and suggestions for future research.

ADF&G receives funding from NOAA to conduct complementary studies of harbor seals in the northern GOA and SEAK. This funding provides an "economy of scale" for many aspects of both studies. For example, disease and genetics analyses of PWS seals have been done at minimal or no cost to this study, but are instead provided through the NOAA-funded harbor seal study. Equipment is shared and analytical techniques and software developed by one project can be used by the other.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

There are no major changes between what we proposed in the 3-year proposal submitted in April 1997 and this renewal proposal. The major focus in FY 00 will be on addressing hypotheses related to food limitation and population trend. This focus will continue in the form of fatty acid analysis, analysis of historical fatty acid samples from Kodiak and SEAK, and analysis of satellite tagging data from pups. Annual molt-period surveys will continue. Survey analysis will include a hierarchical Bayes approach that should eliminate some problems with variance associated with so many count locations and the variety of covariates.

PROPOSED PRINCIPAL INVESTIGATOR

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PERSONNEL QUALIFICATIONS

Kathryn Frost (the principal investigator) has conducted research on marine mammals in Alaska since 1975. She has undertaken extensive research on natural history and ecology of seals, including aerial surveys; studies of food habits and trophic interactions; and studies of habitat use using satellite tags. She has conducted extensive aerial surveys of harbor seals in PWS and boat-based observations and sampling of harbor seals as part of NRDA studies following the EVOS. She has conducted satellite tagging studies of harbor seals in PWS from 1991 through 1998.

Lloyd Lowry is the Marine Mammals Coordinator for the State of Alaska. He has conducted research on marine mammals in Alaska since 1975, including studies of the natural history, ecology, distribution, abundance, and food habits of seals. He has participated in all NRDA and Restoration studies on harbor seals, including the development of methodology to catch and attach satellite tags to harbor seals. He has been responsible for project coordination and management of state and federally funded research projects, and is familiar with the federal marine mammal permit system.

Rob DeLong is an Analyst Programmer for ADF&G. He has developed custom software for analysis of data from satellite-tagged seals. Mr. DeLong is also accomplished in seal catching and tagging techniques.

Dr. Jay Ver Hoef is a Biometrician for ADF&G. He has been responsible for statistical analysis of all harbor seal data during NRDA and Restoration studies. He has participated in field work in PWS and is familiar with seal catching and tagging techniques.

Grey Pendleton is a Biometrician for ADF&G with extensive background in analyzing satellite tagging and aerial survey data. He will be responsible for statistical analysis of satellite tagging data for this and other ADF&G harbor seal projects.

Dr. Sara Iverson is an Assistant Professor at the University of Dalhousie. She is currently conducting research at Sable Island, Nova Scotia, on the lipid metabolism of seals and the use of fatty acids to determine marine food webs. She received her Ph.D. in nutritional sciences, conducting studies of the energetics of reproduction and fatty acid metabolism in seals. She developed procedures for analysis of lipids in milk, blubber and tissues of pinnipeds. Dr. Iverson has published extensively on these subjects.

KEY PERSONNEL

Kathryn Frost:	Project management and coordination, planning, data analysis, reporting, seal tagging, aerial surveys
Lloyd Lowry:	Permitting, tagging, GIS analysis, coordination with other ADF&G studies
Robert DeLong:	Tagging, programming, GIS analysis of SDR data
Jay Ver Hoef:	Statistical analysis of survey data, tagging
Grey Pendleton	Statistical analysis of tagging data
Sara Iverson:	Fatty acid analysis and interpretation

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Table 1. Harbor seals instrumented with SDRs and sampled during 1992-1998.

		SDRs										
Location	Date	AdM	SubM	AdF	SubF	PupM	PupF	DNA	Blood	Fat	Whiskers	D_2O
Northern PWS												
Dutch Group/Lone I	May 95		1					5	5	5	5	
Northeastern PWS												
Gravina Island	Sep 94		1					3	3	3	3	
	Sep 95				1		1	2	2	2	2	
Olsen Bay	May 95				1			2	2	2	2	
	May 96							4	4	4	4	
	Jun 97							7	7	6	7	3
Central PWS												
Applegate Rocks	May 92		3	1					5			
	May 93	2						5	5			
	Sep 93							1	1		1	
	Sep 95							2	2	2	2	
	May 96				1			2	2	2	2	
	Sep 96				1			3	3	3	3	
	Jun/Jul 97					1	3	21	21	21	21	12
	Jun 98					2		18	19	22	18	12
Bay of Isles	Sep 93	1						1	1		1	
Seal Island	May 92							1	3			
	May 93	3		1				7	7			
	Sep 93	2	1	1				10	10		10	
	May 96		1					3	3	3	3	
	Sep 96							4	4	4	4	
	Jun 97					2		2	2	2	2	2
	Jun 98					1	1	11	11	11	11	7

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel		$66.6
Travel		$6.6
Contractual		$43.4
Commodities		$1.3
Equipment		$0.0
Subtotal	$0.0	$117.9
General Administration		$13.0
Project Total	$0.0	$130.9
Full-time Equivalents (FTE)		0.9
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
		Estimated FY 2001	Estimated FY 2002		
		$0.0	$0.0		

Dollar amounts are shown in thousands of dollars.

Comments:

This proposal is for the last year of an ongoing harbor seal study. It provides information on population trends, movements, and ecology of harbor seals, including changes in diet, in order to identify causes of the apparently ongoing decline among harbor seals in central PWS. Emphasis in FY 00 will be on analysis of previously gathered telemetry data on adults and preparation of manuscripts dealing with fatty acids analyses, modeling population dynamics relative to carrying capacity, Bayesian survey analysis, and diving behavior of seals.

None of the costs identified in this budget are for NEPA compliance. Marine mammals projects obtain permits required under the Marine Mammal Protection Act from NOAA as part of routine operations. Costs for meeting attendance are identified under travel and total $3.7 K. This includes attendance at the annual EVOS workshop, and two persons to present papers at the 13th Biennial Marine Mammal Conference.

The proposed FY 00 budget is within the guideline presented in the FY00 Invitation to Submit Restoration Proposals. This project achieves major cost savings by collaborating with other studies and agencies to conduct this work. For example,ADF&G receives funds to conduct harbor seal studies in other parts of Alaska. This enables investigators to share costs for equipment, computers and software, as well as new methodologies and approaches to data analysis. Costs for fatty acid model development will be shared with Scotian Shelf research projects. Fatty acid samples to be use din comparisons of PWS and other geographic areas will be provided by other ADF&G harbor seal studies.

FY00

Prepared: 4/8/99

Project Number: 00064
Project Title: Monitoring. Habitat Use and Trophic Interactions of Harbor Seals in Prince William Sound
Agency: ADF&G

FORM 3A
TRUSTEE
AGENCY
SUMMARY

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

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
K. Frost	WBIII - Program Coordinator and Mngt	18K	5.0	6.5		32.5
L. Lowry	WBIV- Sat Tag Analysis & Interpretation	20J	2.0	7.0		14.0
R. DeLong	Analyst Programmer III-GIS Programming	17F	0.5	6.0		3.0
J. Ver Hoef	Biometrician II - survey statistical analysis	19F	1.0	6.4		6.4
G. Sheffield	WBI - data anlysis and graphics	14A	2.0	4.0		8.0
G. Pendleton	Biometrician II - sat tag analysis	19B	0.5	5.3		2.7
	Subtotal		11.0	35.2	0.0	
					Personnel Total	$66.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
Fbks-Cordova for Aug surveys, 1 person	0.5	1	12	0.1	1.7
Fbks-Anchorage, annual workshop, 1 person	0.2	1	5	0.1	0.7
Rental car, Cordova for surveys			12	0.1	1.2
Fbks - Hawaii for 13th Biennial Marine Mammal Conference	0.8	2	14	0.1	3.0
				Travel Total	$6.6

FY00

Prepared: 4/8/99

Project Number: 00064
Project Title: Monitoring. Habitat Use and Trophic Interactions of Harbor Seals in Prince William Sound
Agency: ADF&G

FORM 3B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed
Description	FY 2000
NOAA contract and ARGOS expenses for ARGOS satellite data, June 99 tags	4.0
Print/graphics (slides for workshops, report production)	0.3
Postage (DHL, courier, etc.)	0.2
Aircraft charter 35 hrs @ $.24/hr	8.4
Lipid analysis contract with Dalhousie University	20.0
Freight and shipping of samples	0.5
RSA with UAF for Bayesian survey analysis	10.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$43.4

Commodities Costs:	Proposed
Description	FY 2000
Misc. field and meeting supplies (notebooks, marine charts, film, etc.)	0.3
Computer supplies and software for graphics, GIS, and other analyses	1.0
Commodities Total	$1.3

FY00

Prepared: 4/8/99

Project Number: 00064
Project Title: Monitoring. Habitat Use and Trophic Interactions of Harbor Seals in Prince William Sound
Agency: ADF&G

FORM 3B
Contractual & Commodities DETAIL

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

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
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
Equipment used by project, purchased with oil spill funds		
Leitz binoculars	1	ADF&G
HP LIID Printer	1	ADF&G
Compaq 286 Computer	1	ADF&G
Zodiac Raft	1	ADF&G
Equipment used by project, but purchased with non-oil spill funds		
20 ft Boston whaler	1	ADF&G
17 ft Boston whaler	1	ADF&G
Seal nets	1	ADF&G
2 486 computers + Plotter	1	ADF&G
Printer	2	ADF&G
Color printer	1	ADF&G

FY00

'Prepared: 4/8/99

Project Number: 00064
Project Title: Monitoring. Habitat Use and Trophic Interactions of Harbor Seals in Prince William Sound
Agency: ADF&G

FORM 3B
Equipment
DETAIL

Monitoring of Oiled Mussel Beds in Prince William Sound

Project Number:	00090
Restoration Category:	Monitoring
Proposer:	Patricia M. Harris and Christine C. Brodersen NMFS, Auke Bay Laboratory ABL Program Manager: Dr. Stan Rice NOAA Program Manager: Bruce Wright
Lead Trustee Agency:	NOAA
Cooperating Agency:	ADF&G
Alaska Sea Life Center:	No
Duration:	closeout
Cost FY 00:	$ 64,000
Geographic Area:	Prince William Sound
Injured Resource/Service:	Mussels, Intertidal Communities, Vertebrate predators ,Subsistence

ABSTRACT

This project assesses the recovery of 28 mussel beds in Prince William Sound that still had significant concentrations of *Exxon Valdez* oil when last sampled in 1995 or 1996. Continued sampling is warranted until impacted mussel predators are fully recovered or hydrocarbon concentrations in the sediments and mussels in the beds return to pre-spill levels. In 1999 we will measure hydrocarbon concentrations in mussels, other invertebrates, and sediments and monitor densities of mussels and other selected invertebrates in these beds. We replaced oiled with clean sediments in 12 of the beds in 1994. Replaced sediments remained clean though 1995 and mussel hydrocarbon concentrations decreased significantly. However, 1996 samples indicated recontamination of the replaced sediments and the potential for recontamination of mussels. Sampling in 16 beds that were not restored will document rates of natural recovery. To complete the design, we will sample mussels, sediments and other invertebrates in two unoiled reference beds. In 2000 we propose to complete the chemical analysis of samples collected in 1999, complete data analysis, and prepare final reports.

INTRODUCTION

Many blue mussel (*Mytilus trossulus*) beds impacted by the *Exxon Valdez* oil spill (EVOS) were not cleaned by the EVOS Interagency Shoreline Cleanup Committee to minimize damage to the beds. Natural processes did not quickly reduce the substantial amounts of *Exxon Valdez* oil (EVO) remaining in mussels and sediments underlying mussel beds. In 1992, the Auke Bay Laboratory and National Park Service (Restoration Project R103) documented 50 mussel beds in Prince William Sound (PWS) and 9 on the Kenai and Alaska Peninsulas with underlying sediment concentrations greater than 1700 Fg/g total petroleum hydrocarbons (TPH) wet weight; 25 of the beds in PWS had concentrations in excess of 10,000 Fg/g TPH. The highest oil concentrations found in animals or sediments in 1991 and 1992 by any researchers in the *Exxon Valdez* spill area were in mussel beds and underlying sediments in PWS. Persistent high concentrations of hydrocarbons in mussels were identified as a possible source of impacts in several consumer species and could also impact human subsistence users.

Attempts to manipulate mussel beds to reduce hydrocarbon levels in 1992 and 1993 (projects R103-1 and 93036) were minimally intrusive and minimally effective. Small scale removal of strips of mussels to increase water circulation through the beds and thereby reduce hydrocarbon levels did not significantly lower hydrocarbon concentrations in sediments or mussels. Adult mussels from the surrounding bed recolonized exposed areas within three months, thus preventing further hydrocarbon flushing. Transplanting small patches of oiled mussels to nearby clean sediments reduced hydrocarbons in those mussels, but mussel mortality was high. (Babcock et al. 1998.). Overall hydrocarbon concentrations in the five manipulated beds remained high (Babcock et al.1996).

The scale of restoration was increased in 1994 (project 94090) at the request of Chenega Bay residents. We manually removed oiled mussels, replaced oiled sediments underlying the mussels with clean sediments, and replaced mussels onto the clean sediments in 12 of the most impacted mussel beds. Hydrocarbon levels in the clean replaced sediments remained low from late summer 1994 through early summer 1995, and total polyaromatic hydrocarbons (TPAH) in mussels were greatly reduced by 1995. However, in 1996 when restored beds were last sampled, TPH concentrations in sediments directly under the mussels ranged from 340 to 9000 mg/g, indicating recontamination in 6 of the 12 beds. Mussel densities showed overall decline in most restored beds from the fall of 1994 to summer 1995. Declines were also observed in reference beds and therefore were not necessarily linked to restoration (Babcock et al.1998.).

In most untreated beds, hydrocarbon concentrations in mussels and underlying sediments declined at variable rates. Environmental differences between sites as well as differences in the distribution and amount of subsurface oil affected the rate of decrease. In 1995, 16 sampled mussel beds in PWS remained oiled; TPH in sediments ranged up to 20,000 mg/g wet weight and TPAH in mussels ranged up to 4.5 mg/g dry weight. Significant natural reductions in hydrocarbon concentration were observed in roughly half of the beds surveyed. Concentrations should reach background levels within three decades of the spill in these beds. (Background

concentrations are defined as 50 ug/g TPH wet weight in sediments and 0.09 mg/g TPAH dry weight in mussels, based on minimum detection limits of analytical instruments and historical data from unoiled sites). The 16 untreated beds have not been sampled since 1995; three of them were still visibly oiled in the spring of 1997.

Hydrocarbon concentrations in other invertebrates in mussel beds have been undersampled, considering these species may also be a pathway for residual oil from sediments to vertebrate species that are still impacted (e.g. have elevated levels of P450 or show negative effects on their populations). Hydrocarbon (TPAH) concentrations in littorine snails, prey of harlequin ducks and black oystercatchers, ranged from 4 to 27 mg/g dry wt. in several 1989 samples [Exxon Valdez Trustee Hydrocarbon Database (EVTHD]. Shigenaka (1997) reported that PAH concentrations in drills and littorines were 1 and 2 orders of magnitude lower respectively than concentrations in mussels at the same site (Smith Island, Prince William Sound in 1990). Concentrations in littorines (*Littorina sitkana* and *L. scutulata*) in 10 mussel beds in the spill area in 1993 were generally not more than 1 order of magnitude lower than concentrations in mussels from the same bed. (Project 99090, unpublished data) Limpets (2 samples) and *Macoma* spp. clams are the only other harlequin prey (other than mussels) that are reported in EVTHD. Prey notably missing from that database are hermit crabs (*Pagurus* spp.), drills (*Nucella* spp.), nemerteans, and annelids, all occasional in the beds we have sampled since 1991. Because crabs, drills, and worms are not filter feeders, they are expected to have lower concentrations of TPAHs than mussels in the same bed, but they could add to the body burden of animals who also prey on mussels or could be a pathway for oil to predators who do not eat mussels. For example, pigeon guillemots, who do not eat mussels, have been observed feeding hermit crabs to their chicks. Masked greenling, a nearshore fish species, was found to have elevated levels of P450 in oiled areas (Holland-Bartels, 1998), but the source of contamination is not clear. In cooperation with restoration project 99375, our project will investigate the link between hydrocarbons in sediment, in closely associated invertebrates, and in nearshore and intertidal fishes.

Clams (*Prototheca, Saxidomus,* and *Macoma* spp.) and cockles (*Clinocardium*) were well sampled soon after the spill by damage assessment studies, but not in recent years (EVTHD). Clams and cockles are common in areas below mussel beds that we have sampled; oil chronically released from mussel bed sediments may impact the communities lower in the intertidal. One *Prototheca* sample we collected in 1993 below a particularly oily mussel bed, contained 4.5 mg/g TPAH, 4 times the mean concentration of mussels in the bed. Otter craters, common below mussel beds sampled since 1991 often had oil sheen in them. Hydrocarbons in clams and cockles may still be affecting predators. *Macoma* spp are consumed by harlequin ducks, who are still listed as Anot recovering@ from the spill; Sea otters and black oystercatchers, Arecovering@ species, consume *Prototheca, Saxidomus,* and *Clinocardium.*

Chemical analysis of samples collected in 1999 will begin in the summer of 1999, but will be completed in fiscal year 2000. Completion of chemical and data analyses is needed to 1) evaluate the effectiveness of mussel bed restoration techniques, 2) evaluate natural recovery rates with respect to modeled rates of recovery 3) examine the degree and pattern of weathering of oil in both restored and untreated beds, 4) assess mussel bed health and 5) examine the hydrocarbon concentrations in other invertebrate fauna in oiled mussel beds to look for links to vertebrate

species that are still impacted. The final report should provide a comprehensive picture of recovery in both restored and naturally recovering mussel beds.

NEED FOR THE PROJECT

A. Statement of Problem

Mussels remain an important food source in PWS intertidal communities, particularly for some predators (e.g. harlequin ducks, sea otters, and black oystercatchers) whose recovery is not yet certain. Additionally, mussel beds provide habitat for many other invertebrate species, which are also prey, directly or indirectly, of impacted species. Continued monitoring of hydrocarbons in mussel beds is warranted until this contaminated habitat has fully recovered. Human subsistence users need to know whether mussels and other species trophically linked to the beds are oil free. Untreated mussel beds have not been sampled since 1995, so their hydrocarbon levels are unknown. The patterns of concentration decline from 1991 to 1995, and observations of visible oiling in some mussel beds in early 1997, indicate that many beds have not returned to pre-spill concentrations. Sediment recontamination in half of the restored beds necessitates further monitoring of these beds.

B. Rationale/ Link to Restoration

Human subsistence harvesters and researchers studying mussel predators need to know if petroleum hydrocarbons still persist in mussel beds. Although the areal extent of contaminated mussel beds is small in proportion to the total area of beds in PWS, the oiled beds are the worst remaining known source of *Exxon Valdez* Oil (EVO) contamination that is biologically available. Other known areas of remaining high contamination are high in the intertidal and armored with asphalt and cobble or boulders (Shigenaka, 1997). Monitoring the gradual return to pre-spill conditions of these beds is basic to all other *Exxon Valdez* Oil Spill (EVOS) studies.

The long term effectiveness of natural recovery and restoration techniques should be assessed to provide guidance in the event of other spills. Oiled beaches remain a problem for PWS residents, prompting this study and other chemical restoration activities.

C. Location

The mussel beds to be evaluated are in the oil-impacted areas of PWS (Knight Island, Disk Island, Eleanor Island, Chenega Island, Latouche Island, Squirrel Island, and Applegate Island) and two not impacted areas, Olsen Bay in eastern PWS and Drier Bay on Knight Island. Residents of Chenega Bay use the beaches near several of the oiled mussel beds.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The results will be reported in non-technical terms to the Chenega Bay Village Council in writing, and if the Council so requests, at a public meeting in Chenega Bay as well. Students

from the Youth Area Watch Program, especially those from Chenega Bay will be invited to participate in sampling.

PROJECT DESIGN

A. Objectives

1. Measure hydrocarbon concentrations in mussels and underlying sediments, and mussel densities, in beds that were restored in 1994 to evaluate degree of recontamination and to assess mussel bed health. Similar measures will be taken in uncleaned control beds for comparison.

2. Measure the hydrocarbon concentrations in mussels and underlying sediments and mussel densities in untreated mussel beds that remained contaminated with EVO in 1995. Similar measures will be taken in uncleaned control beds for comparison.

3. Measure the hydrocarbon concentrations in selected invertebrate fauna associated with both categories of mussel beds. We will target prey species of vertebrate species still not fully recovered from the spill. (harlequin duck, pigeon guillemot, sea otter, black oystercatcher) and of vertebrate species that may be prey of the impacted species (nearshore forage fish).

B. Methods

Our working hypotheses are 1) that the beds restored in 1994 have remained clean and intact and 2) that sediment and tissue hydrocarbon concentrations in untreated oiled PWS mussel beds have returned to pre-spill levels. Data to be collected are TPH (sediments) and TPAH (mussels and other invertebrates) concentrations and faunal densities (e.g. mussels/m^2).

Objective 1

Site Selection

Sites to be sampled in 1999 include those restored in 1994 and adjacent uncleaned beds that represent natural restoration.

Restored Mussel Beds Proposed for sampling in 1999

Beach Segment*	Geographic Name	Notes
CH10B-2A	Chenega Island	originally sampled as 2 beds, now as 1 bed with 3 zones
CH10B-2B	Chenega Island	
CH10B-2C	Chenega Island	
CH10B-2D	Chenega Island	uncleaned reference bed
DI067A-1	Disk Island	
DI067A-2AL	Disk Island	
DI067A-2AR	Disk Island	

DI067A-2B	Disk Island	
DI067A-2C	Disk Island	uncleaned reference bed
EL011A-B	Eleanor Island	
EL011A-C	Eleanor Island	
EL011A-D	Eleanor Island	uncleaned reference bed
KN113B-2	Herring Bay	sample 2 depths and up slope area
SL001D-2	Squirrel Island	

* nomenclature follows the interagency Shoreline Cleanup Assessment Team (SCAT) shoreline assessment segment designations. Where we sampled multiple oiled mussel beds within one segment, they are designated with a number following the segment number.

Sampling

Within each of these beds, triplicate pooled samples of mussels and of sediments will be collected at 8 random spots and placed in hydrocarbon-free glass jars. Approximately 20 mussels, will be collected by hand; the sediments will be collected with a hydrocarbon-free spoon. In 1992, intensive sampling indicated 3 distinct zones of oiling at CH010B-2A (Harris et al. 1996). These zones were obscured when the bed was cleaned, at least to a depth of 12 cm, but the recontamination pattern shown in 1996 samples indicates the re-formation of zones. Therefore, at CH010B-2A the initial zones will be re-sampled, so that triplicate pooled samples will be collected from each zone. At most cleaned beds and at the 3 uncleaned reference beds, sediments will be sampled at 3 depths: surface (0-2 cm), deep (4-6 cm), and below replaced sediment depth (>12 cm) to enable us to determine if oil below the replaced layer has recontaminated surficial sediments. Sediments will be sampled at only two depths, surface and deep, at the Herring Bay restored bed (KN113B-2) because oiled sediments were removed down to bedrock. In that bed, the recontamination source in 1996 appeared to be oiled sediments up slope of the restored area so the up slope area will be re-sampled.

All samples will be immediately cooled, and frozen within 6 h. Samples will be given a unique number in the field to facilitate sample tracking through chemical and data analysis and inclusion in a restoration hydrocarbon data base. Mussel densities will be estimated by counting mussels in 2 of the 4 frames within a 0.25 m x 0.25 m sampling quadrat in at least 8 subsites along the transect and will be expressed as mussels/m5. In the same 8 quadrats, we will count the number of targeted invertebrates and express densities as species name/m^2.

Chemical Analysis

Sediment samples will be analyzed by ultraviolet fluorescence as adapted from Krahn et al.(1991) and used successfully at Auke Bay Laboratory since 1992. Concentrations will be reported in mg total hydrocarbons /g wet weight of sediment (TPH). All mussel, other invertebrate samples, and selected sediments will be analyzed by gas chromatography/mass spectroscopy (GC/MS) for quantitative measurements of individual polynuclear aromatic hydrocarbons (PAH) (Larsen et al., 1992); concentrations will be reported in mg total PAH / g dry weight of mussel or sediment (TPAH). Perylene, which is biogenic, will not be included in TPAH. At least one sediment sample from each bed will be analyzed by GC/MS to examine the degree and pattern of weathering of EVO if TPH levels in that bed are above pre-spill levels (50 mg/g).

Data Analysis
Hydrocarbon data will be tested for normality and log transformed if necessary to carry out ANOVA to examine differences between sites (1999 data) and sampling times at each site (using 1992-1999 data). A longer time series will be possible for some sites where hydrocarbon samples have been collected since the mid 1970's. Assuming triplicate sampling as proposed, statistical power will be 80% (alpha =0.05) to detect a change or difference of 60% at two sites or two sampling times at the same station (Kinetic Laboratories, 1993). Weathering of EVO will be examined using first-order kinetic loss rate modeling (Short and Heintz 1997)
Densities of targeted invertebrates in restored beds will be compared with densities in the appropriate unrestored bed(s).

Objective 2

Site Selection:
The 14 oiled mussel beds selected for sampling still contained > 0.09 mg/g TPAH in mussel tissues and/or > 200 mg/g TPH in underlying sediments in 1995. KN004-2 was not sampled in 1995, but was selected because TPAH in mussels was 0.6 mg/g in 1994. Olsen Bay and Barnes Cove, two unoiled reference beds monitored since 1991, will be also be sampled.

Unrestored Mussels Beds Proposed for Sampling in 1999:

Beach Segment*	Geographic Name	Notes
AE005A-2	Applegate Island	
CH009A-3	Chenega Island	
DI067A-6	Disk Island	sampling 2 sediment depths
EL013A	Eleanor Island	sampling of 2 zones, 2 sediment depths
EL015A	Eleanor Island	
EV036A	Evans Island	
KN004-2	Bay of Isles	
KN119A	Herring Bay	
KN133A-1	Herring Bay	sampling of 3 zones, 2 sediment depths
KN136A-1	Bay of Isles	
KN136A-3	Bay of Isles	sampling 2 sediment depths
KN505A	Herring Point	
KN575A	Barnes Cove	unoiled reference
LA015E-2	Latouche Island	sampling 2 sediment depths
MA002C	Foul Bay	
OLSEN	Olsen Bay	unoiled reference

Three additional small untreated beds will be sampled, but because these will be sampled similarly to the restored beds they are included under objective 1.
Sampling:
In the untreated beds, mussel and sediment sampling will follow methods developed by this project in previous years (Babcock et al. 1996). In most of the above beds, a transect, generally

30 m long and parallel to the water line (as topography allows), will be established through the middle of a mussel bed. Triplicate pooled samples of 20-25 mussels each will be collected along the transect and within 1 m above and below the transect and placed in three hydrocarbon (HC)-free jars. Other invertebrates will also be collected along the transect. Three pooled subsamples of surficial sediment (0-2 cm deep) under the mussels will be collected with a HC-free stainless steel spoon into each of three HC-free glass jars. A sample of sediments 4-6 cm below the surface will be taken in five beds where samples at that depth have been collected since 1992 to see if initial patterns of oiling related to depth still persist (see table above).

Two beds, KN133A and EL013B, had zones of significantly different concentrations of oil in 1992 (Harris et al., 1996). These beds will be re-sampled by the zones observed in 1992 (rather than by transect) to see if the initial within-bed oiling pattern persists as concentrations have declined. In each zone, three pooled replicate samples of sediments at depths 0-2 cm, three pooled replicate sediment samples at depths 4-6 cm, and three pooled replicate samples of mussels will be collected. Targeted invertebrates will be collected over the whole bed; replicate samples will be collected if density permits. Sample handing, chemical analysis, and data analysis will follow the procedures discussed under objective 1.

Chemical and Data Analysis
Chemical analysis of samples and data analysis will follow methods described for objective 1.

Objective 3.

Site Selection
Selected invertebrates will be collected in all beds sampled under objectives 1 and 2.

Sampling
Invertebrate groups selected for collection are littorines, drills, limpets, chitons, annelids, nemerteans, hermit crabs, clams, and cockles. The latter two groups will be collected below (lower in the intertidal) mussel beds; others will be collected in the bed. Observations in the mussel beds since 1991 indicate that distribution of these select invertebrates is patchy and densities are low, so no specific sampling protocol is proposed; samples will probably have to be collected throughout the bed or the intertidal area below the bed to obtain enough for a tissue sample (5 g) of each species. When densities permit, replicate samples of each species will be collected. Samples will be placed in HC-free glass jars and handled as mussel samples are.

Chemical and Data Analysis
Methods follow those for mussel tissue, except that littorines will not be dissected from their shells. A subset of littorines will be dissected and dried to determine the relationship between littorine tissue dry weight and littorine whole body dry weight, so that hydrocarbon concentrations in littorines may be compared with that in mussels and other animals in which just the tissue is analyzed.

Summary of Sampling and Analytical Methods

Sample Type	Objective 1 Restored Beds	Objective 2 Unrestored Beds	Objective 3 Other Invertebrates	Totals

UV Sediment	141	78		219
GC/MS				
Sediment*	6	13		(19)
Targeted invertebrates+			20	20
Mussels	48	51		99
				338

* Sediments to be analyzed by GC/MS are subsamples of UV sediment samples and therefore do not affect sample totals for each objective. The maximum number of sediments to be analyzed by GC/MS is 19. Sediments will not be analyzed by GC/MS if TPH concentrations are not above pre-spill levels in a bed.

+ maximum number of samples to be collected is estimated at 20, depending on the abundance of selected species

C. Cooperating Agencies, Contracts, and Other Agency Assistance

We will share a sampling platform in 1999 with Restoration Project 99379, Assessment of Risk to Residual Exxon Valdez Oil in PWS Using P450 Activity in Fishes. We will also suggest sample sites to ensure sampling coordination with that project so that we may be able to support that project with apprropriate chemical data. The only contracts involved will be contract labor for chemical sample processing.

SCHEDULE

A. Measurable Project Tasks for FY 2000 (October 1, 1999 - September 30, 2000)

Jun.-Sept. FY99	initiate hydrocarbon analyses (60% complete by Sept.30)
Oct. - Dec.	complete hydrocarbon analyses
Dec.-Jan.	data analysis
Jan.	EVOS workshop
April	final report
May-Sept.	publication preparation

B. Project Milestones and Endpoints

Data analysis and reporting for samples collected in summer of 1999 will be completed in winter 2000, submission of an final report in April of 2000, and preparation of a more public final report or presentation.

C. Completion Date

If our working hypotheses are shown true (significant amounts of oil are *not* found in PWS mussel beds), our objectives will have been met in April of 2000. If the hypotheses prove false, and significant amounts of oil *are* found, another round of sampling will be proposed probably in 2002.

PUBLICATIONS AND REPORTS

FY99: none
FY00: final reports (one to the EVOS trustees, one for the general public) and 2 manuscripts; Effectiveness of Manual Restoration of Oiled Mussel beds, Natural Recovery of Mussel beds Impacted by EVO.

PROFESSIONAL CONFERENCES

FY00: EVOS workshop

NORMAL AGENCY MANAGEMENT

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

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Logistics of sampling in 1999 will be tied as closely as practical to the sampling efforts of the Pristane Monitoring project. The potential for overlap is great since the same personnel will be involved. Data and results will be shared with other projects, project 99379 (as discussed) and projects involving mussel predators (Nearshore Vertebrate Predators 99025, Alaska Predator Ecosystem Experiment (99163), and Differentiation/Interchange of Harlequins. Students from the Youth Area Watch (99210) will be invited to participate in sampling. Cooperative efforts in 2000 will largely be data sharing and will result in synthesis of information from other projects, particularly those focusing on predators of mussels and other musel bed invertebrates.

PROPOSED PRINCIPAL INVESTIGATORS

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PRINCIPAL INVESTIGATORS

Patricia M. Harris

Education:
New York University
University of Alaska Fairbanks; B.S. Biological Science 1966
Graduate courses at U of A Fairbanks, U of A Southeast, University of British Columbia, U. of Washington

:
Patricia Harris has been involved in *Exxon Valdez* Oil Spill research since March 1989; as a co-principal investigator for NRDA project Subtidal 3, Mussel bed monitoring and restoration (R103-99090), and Pristane monitoring in mussels (96195-99195), she has been r esponsible for study design, field logistics, sample collection and assisted in data analysis and proposal and report preparation. She has also assisted sampling for Near shore Vertebrate Predator Project (96025) and Chenega Cleanup project (97291, 98291).

Relevant publications: Co-author of annual and final reports for NRDA study Subtidal 3 and restoration project Monitoring of Oiled Mussel beds, contributing author to annual reports for Pristane Monitoring project, author of several publications pertaining to distribution of Exxon Valdez oil in mussels and underlying sediments. Several public presentations of oil-related scientific research.

Responsibilities: Study design, sample collection logistics, collect hydrocarbon samples, analyze data, prepare proposals and reports.

Christine C. Brodersen

Education:
University of Washington; B.S. Zoology 1971
Graduate work at U of A Southeast

Relevant Experience:
1974 - present: Fisheries Research Biologist at Auke Bay Fisheries Laboratory, including:

1974 - mid-1980s: Conducted laboratory research on the toxicity of Alaskan crude oils to Alaskan marine species, especially larval stages.
1989 - 1991: Conducted training classes in the handling of hydrocarbon-analysis samples for personnel in agencies doing EVOS field work; coordinated legal chain-of-custody procedures for Auke Bay Laboratory EVOS work.

1989 - present: Participated in proposals, data analysis and reporting for mussel bed monitoring and restoration work (R103 - 96090) and conducted associated laboratory experiments on measures of potentially oil-related stress in mussels.

1994 - 1996; Conducted laboratory experiments on trophic transfer of pristane that helped establish the theories behind the PWS pristane project (96195).

1996: Participated in extensive mussel population surveys in PWS with Nearshore Vertebrate Predator study.

1997 & 1998: Principal investigator of the oil and biology monitoring portion of the Chenega Shoreline Restoration project (97291, 98291).

Relevant publications & presentations:
More than a dozen papers, reports and presentations on the effects of Alaskan oil, tanker ballast water, and the EVOS.
Responsibilities: Analyze data, prepare proposals, track samples, and collect hydrocarbon samples.

LITERATURE CITED

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2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 19 eptember 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000						
Personnel	$96.5	$46.4						
Travel	$15.2	$2.2						
Contractual	$11.3	$6.0						
Commodities	$11.7	$2.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$134.7	$56.6			Estimated FY 2001	Estimated FY 2002		
General Administration	$15.3	$7.4						
Project Total	$150.0	$64.0			$0.0	$50.0		
Full-time Equivalents (FTE)		0.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$49.5	$37.0						

Comments:

NOAA's Contribution:
Personnel: Habitat Program Manager, S. Rice .5 mo. @1 1.3mo, J.W. Short .5 mo @8.4mo, Co- PI Biologist C. Brodersen 1 mo @ 6.7K, Co-PI, P Harris 1 mo @6.2mo. statistical advisor and editor, Mark Carls, 1 mo. @ 7k

Other: NOAA also contributed the cost of analysis of 1996 sediment samples from restored beds 7K for total NOAA contribution of 37K

FY00

Prepared:4/12/99

Project Number: 00090
Project Title: Monitoring of Oiled Mussel Beds in Prince William Sound
Agency: NOAA

FORM 3A TRUSTEE AGENCY SUMMARY

2000 EXXON VALDEZ TI E COUNCIL PROJECT BUDGET
October 1, 1 eptember 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
Harris	Zoologist	GS-11/2	3.0	6.2		18.6
Brodersen	Fisheries Research Biologist	GS-11/7	1.0	6.7		6.7
						0.0
Chem Lab personnel for analyses:						0.0
Holland	Chemist	GS-11/6	1.0	6.7		6.7
Larsen	Chemist	GS-11/6	0.5	6.7		3.4
Lunasin	Chemist	GS-9/6	2.0	5.5		11.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal	[redacted]	7.5	31.8	0.0	[redacted]
					Personnel Total	$46.4

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
					0.0
Juneau- Anchorage Restoration Workshop	0.4	1	3	0.2	1.0
					0.0
travel to SEATAC meeting to present paper, 1 person	0.6	1	3	0.2	1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.2

FY00

Prepared:4/12/99

Project Number: 00090
Project Title: Monitoring of Oiled Mussel Beds in Prince William Sound
Agency: NOAA

FORM 3B
Personnel & Travel DETAIL

2000 EXXON VALDEZ TI[illegible]E COUNCIL PROJECT BUDGET

October 1, 1[illegible]eptember 30, 2000

Contractual Costs:		Proposed
Description		FY 2000
contract labor chem lab, 2 month at 2.5K/month		5.0
publishing costs		1.0
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$6.0

Commodities Costs:		Proposed
Description		FY 2000
Chem Lab supplies for analyses (solvents , glassware, gasses)		2.0
	Commodities Total	$2.0

FY00

Prepared:4/12/99

Project Number: 00090
Project Title: Monitoring of Oiled Mussel Beds in Prince William Sound
Agency: NOAA

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		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
computer, printer	4	NOAA
GC/MS	1	NOAA
HPLC	1	NOAA
GPS	1	NOAA
UVF radio	1	NOAA
camera	1	NOAA
freezer	1	NOAA

FY00

Prepared:4/12/99

Project Number: 00090
Project Title: Monitoring of Oiled Mussel Beds in Prince William Sound
Agency: NOAA

FORM 3B Equipment DETAIL

Project Title: Tatitlek Coho Salmon Release

Project Number:	00127
Restoration Category:	General Restoration
Proposer:	Tatitlek IRA Council
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	Tatitlek IRA Council
Alaska SeaLife Center	
Duration:	6th year, 5 year project
Cost FY 00:	$10.7
Cost FY 01:	$0.0
Geographic Area:	Boulder Bay, Prince William Sound
Injured Resource/Service:	Salmon/Subsistence

ABSTRACT

This project will create a coho salmon return to Boulder Bay near Tatitlek village. Enough coho eggs to produce 50,000 smolt will be collected from an ADF&G approved stream, incubated and reared to smolt at the Solomon Gulch Hatchery transported and held for two weeks in net pens in Boulder Bay before release. Release will produce a 2,000 to 3,000 adult return to Boulder Bay for harvest in a subsistence fishery. This request will extend the project for an additional year beyond the originally scheduled termination date.

A. INTRODUCTION

Subsistence fisheries available to residents of Tatitlek village were severely disrupted by the *Exxon Valdez* oil spill. This project is intended to enhance subsistence resources near Tatitlek by creating a 2,000 to 3,000 coho salmon return to Boulder Bay immediately adjacent to Tatitlek village. This resource is intended to partially replace other subsistence resources, such as harbor seal, that were injured by the spill. Although the last year of this project was scheduled to be FY 99, the resources this project replaces have not recovered to the point that they can again supply the subsistence needs of the villager. This request will extend the project for an additional year.

This coho salmon return will be created through an annual release of 50,000 coho salmon smolt in Boulder Bay. The smolt are produced at the Solomon Gulch Salmon Hatchery under an agreement between its operator, the Valdez Fisheries Development Corporation and the Tatitlek IRA Council. The coho salmon eggs needed to produce the smolt come from a wild coho run that has been approved by ADF&G for the egg take. The eggs are taken to the Solomon Gulch hatchery for incubation and rearing to the smolt stage. The sea ready smolt are then transported by boat to Boulder Bay and are imprinted to the bay by placing them in net pens for about a two week period before being released into the wild.

The EVOS Trustee Council approved this project in FY 95. Funds were appropriated to underwrite the environmental assessment, a draft of which has been produced. Funds received in FY 96 and beyond will be used to produce the coho salmon returns to Boulder Bay.

NEED FOR THE PROJECT

A. Statement of Problem

Subsistence harvests by Tatitlek village residents have declined considerably since the oil spill. Most marine resources that were utilized for subsistence by Tatitlek villagers have not substantially improved since the spill. Subsistence harvests are still a lot less then they were prior to the spill.

B. Rationale/Link to Restoration

This project would enhance the recovery of the local salmon resource that is utilized for subsistence and provides a means for lessening the impacts of continued harvests on other subsistence resources injured by the spill such as harbor seals.

C. Location

This project will be undertaken at the Solomon Gulch Hatchery and in Boulder Bay near Tatitlek. Those participating in the subsistence fishery created by this project will realize the benefits. These will mainly be residents from Tatitlek.

COMMUNITY INVOLVEMENT

This project was initiated at the request of the Tatitlek Bay IRA Council. The council negotiated the agreement with the Valdez Fisheries Development Corporation to produce the smolt for the project. Members of the village set up the net pen site each year in Boulder Bay and hold and feed the smolt each year prior to release. The villagers participate in the subsistence fishery on the returning adults.

PROJECT DESIGN

A. Objectives

1. Continue agreement with the Valdez Fisheries Development Corporation to produce 50,000 coho salmon smolt for release in Boulder Bay.

2. Imprint smolt to Boulder Bay by holding and feeding them in net pens in the bay for two weeks prior to release into the wild.

3. Harvest for subsistence 2,000 to 3,000 coho salmon annually upon their return to the imprint site.

B. Methods

The purpose of this project is to create a run of coho salmon in Boulder Bay near Tatitlek for subsistence use. The project would be undertaken annually and could be classified as "put and take" since it is unlikely that the coho returns produced by this project would establish a wild run. There are four basic steps to the project; egg take, incubation and rearing to the smolt stage, imprinting and release of smolt and the subsistence harvest.

The Solomon Gulch hatchery is responsible for the egg take and smolt production, Tatitlek village is responsible for imprinting and releasing the smolt into the wild. The subsistence fishery is open to all, but mostly consists of Tatitlek village residents.

The eggs are taken from a coho run approved by ADF&G for use in this project. Enough eggs are taken to produce 50,000 smolt. They are taken to the Solomon Gulch hatchery where standard fish culture practices are utilized to incubate the eggs and rear the resultant fry to the smolt stage. The smolt are then transported by boat to Boulder Bay where they are placed in net pens and held (and fed) for a two week period during which time they imprint to Boulder Bay. The smolt are then released into the wild and proceed to their ocean rearing grounds returning back to Boulder Bay approximately 12 months later as adults. Around 2,000 to 3,000 adult coho salmon return to Boulder Bay from the smolt release. As many of these fish as possible (usually 75% to 85%) are harvested in a subsistence fishery that has been set up specifically for this purpose. The unharvested fish die without spawning.

C. Cooperating Agencies, Contracts and Other Agency Assistance

The Tatitlek IRA Council is contracted by ADF&G to oversee this project. The council in turn

contracts with the Valdez Fisheries Development Corporation to take the eggs and produce the smolt.

SCHEDULE

A. Measurable Project Tasks for FY 99

August, 1999	Egg take
May 20 to 25, 2000	Smolt transported to Boulder Bay and placed in net pens.
June 3 to 8, 2000	Smolt released into Boulder Bay

B. Project Milestones and Endpoints

Objective 1.	Initial agreement in place. Will be reviewed and renewed by April 15 each year.
Objective 2.	Completed by June 15 each year.
Objective 3.	Completed by July 15 annually.

C. Completion Date

This project will continue until the subsistence resources injured by the spill have fully recovered.

PUBLICATIONS AND REPORTS

Annual reports	Describe project activities for each fiscal year. Due April 15 following the fiscal year being reported on.
Final report	Synopsis of each year's activities and analysis of project as a whole. Due April 1 following the year in which the final adult return occurs.

PROFESSIONAL CONFERENCES

No travel to professional conferences is planned under this project.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

There appear to be no opportunities to coordinate or integrate this project with other restoration efforts.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

There are no project design or schedule changes in this proposal from the DPD approved by the

Trustee Council for FY 99.

PROPOSED PRINCIPAL INVESTIGATOR

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Fax (907) 325-2298

FY 98 EXXON VALDEZ TRU[illegible] COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FFY 1998	Proposed FFY 1999						
Personnel	$0.0	$0.0						
Travel	$0.0	$0.0						
Contractual	$9.8	$10.7						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$9.8	$10.7	Estimated FFY 2000	Estimated FY 2001	Estimated FFY 2002	Estimated FFY 2003	Estimated FFY 2004	Estimated FFY 2005
General Administration	$0.7	$0.7						
Project Total	$10.5	$11.4	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY 99

Prepared : 4/8/97

Project Number: 99127
Project Title: Tattilek Coho Salmon Release
Agency: AK Dept. of Fish & Game

FORM 3A
AGENCY
PROJECT
DETAIL

Printed: 4/15/99

FY 98 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1999
*							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	
Those costs associated with program management should be indicated by placement of an *.						**Personnel Total**	$0.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1999
						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 costs associated with program management should be indicated by placement of an *.					**Travel Total**	$0.0

FY 99

Project Number: 99127
Project Title: Tattilek Coho Salmon Release
Agency: AK Dept. of Fish & Game

FORM 3B
Personnel
& Travel
DETAIL

Printed: 4/15/99

Contractual Costs:	Proposed FFY 1999
Description	
Contract with non-trustee agency	10.7
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$10.7

Commodities Costs:	Proposed FFY 1999
Description	
Commodities Total	$0.0

FY 99

Project Number: 99127
Project Title: Tattilek Coho Salmon Release
Agency: AK Dept. of Fish & Game

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1999
			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

FY 99

Project Number: 99127
Project Title: Tattilek Coho Salmon Release
Agency: AK Dept. of Fish & Game

FORM 3B
Equipment
DETAIL

FY 98 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FFY 1998	Proposed FFY 1999	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	Estimated FFY 2003	Estimated FFY 2004	Estimated FFY 2005
Personnel	$2.6	$2.8						
Travel	$0.0	$0.0						
Contractual	$6.2	$6.9						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0						
Subtotal	$8.8	$9.7						
Indirect	$1.0	$1.0						
Project Total	$9.8	$10.7	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)		1.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY 99

Prepared: 4/7/97

Project Number: 99127
Project Title: Tattilek Coho Salmon Release
Agency: AK Dept. of Fish & Game

FORM 4A
Non-Trustee
DETAIL

Printed: 4/15/99

FY 98 EXXON VALDEZ TRU[redacted] COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs:				Months	Monthly		Proposed
	Name	Position Description		Budgeted	Costs	Overtime	FFY 1999
[redacted]		Net Pen Worker	[redacted]	0.5	$2,800		1.4
		Net Pen Worker		0.5	$2,800		1.4
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal	[redacted]	1.0	5,600	0	[redacted]
						Personnel Total	$2.8

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FFY 1999
[redacted]						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

FY 99

Project Number: 99127
Project Title: Tattilek Coho Salmon Release
Agency: AK Dept. of Fish & Game

FORM 4B
Personnel
& Travel
DETAIL

Printed: 4/15/99

Contractual Costs:	Proposed FFY 1999
Description	
Transport 20,000 coho smolt to Boulder Bay, provide fish food & supplies	6.1
village skiff rental	0.8
Contractual Total	$6.9

Commodities Costs:	Proposed FFY 1999
Description	
Commodities Total	$0.0

FY 99

Project Number: 99127
Project Title: Tattilek Coho Salmon Release
Agency: AK Dept. of Fish & Game

FORM 4B
Contractual & Commodities DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1999
			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	

FY 99

Project Number: 99127
Project Title: Tattilek Coho Salmon Release
Agency: AK Dept. of Fish & Game

FORM 4B
Equipment
DETAIL

00139 A2

Project Title: Port Dick Creek Tributary Restoration and Development Project.

Project Number:	00139-A2.
Restoration Category:	General Restoration.
Proposer:	Alaska Department of Fish and Game.
Lead Trustee Agency:	Alaska Department of Fish and Game
Cooperating Agency:	
Alaska Sea Life Center:	
Duration:	5th year, 5 year project
Cost FY 00:	$47,000
Cost FY 01:	$15,000
Cost FY 02:	$5,000
Geographic Area:	West Arm Port Dick Bay, Outer Gulf Coast of Southern Kenai Peninsula.
Injured Resource/Service:	Pink and Chum Salmon. Lost or reduced commercial fishing services.

ABSTRACT

Port Dick Creek, located 25 miles southeast of Homer on the outer coast of the Kenai Peninsula is an important pink and chum salmon producer in Lower Cook Inlet (LCI). Because the stream experienced declines in total returns since 1987, the Alaska Department of Fish and Game (ADF&G) conducted a five-year feasibility analysis and initiated EVOS-funded efforts to restore spawning habitat in two former tributaries taken out of production by the 1964 Alaska earthquake. Approximately 3,000 m^3 of material was excavated from both tributaries and since 1996, over 3,300 pink and chum salmon have colonized and spawned in the new habitat. To date, spawning adults of both species potentially deposited over 5,000,000 eggs with over 458,000 fry estimated emerging from the tributaries. Additional sedimentologic parameters (bedload transport, accumulated sediments and gravel/cobble transport rates) will be further evaluated to support the stability analyses of the Port Dick Creek salmon restoration project.

INTRODUCTION

In 1991, the Alaska Department of Fish and Game, (ADF&G) Commercial Fisheries Management and Development Division (CFM&D), conducted restoration surveys (R105) on the outer coast of the Kenai Peninsula to identify pink salmon *Onchorynchus gorbusca* and chum salmon *Onchorynchus keta* spawning systems that would benefit from instream habitat restoration. Port Dick Creek, located within Kachemak Bay State Wilderness Park approximately 25 miles southeast of Homer (Figure 1) was chosen because 1) it is considered one of the more important wild pink and chum salmon production streams in the Lower Cook Inlet area; 2) the 1964 earthquake caused an uplift of material within two tributaries of Port Dick Creek that virtually eliminated the available spawning habitat in existence prior to the earthquake (Val McLay, personal communication); and 3) the total return of chum salmon to Port Dick Creek has declined in recent years.

The total return (catch & escapement) of Port Dick Creek Chum salmon has averaged only 4,600 fish for the ten year period, 1989-1998, compared to the previous 15 year period (1974-1988) of 31,000 fish (Figure 2). A complete closure on directed commercial fishing for Port Dick Creek chum salmon has been in effect since 1994 and the biological escapement goal, established at 4,000 fish, has been met only twice since 1988 ADF&G (*in press*). The primary species targeted is the native chum salmon of Port Dick Creek, although, pink salmon will also benefit from the instream restoration project.

The goal of the restoration project is to reverse the decline in chum and pink salmon stock abundance and provide for a harvestable surplus as a mitigative measure to address the results of the *Exxon Valdez* Oil Spill (EVOS). If stable surface water can be restored within the two Port Dick Creek tributaries, then annual fry production of 500 and 297 fry/m^2 can be expected at a spawning density of 1.0 female/m^2 for pink and chum salmon respectively (McNeil, 1969; Heard, 1978; Lister et. al, 1980; Bonnel, 1991).

The two intermittent but largely subterranean tributaries of the Port Dick Creek watershed were selected for restoration as shown in Figure 3, and designated as the primary and secondary tributaries. The larger primary tributary intersects Port Dick Creek near the high tide line and receives its surface water flow from a small lake of less than 4 ha. at an elevation of 300 m. Prior to the 1964 earthquake, the historic primary tributary successfully produced pink and chum salmon (Val McLay, Homer fisherman, personal communications). The lower 150 m of the primary tributary was affected by uplift from the earthquake, causing a stable surface water system to become a dry streambed of large gravel and cobbles from subterranean flow during times of average to low discharge. The nearby secondary tributary shown in Figure 3 also had intermittent surface water flow due to fluctuations in the alluvial water table. Previous to restoration there was no evidence of salmon spawning within the secondary tributary; however, it provided an opportunity to create additional spawning habitat within the Port Dick Creek drainage. Feasibility studies conducted from 1991 through 1995 were designed to determine the suitability of excavating the tributaries to increase spawning habitat. The studies revealed that during the winter months surface water withdrew 10-80 cm below streambed level in the primary tributary and 10-30 cm in the secondary tributary (Dudiak et al., 1996). The tributaries were carefully designed from the collected data to withstand two extremes, low and high water events with a goal of sustaining long term salmon habitat.

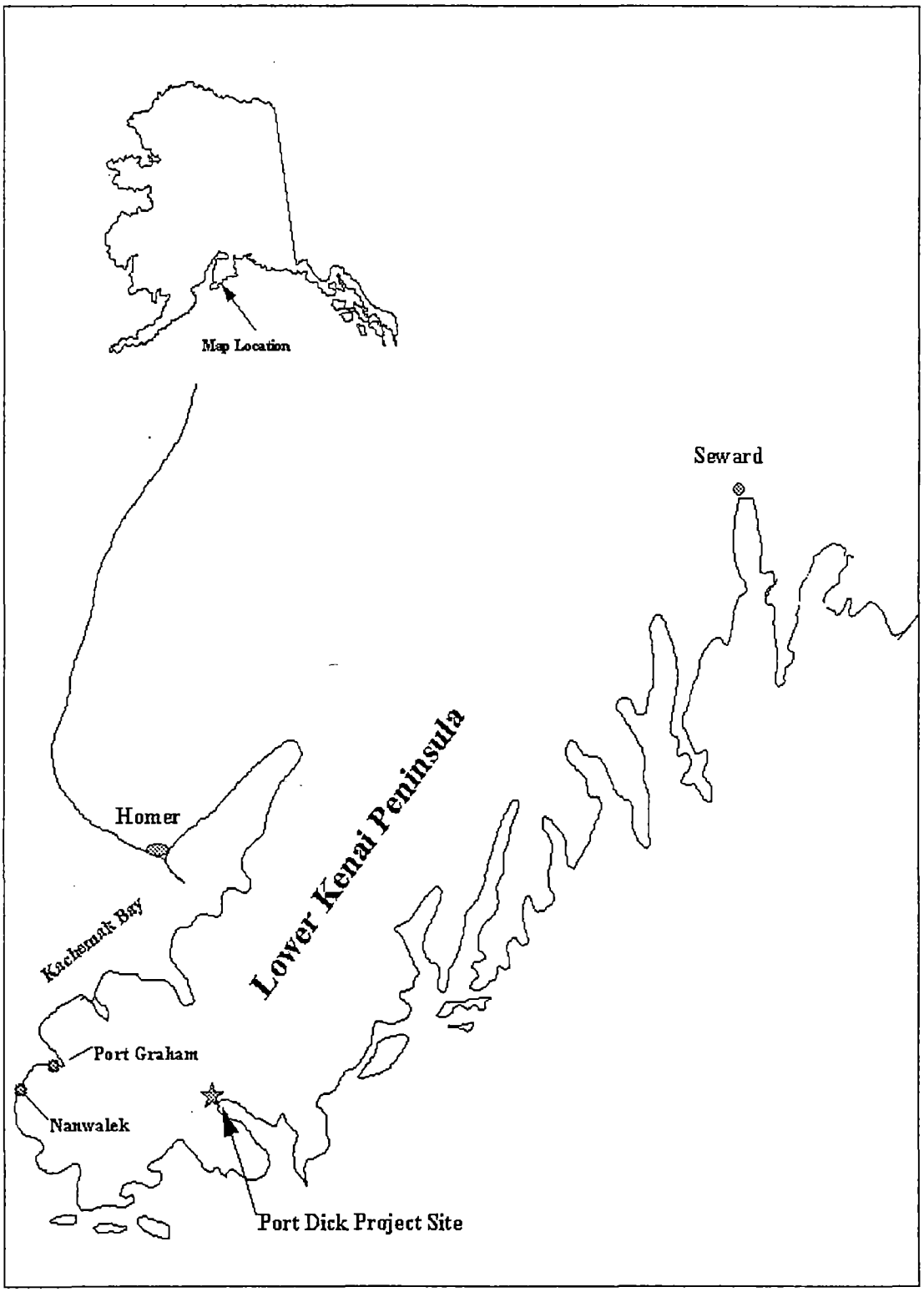

Figure . Map of the outer gulf coast of the Kenai Peninsula showing the location Port Dick Project site.

In June of 1996, approximately 3,000 m^3 of deposited material was excavated from both tributaries creating up to 2,500 m^2 of stable spawning habitat. In July and August 1996, an estimated 1,229 pink and 466 chum salmon colonized and spawned in both tributaries depositing an estimated 1,517,935 pink and chum salmon eggs. The following spring ADF&G field staff enumerated 146,936 pink and 131,519 chum fry from the primary and 34,405 pink fry from the secondary tributary for a total of 312,860 fry. Colonization and spawner abundance for the subsequent years 1997 and 1998 were estimated at 938 and 3,361 pink and chum salmon, respectively from both tributaries. Mean length at emergence for chum (39.2 mm) and pink fry (33.9 mm) falls within the size range expected for emergent chum and pink fry throughout their Pacific range as discussed in Groot & Margolis (1991).

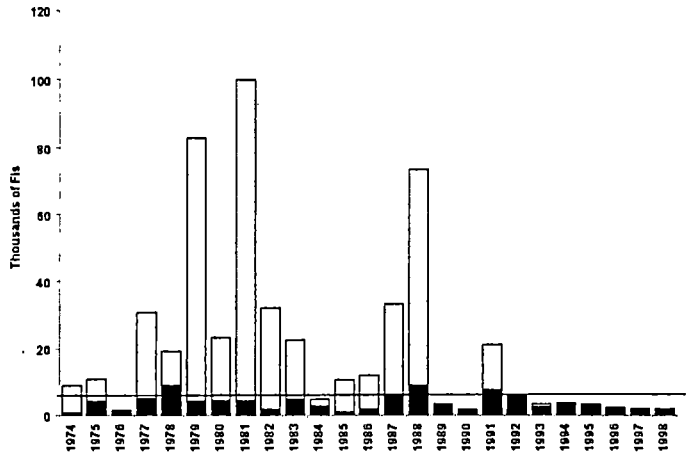

Figure 2. Total return (catch & escapement) of Port Dick Creek Chum Salmon, 1974-1998.

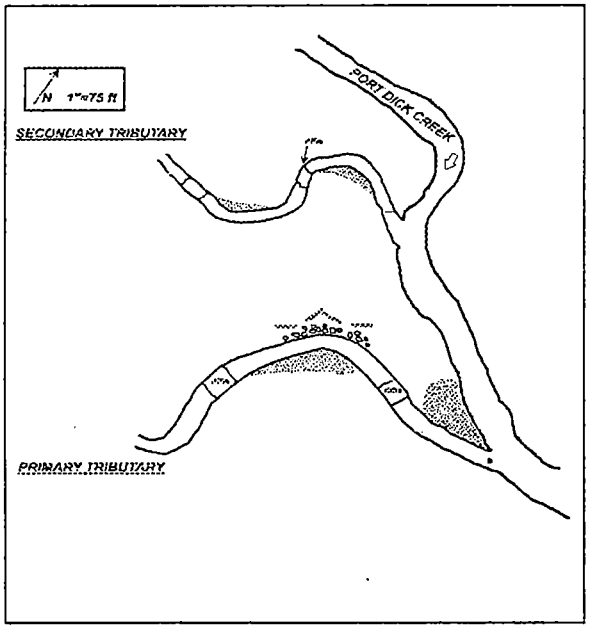

Figure 3. Diagram of the Primary and Secondary Tributaries entering Port Dick Creek.

The tributaries were designed from data collected from the feasibility analysis to withstand two extremes, low and high water events, with a goal to sustain spawning channel stability. Project evaluation is limited to overall survivability, i.e. spawning success as measured by fry production. Additional project success is evaluated through long term monitoring and evaluation of the physical stability of the tributaries by evaluating sediment and bedload transport as well as the stability of riffles and streambanks in the project site area. This is the fifth year of a five-year project funded by the EVOS Trustee Council. The five year feasibility study, 1991-1995, was jointly funded by ADF&G and the EVOS Trustee council.

NEED FOR THE PROJECT

A. Statement of Problem

The targeted resource is the wild pink and chum salmon stocks of Port Dick Creek, in the West Arm of Port Dick Bay. Benefits realized from the restored spawning habitat will accelerate the recovery of the currently depressed wild pink and chum salmon stocks of Port Dick Creek. The total return of the Port Dick Bay chum salmon has averaged only 5,000 fish for the nine year period, 1988-1997, compared to the previous 15 year period (1974-1987) of 31,000 fish. The minimum spawning escapement goal at Port Dick Creek for chum salmon, has been met only twice since 1988 (ADF&G. 1996). Lost or reduced commercial fishing services would also be expected to benefit the LCI area from the increased salmon production at Port Dick Creek. The exvessel value of harvested pink and chum salmon would also serve as a base for the economic multiplier effect in nearby communities through processing and other fishery related services.

Success of the recently restored tributaries depends on a wide variety of physical parameters. Without adequate monitoring of temperature, water level and in some cases water velocity and salinity it would be difficult to compare fry survival rates to the expanded and restored and changed spawning habitat during the monitoring period, for example. During the design and construction planning stage of the tributary systems it became apparent that bedload transport was an additional important and compatible system that should be monitored. Long term shifting of the spawning channel gravel and sediment is expected and important to characterize for the future of such projects.

B. Rationale/Link to Restoration

The ultimate goal of this project is to restore the wild pink and chum salmon stocks of Port Dick Creek. The major hypothesis relates to the theory that the major survival problem occurs during the instream incubation and residence period for both chum and pink salmon. It is theorized that survival problems are caused by the unstable nature of the spawning habitat within the mainstream of Port Dick Creek. There has been a substantial investment, to date, by the EVOS Trustee Council and ADF&G to restore the spawning habitat at Port Dick Creek. This proposal will continue to thoroughly evaluate the effectiveness of this restoration project for publication, given the projected importance of stream restoration projects in the future.

In order to fully achieve the goal of restoration of the wild stocks, several parameters must be monitored to evaluate the success of the project. For example, the chum and pink salmon life history are similar, in that the females of each species migrate upstream to spawn in the summer and fall. They create a gravel cavity or redd and deposit their eggs until they emergence as fry in the spring. Clearly the stability of the gravel substrate is an important habitat component that should be monitored in light of the changed post construction streambed hydraulic parameters (streambed slope, meander curvature, placement of riffles and point bars).

Due to the fact that salmon fry emergence occurs in the spring and a salmon run occurs in the summer, it is apparent that the salmon life cycle essentially requires year-round hydrologic monitoring to properly evaluate the spawning channel project. Long term data adjustments have

been made, such as the addition of a third water level monitoring station, additional riffle and streambed elevation monitoring and the addition of an offsite sediment trap.

C. Location

Port Dick Creek is located on the Outer Gulf Coast of the Kenai Peninsula on the exposed coastline of the Gulf of Alaska. The area is characterized and influenced by the warming effect of the maritime currents of the North Gulf Coast, and annual rainfall can exceed 60 inches (ADNR 1994). The predominate vegetation type of the Port Dick Creek drainage is Sitka Spruce and Western Hemlock forest and is considered climax. Sitka Spruce in this area commonly reach a diameter of 24 inches. The creek corridor is narrow (less than 250m) with adjacent slopes in excess of 30% grade. Port Dick Creek is a fresh water creek with the headwaters originating 2 miles to the west of tide water. The soil at the project site is alluvial being poorly drained and low in organic matter.

COMMUNITY INVOLVEMENT

The Alaska Department of Fish and Game is the lead trustee agency for the Port Dick Creek project. A scoping meeting was held in Anchorage at the Alaska Department of Fish and Game Office, 333 Raspberry Road on June 19, 1995. ADF&G (Commercial Fisheries Management and Development Division) communicated with the U.S. Forest Service and ADF&G (Habitat and Restoration Division).

This project was reviewed by the *Exxon Valdez* Trustee Council (TC) in April 1995 and approved the project pending federal NEPA requirements be satisfied prior to further funding. State of Alaska members on the Trustee Council include the Attorney General, and the Commissioners of ADF&G and the Department of Environmental Conservation (DEC). Federal agency members include representatives of the U.S. Departments of the Interior and Agriculture and the National Oceanographic and Atmospheric Administration (NOAA). As part of the review process, the EVOS Trustee Council Public Advisory Group (PAG) reviewed this salmon instream habitat and stock restoration project in 1994 and 1995 prior to preparing recommendations to the Trustee Council. The PAG unanimously approved this type of project in 1994. In 1995, the PAG made no motion to approve or disapprove this project, however the project had received strong public support. In addition, conclusions from the Trustee Council Wild Stock Supplementation Workshop in January 1995 also supported this project. Questions concerning goals, linkage to injury and benefit/cost were addressed and incorporated into the proposal.

A public hearing on the proposed Port Dick Restoration project was held in Homer in April, 1995, by the Oil Spill Restoration Office. There were no negative comments and most people voiced support for the project.

The proposed project has been listed in the Quarterly Chugach National Forest, schedule of proposed actions for environmental analysis since July 1995. This project, among others, is briefly described for interested parties at over 280 addresses. No comment has been received from this effort.

A letter summarizing the scoping meeting and the potential issues was drafted and sent to the U. S. Forest Service and other concerned parties. The letter elicited responses from the following: the Cook Inlet Regional Planning Team (CIRPT), Kenai Peninsula Borough Coastal Management Program and members of the Cook Inlet Seiners Association (CISA). All three organizations have endorsed the project.

Mr. Roger MacCampbell, District Ranger for the Kachemak Bay State Wilderness Park (KBSWP) has received a draft copy of the Environmental Assessment written for the Port Dick Project. Mr. MacCampbell has responded with written comments and found no objections to the implementation of the proposed action. Mr. Wayne Biessel, Park Ranger for the KBSWP, recently visited the site on the invitation of the project team (January 8, 1999).

In addition to the above community involvement, the marine biology class of the Homer High school in cooperation with ADF&G, entered into a program to test and evaluate instream salmon egg incubators. The incubators were to be used for supplemental colonization at Port Dick Creek should they be needed. The high school class secured a fish transport permit and actually incubated salmon eggs in the incubators in Fritz Creek near Homer.

In December 1996, a slide presentation of project accomplishments was presented at the annual Lower Cook Inlet Seiners Association Membership meeting. It was well received and won unanimous support.

PROJECT DESIGN

A. Objectives

(October 1, 1999 through September 31, 2001

The primary and secondary tributaries were excavated in June 1996. Objectives included in this proposal are designed to continue to evaluate project success through spawning success and long term sedimentologic stability as related to these tributaries.

1. Analyze collected data from the 1999 field season.
2. Prepare and develop draft copy of final report for submission to the Chief Scientist for review.
3. Concurrent objectives include preparing a draft copy for a peer-reviewed article. Anticipated journal(s) include *Transactions of the American Fisheries Society, The North American Journal of Fisheries Management and Journal of Hydrology.*
4. Continue to evaluate the success of the restored tributaries through sediment transport parameters on a bi-monthly basis.
5. Prepare long term monitoring results for peer review and evaluation in preparation for publication.
6. Monitor and evaluate water/tributary parameters including proposed sediment transport parameters on a bi-monthly basis

B. Methods

Part B, *Physical Parameter Evaluation*

Because this is a closeout fiscal year for this project, and due to the infrequent onsite gravel transport events common in gravel-bedded streams (e.g. Andrews and Nankervis, 1995), it is important to continue to obtain the proposed field data for the final report. This data will greatly assist the analyses for the final report, in addition to providing the invaluable long-term monitoring of spawning channel restoration stability.

Following excavation of the tributaries in June, 1996, 4 types of sensors were installed: water temperature, level, velocity and conductivity. Figure 4 shows the general measurement locations and field arrangement of the equipment. Project methods for FY/00 will continue to measure spawning channel bed-load sediment transport that will address the stability of the spawning habitat created through the restoration project.

The changing channel geometry after construction and sensitivity of salmon eggs to water level necessitates monitoring of water levels after the spawning habitat was restored. The changing channel geometry after construction and sensitivity of salmon eggs to water level necessitated monitoring of water levels after the spawning channel was constructed. This data is collected using pressure transducers accurate to 0.01 ft of water within the pressure range expected at the site.

The transducers measure pressure relative to atmospheric pressure so that atmospheric pressure effects need not be taken into account. The water level measurement scheme is shown in Figure 4, where the transducer strandpipes are situated in the stream bank.

Temperature is measured to an accuracy < 0.4 C at least every hour, in both surface water and in the spawning gravel of both tributaries. Temperature effects on salmon cited in the literature (e.g. Pauley, 1988; Wangaard, 1983) correlate fry survival rates to temperature using similar accuracy. Temperature is one of the spawning channel performance criteria, and therefore is monitored in both spawning gravel and surface water.

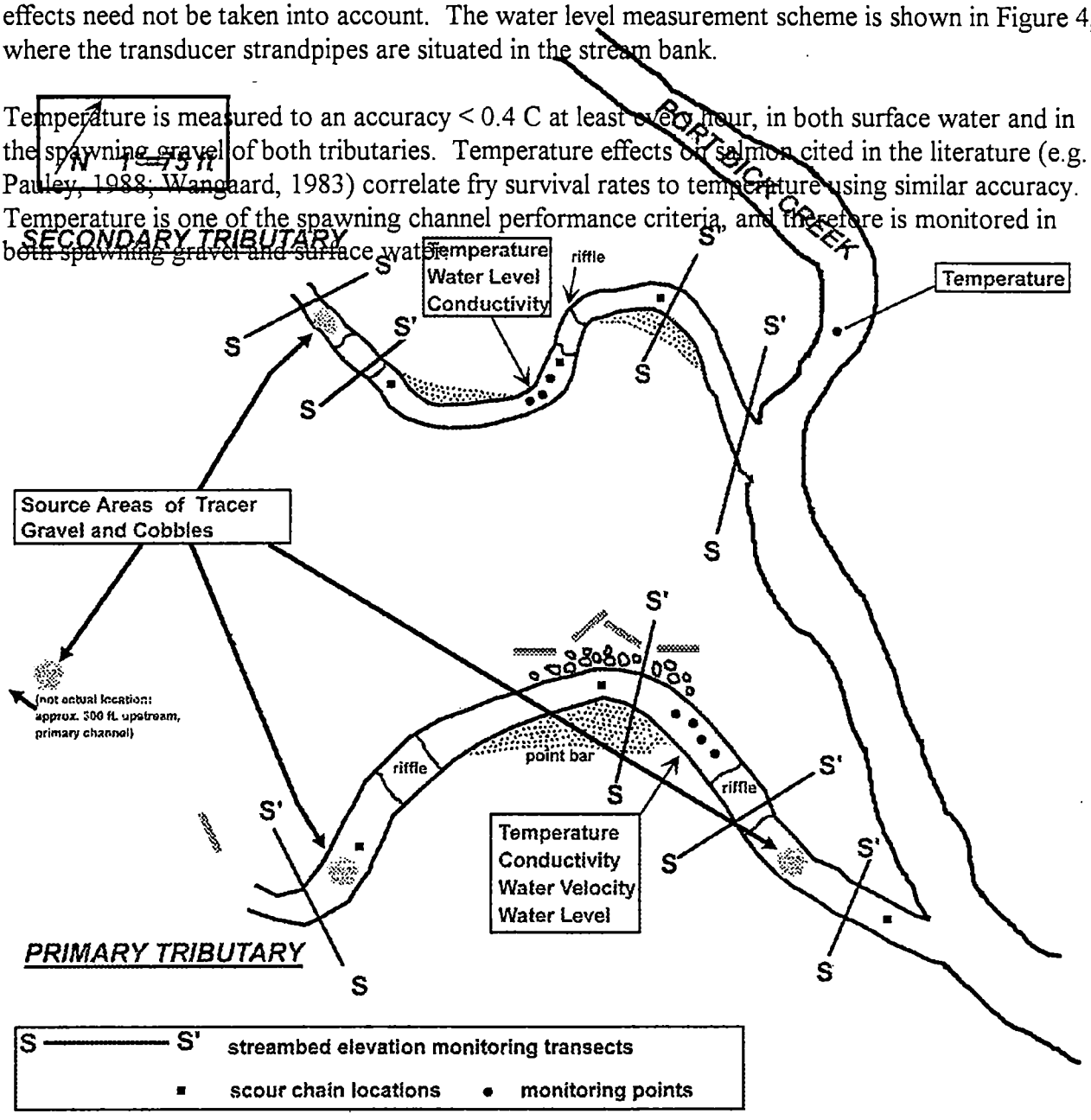

Figure 4. Physical and Hydrologic Parameter Monitoring Locations

Temperature monitoring locations are shown in Figure 4. There are expected to be some temperature differences between the lower reaches of the spawning channel and the upper reaches, particularly in summer and fall months. The variation of temperature with depth in the spawning channel is not thought to be significant due to the turbulence of the water. The spawning gravel temperature probes are secured within the top 10 cm of substrate to facilitate comparisons of spawning gravel conditions as part of the long term monitoring. An additional temperature monitoring point in Port Dick Creek is used to provide a comparison to the known chum and wild pink salmon runs in that reach as shown in Figure 4.

Water velocity measurements are a long term spawning channel performance criteria because low and high stream velocities can both adversely affect chum salmon. Spawning adult chum salmon use water with velocities varying between 46 and 101 cm/sec (Pauley, 1988). Streamflow therefore regulates the amount of spawning area available: increased flow covers more gravel, thus making more suitable spawning substrate available. Higher stream velocities erode the substrate and suitable spawning is decreased.

In addition, salmon eggs require sufficient water velocities to keep the stream well-oxygenated, protect the streambed from freezing temperatures, and to remove waste metabolites (CO_2). Siltation is a major cause of egg and alevin mortality as mentioned previously, which is directly correlated to stream velocity. The current meter used is a non-mechanical flowmeter, which has the required accurate window of measurement of between 0.01 and 5.0 meters per second.

The salinity effects of tides are now well understood for the measurement points, however these sensors will remain useful in distinguishing tidal influences during flood events. Salinity is correlated to conductivity which is the parameter actually measured. Sea water has a conductivity of approximately 40 to 50 msiemens, which requires an electrode spacing much greater than conductivity sensors for fresh water. The conductivity meter used is calibrated from fresh water to full strength sea water, however the electrode spacing is designed for discerning salinity changes in the spawning channel. The conductivity sensors are attached to the temperature sensors in the substrate at approximate locations shown in Figure 4.

The datalogging equipment used by the sensors easily retains measurements every 30 minutes for 2 months, and a solar panel was added to increase the battery life. Several rapid sampling intervals will again be monitored to obtain more information on tidal and flood events, and an attempt to do this using datalogger programming can now be made. This will help interpret both the biologic and sedimentologic events recorded already.

The datalogging equipment is rugged, and can operate under conditions ranging from -55 to +80 degrees centigrade. Dataloggers and power supplies are housed in fiberglass reinforced and humidity controlled field enclosures for long term monitoring. CGS provides a researcher in the field to provide for situations that have required a change in monitoring objectives, programming and repair of equipment in the field.

Part C, Sediment Transport and Spawning Channel Stability Evaluation:

The stability of stream channels and banks substantially affects the quality of riparian and aquatic habitats. Stream stability is affected by channel morphology and channel material (Myers et al., 1992), both factors of which were changed during spawning channel excavation. The benefits of characterization of sediment transport in the gravel-bedded channels can range from moderately helpful to extremely important.

Sediment and bedload transport in gravel-bedded rivers has received far less attention in the published literature compared to stream channels of finer grained sediments. One reason for this is that spawning gravel and cobbles are typically transported as bedload only by large and infrequent discharges (Andrews and Nankervis, 1995). Discerning the effects of altering a gravel-bedded stream channel on sediment transport and deposition can be a side benefit from the data of this study useful for future spawning habitat rehabilitation projects.

The Port Dick Creek salmon spawning channel construction project has provided a unique sedimentologic study of the effectiveness of this restoration project. Four methods typically used in detailed sediment transport studies of gravel-bedded streams are being used for this project. The methods are designed for inexpensive long term monitoring in conjunction with the hydrologic parameter monitoring. The four methods include measurement and comparison of changes in surveyed stream transects, use of tracer cobbles and gravel, measurement of changes in scour chain orientations and measurements of surface water energy slope. The implementation and justification of each technique is described below.

Stream Transects

Measuring the variation of parameters across a section of a stream channel as depicted in Figure 4 can be a very useful way to monitor streambed stability. Numerous studies have used this technique successfully, e.g. Jacobsen, 1995 in AGU Monograph 89. *Dietrich and Whiting 1989* concluded in their work with gravel-bedded rivers that monitored stream cross sections were very useful for the study of gravel transport. Transects are also useful in the hydrologic parameter objectives for this project for determining estimates of egg mortality due to erosion (McNeil, 1965), an important performance criteria, and which is of particular interest in the few years following excavation of the spawning channel. Therefore monitoring stream transects is an important parameter to consider for all objectives of this project.

Streambed elevation along a transect has been useful for monitoring net erosion and sedimentation of the streambed. The elevation and position of each point along a cross section is obtained using a total station, and compared to previous cross sections to determine a sediment budget. It has also been useful to obtain streambed elevations between and upgradient of the cross sections as another way to determine the long term streambed changes and streambed gradients at the site.

Many studies find streambed elevation changes useful over the very long term by monitoring waves of sediment as they flow by a station (Jacobsen, 1995). In this case the study will be useful in

determining relatively short-term changes (a few years) that may be reversed or enhanced by small alterations in the spawning channel geometry.

Certain upgradient cross sections may be affected by the drainage caused by moving the seepage face from the spawning channel sites to upgradient areas. This may mean a cross section will not receive flow at low to average discharge. It is recommended that some of the water velocity measurements used for obtaining the important discharge parameters be taken in the stream channel far upgradient from both channels. This value would be useful to compare to onsite discharge measurements, particularly for a dramatically 'losing' (recharging) stream. Depth-integrated water velocity measurements (using two measurements per station) are more accurate for discharge calculations, though frequently the water is too shallow to apply more than one value (CGS uses the 60% depth for single measurements).

Near-bed water velocity is a novel parameter that can be monitored using an on-line water velocity probe. The bed shear velocity, a parameter important in gravel-bedded stream sediment transport models, may be estimated using near bed velocity (Wilcock, 1996). This can also be done with the local shear stress parameter. These parameters are important in calculating scour or deposition rates and other channel changes. CGS maintains two Price-type meters, but does not recommend using these mechanical gauges for online monitoring since they need frequent calibration and can easily get fouled (Pitlick, 1992). Other studies have found non-mechanical water velocity devices useful for gravel bedded river measurements (e.g. Dinehart, 1992).

Bedload sampling has the valuable advantage of directly sampling the rate of bedload transport along the streambed for a given measured discharge, however this method does not work well unless sufficient discharge is available for transport, particularly a problem for gravel transport which has longer residence times as mentioned previously. Since this type of sampling is only useful for monitoring the gravel component of bedload transport if significant flow events are occurring, a third water level monitoring station was added to help determine when gravel transport events would be occurring. A bedload sediment trap was added far upgradient of both channels to assist in monitoring the boundary sediment transport rate.

Surveyed markers and marked trees are used to locate stream transect sections. A surveyor tape is stretched between the markers for horizontal reference. Streambed elevations are then measured to ~0.01 ft with the total station at approximately 2 foot intervals across the transect. This is a standard method for monitoring changes in streambed morphology with time, compatible with other detailed studies of stream sediment transport in gravel-bedded streams (e.g. Jacobson, 1995). Eight such transects are currently being used, with approximate locations shown in Figure 4. Subsequent transects will show how much the stream channel adjusts to the designed spawning channel, particularly after high discharge events.

Tracer Gravel

Tracer gravel and cobbles are being used to determine rates of gravel transport, of particular concern for determining the performance of the constructed spawning channels. Port Dick Creek tributary gravel and cobbles were constructed into the tracer material. Some of the gravel used is

in the range useful for salmon spawning grounds. The cobbles and gravel were marked using holes drilled in the material and filled with numbered copper discs and epoxy (the tracers must be unobtrusive, yet easy to find). The shape of the tracer material was as rounded as possible in order to reduce shape-induced uncertainties in the course of their movement (Cavazza, 1981). Approximately 400 new tracers have been constructed with Aluminum markers and are scheduled to be placed in the field in FY2000.

The 700 original tracers were weighed, and then carefully replaced with other gravel along the marked stream source areas shown in Figure 4. The tracers are being relocated periodically with a metal detector to determine the amount of movement from the source area for the specific tracer material during periods of high discharge. Significant movement of the tracers has been shown to occur only during significant flood events (Coble et al., 1999). Each tracer will be re-weighed periodically throughout the long-term monitoring, and re-deployed to the source area if found near the mouth of either tributary.

Results from tracer tests are also of fundamental value in characterizing the size and rate of bedload transport averaged between monitored periods. The tracer data have determined accurate rates of bedload transport by comparison to the continuously monitored water level and stream velocity parameters. These direct measurements of gravel and cobble transport are useful for determining construction techniques for future spawning channel projects in gravel-bedded streams.

The movement of bed load is complex, intermittent and yet very important to the understanding of problems this project poses. Gravel morphology and density play an important role in the entrainment of gravel, so use of onsite gravel is a good choice for tracer material, particularly since the data is to be published as part of the stability evaluation. Different sized gravel can be used for comparisons to a size-selective tracer study such as Ashworth et al. (1989). Bridge et al. (1992) show why tracer densities and tracer dimensions are important for studying the results of tracer transport, so the lengths of the orthogonal gravel axes and specific gravity were measured for each tracer for completeness. Hassan et al. have also had success using tracer gravel in gravel-bedded streams to calculate gravel transport rates.

Scour Chains

Use of scour chains continues to be helpful in addressing long term streambed stability. Scour chains are an inexpensive method for determining the thickness of bed mobility (depth of scour and depth of fill) following high discharge events. The scour chains consist of vertically oriented and weighted stainless steel link chain (1 inch links). The chains are periodically located and unburied; the length of horizontal chain and depth to the chain are recorded, and the chain reoriented vertically for the next high discharge event. This allows the evaluation of scour events such as the depth of bedload scour and subsequent sediment burial thickness. Such maximum-event data helps determine the mobility of sediment during high discharge (Gordon et al., 1992). The amount of bedload transport from a flood event can be estimated with scour chains in combination with stream elevation cross sections, tracer gravel and cobbles.

Scour chains are useful in estimating the amount of bed material eroded as a measure of salmon egg mortality. McNeil (1965) used ping pong balls buried vertically for this purpose, but had problems estimating scour depth when losing all of them in one location. The advantage of scour chains is they can be straightened and re-buried vertically quickly, and they can be relocated using a metal detector. Scour chains are useful in conjunction with stream elevation transects to understand the history of sediment transport between site visits.

Sediment Transport Analyses

There are many types of sediment transport analyses that benefit the spawning channel project both directly and indirectly. Although this project focuses on sediment transport as it affects the stability of the Port Dick Creek spawning channel project, a concurrent proposal would use the obtained data to determine a fieldwork and design program for future restoration sites in support of resource management.

One of the concerns prior to the Port Dick Creek tributary spawning channel rehabilitation was the effects of large gravel size and streambed armoring on pink and chum salmon spawning habitat. There have been a number of direct studies involving salmonids that compare onsite gravel sizes to those preferred by salmonids or to recognize the influence salmonids have on fluvial gravel size (Kondolf, 1993). There have even been studies of gravel morphology on salmon egg mortality (Meehan, 1977).

Perhaps more importantly, however, are concerns over the long term stability and viability of the spawning channels. The best way to approach this is to use onsite data from the sediment transport monitoring is to calculate basic sediment transport parameters via a variety of simple to complex techniques. These sediment transport parameters are often used in surface water models to help answer questions concerning the long term streambed stability. Of additional concern is the ability for the channel to maintain its water depth and to determine what changes in the channel geometry could be made to improve the streambed stability. Comparison studies can also be made with other gravel-bedded stream studies in the literature.

The 'flushing flow' discharge from hydroelectric projects is a current matter of intensive research. This 'flushing flow' is on a small scale directly related to the critical discharge necessary for bedload transport in gravel-bedded streams (e.g. Kondolf, 1990). Other basic parameters that must be derived from onsite data have been discussed previously (shear stress, sedimentologic characteristics, stream width, stream depth profile, variations in discharge etc.). Calculation of parameters as basic as discharge in gravel bedded streams are still a matter of research (e.g. Bridge, 1992), particularly where there are many obstructions as is the case upgradient of the spawning channels.

Models that use the parameters for gravel-bedded streams are continually being refined, researched and published. For example, Bridge et al. recently published a basic sediment transport model for gravel-bedded streams that includes the critical discharge parameter, Hassan et al. proposed a model for gravel movement using tracer data (1991) and a model for the mixing of bedload downgradient from a source area (1994). Dietrich and Whiting (1993) have worked with models

that include meanders in gravel bedded rivers, an important component at this site, and Pizzuto (1991) published an important model concerning gravel channel widening predictions and the importance of sediment supply from streambanks. In addition there are valuable published data sets for comparison studies available for gravel bedded flow, for example from laboratory flume studies (e.g. Pizzuto, 1990).

A final subject that is of interest to the site is studying the influence of small and large drop structures and their effect on gravel sediment transport in evaluating the Port Dick spawning channel project. These topics often appear in the context of bridge construction, since bridges frequently must be founded on erodible material. The scour of a gravel-bedded river is different at the location of a drop structure, so a variety of studies (e.g. Laursen et al., 1984) indicate the stable sediment size at sloping sills and erosion depth directly below drop structures.

Laursen et al. (1984) proposed a model for the size of riprap needed on the face of a sloping sill similar to the seepage face on the primary tributary. Elements of more specific papers on drop structures can also be useful in deriving models that describe sediment transport at drop structures (e.g. Humpherys, 1986; Fiuzat, 1987; Christodoulou, 1985). A related topic is streambank stability analyses (e.g. Chang, 1990). These topics are useful to keep in mind should future channel changes be deemed necessary, and for further research to support resource managers.

Mr. Coble has spent his 12-year hydrologic career as a specialist in numerical modeling, and looks forward to applying his knowledge and experience to the interesting problems presented by the Port Dick Project, as might be expected. Monitored hydrologic and sedimentologic parameters as they relate to the Port Dick Creek tributary salmon spawning habitat and stream channel construction are planned for publication in peer-reviewed publications such as Water Resources Bulletin, Hydrologic Sciences Journal and/or the Journal of Hydrology. Information transfer to resource managers through analyses is the subject of the concurrent Port Dick proposal.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The actual excavation/restoration of the tributaries was contracted out to the private sector in FY/96. The physical parameter monitoring and the studies to evaluate the stability of the excavated tributaries are contracted to Coble Geophysical Services of Homer.

SCHEDULE

A. Measurable Project Tasks for FY/00 (October 1, 1999 - September 30, 2000)

Continuous through 2000:	Monitor hydrologic parameters within restored tributary e.g. water temperature, velocity, salinity and level. Monitor bedload transport, accumulated sediments and gravel/cobble transport rates. Certain bedload transport activities proposed continuous through 2002.

10-1-99 through 4-1-00	Fall- measurement of riffle elevations, streambed scour and sedimentation.
10-1-99 through 4-15-00	Data analysis and preparation of draft of final report as well as draft of journal article.
4-16-00 through 9-31-00	Address editorial comments from the Chief Scientist and journal editors on draft report.

B. Project Milestones and Endpoints

- Collect final riffle elevations, streambed scour and sedimentation data for analysis and inclusion into final report. **November 1999.**
- Analyze collected field data and submit draft copy of final report to Chief Scientist for comment, **April 15, 2000**
- Submit draft copy of article to peer-reviewed journal; tentative journal(s) *Transaction of the American Fisheries Society, North American Journal of Fisheries Management and Journal of Hydrology*, **April 15, 2000.**
- Submit final report on or before **April 15, 2001**.

C. Completion Date

Final report due April 15, 2001. Additional monitoring of sediment transport parameters is proposed through 2002 (separate proposal, FY01) to monitor channel stability as a basis for publication/research and possible transfer of information to resource managers.

PUBLICATIONS AND REPORTS

For FY/00 we will have results showing the chronology of the newly restored Port Dick Creek tributary spawning habitat available for possible report publication. Monitored hydrologic and sedimentologic parameters as they relate to the Port Dick Creek tributary salmon spawning habitat and stream channel construction are planned for publication for FY/00 in either the *Transactions of the American Fisheries Society, North American Journal of Fisheries Management* or the *Journal of Hydrology*.

PROFESSIONAL CONFERENCES

The conferences that we anticipate attending include the annual Exxon Valdez Oil Spill Trustee Council Restoration Workshop, the annual AWRA-Alaska conference (Mr. Coble will present more results at the April 12th, 1999 AWRA Conference in Juneau, Alaska) and the Fall 1999 American Geophysical Union (AGU) meeting. Results are also planned for presentation at an appropriate International

Association of Hydrological Sciences symposium to be included in their published proceedings. The project team includes members of these organizations and other professional organizations.

NORMAL AGENCY MANAGEMENT

The Department of Fish and Game does not have the funding ability to respond to unforeseen crisis events such as the *Exxon Valdez* Oil Spill, which impacted the Port Dick area with moderate to heavy oiling. The Port Dick Creek restoration project was originally funded by the Trustee Council in 1991 and is currently funded in FY/97 to conduct project evaluation.

The project was originally proposed to facilitate restoration of the depressed Port Dick Creek pink and chum salmon stocks. This is the first spawning channel/spawning habitat restoration project conducted in the Lower Cook Inlet area.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This instream habitat restoration project is the only commercial fisheries EVOS related project on the Outer Gulf Coast of the Kenai Peninsula currently being considered for further funding.

PRINCIPAL INVESTIGATOR

Wes Bucher
Mr. Bucher is the finfish area management biologist with the Alaska Department of Fish and Game in Lower Cook Inlet. He has worked for the Department as a fisheries biologist since 1971 serving in several capacities throughout Cook Inlet and Bristol Bay. While he has been responsible for a variety of fishery research and management programs ranging from hydroacoustics, limnology, rehabilitation and enhancement, most of his recent work has involved management of commercial salmon and herring fisheries.

OTHER KEY PERSONNEL

Project Manager
Mark Dickson, Fish and Wildlife Technician IV.

Mr. Dickson has been employed as a fish culturist and fish and game technician with the Alaska Department of Fish and Game for the past 20 seasons. He has considerable experience in fish cultural practices in the field and in the hatchery management projects that restore and enhance sport and commercial fisheries in the Lower Cook Inlet area. Mr. Dickson has worked in the Lower Cook Inlet area participating in and managing salmon restoration projects.

Geoff Coble, Project Geoscientist and Engineer

Mr. Coble is currently the owner and manager of CGS, a local firm specializing in water resources geophysics. Mr. Coble has a multi-disciplinary and academic approach to his career, combining three college degrees in Water Resources Science, Geology and Geophysics with water resources numerical modeling as a specialty. The fact that basic questions concerning transport of gravel in gravel-bedded streams remain unanswered, combined with the unique complexities of this site make it an ideal research project for Mr. Coble.

The Port Dick Creek sedimentology project was selected and defined based on the strengths of Mr. Coble and the value of the project for research. Mr. Coble has a long record of presenting his work for peer review, and has already made agreements for project review with other nationally published experts in hydrology and sediment transport.

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2000 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 2001	Estimated FY 2002				
Personnel	$44.0	$8.6						
Travel	$0.6	$0.6						
Contractual	$31.0	$34.1						
Commodities	$1.4	$0.0						
Equipment	$0.0	$0.0						
Subtotal	$77.0	$43.3						
General Administration	$8.8	$3.7						
Project Total	$85.8	$47.0	$17.0	$5.0				
Full-time Equivalents (FTE)		0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Projected year 2001 funding:

1 month @ $4300.00 to address editorial comments from peer-reviewed journal: anticipated journal(s), *Transactions of the American Fisheries Society, The North American Journal of Fisheries Management.*

$750.00 for page printing costs

General adminstration costs as well as contractual costs incurred to finish peer-reviewed article.

FY00

Prepared:

Project Number: 00139-A2
Project Title: Port Dick Creek Tributary Restoration
Agency: Alaska Dept of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2000 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2000
						0.0
Mark Dickson	Fisheries Technician IV (project Manager)	13J	2.0	4.3		8.6
						0.0
	Project administration:					0.0
	Field data reduction and analysis					0.0
	Final report preparation and writing					0.0
	Annual symposium participation					0.0
	Work towards manuscript development					0.0
	in the peer reviewed literature					0.0
						0.0
						0.0
						0.0
	Subtotal		2.0	4.3	0.0	
					Personnel Total	$8.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
Symposium participation:					0.0
Round trip, Homer-Anchorage & return	180.0	1	3	150.0	630.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.6

FY00

Prepared:

Project Number: 00139-A2
Project Title: Port Dick Creek Tributary Restoration
Agency: Alaska Department of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed
Description	FY 2000
	0.0
4A Linkage	35.6
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$35.6

Commodities Costs:	Proposed
Description	FY 2000
Commodities Total	$0.0

FY00

Prepared:

Project Number: 00139-A12
Project Title: Port Dick Creek Tributary Restoration
Agency: Alaska Department of Fish and Game

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
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

FY00

Project Number: 00139-A2
Project Title: Port Dick Creek Tributary Restoration
Agency: Alaska Department of Fish and Game

FORM 3B
Equipment
DETAIL

Prepared:

2000 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$28.7						
Travel		$1.4						
Contractual		$3.3						
Commodities		$0.7						
Equipment		$0.0						
Subtotal	$0.0	$34.1	Estimated FY 2001	Estimated FY 2002				
Indirect								
Project Total	$0.0	$34.1	$11.0	$5.0				
Full-time Equivalents (FTE)		0.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:
Matching funds will be requested for FY2001 and FY2002

FY2001 budget includes funds for manuscript development in the peer reviewed literature.

FY00

Prepared:

Project Number: 00139-A2
Project Title: Port Dick Creek Tributary Restoration
Name: Coble Geophysical Services

FORM 4A
Non-Trustee
SUMMARY

2000 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Personnel Costs: Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 2000
Physical Parameter Monitoring						0.0
G. Coble	Field Hydrologist/Technician		6.0	0.2		1.2
G. Coble	Field Hydrologic /Technician		2.0	4.4		8.8
Spawning Channel Stability Evaluation						
G. Coble	Data Analysis		1.5	5.0		8.0
G. Coble	Field Hydrologist/Technician		1.5	1.8		3.2
G. Coble	Project review, Conferences		0.5	2.1		1.1
Final Report and Collaborative Journal Article(s)			(monthly rate varies according to task)			
G. Coble	Geophysicist, Hydrologist					6.4
						0.0
		Subtotal	11.5	13.5	0.0	
					Personnel Total	$28.7

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 2000
Helicopter for Instrument Inspection, download data	0.8	2	2	0.0	0.4
Plane trip for instrument inspection, download data (Super Cub)	0.2	4		0.0	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.4

FY00

Prepared:

Project Number: 00139-A2
Project Title: Port Dick Creek Tributary Restoration
Name: Coble Geophysical Services

FORM 4B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed
Description	FY 2000
Physical Parameter Monitoring	FFY 1997
2 Marsh McBirney water velocity sensors and equipment, rental	0.8
2 Pressure Transducer, Hastelloy diaphragm-stainless casing, rental	0.3
3 Temperature Probe, rental	0.1
2 Conductivity probe, rental	0.3
2 Datalogger, rugged full bridge, half bridge and pulse measurements, rental	0.5
Spawning Channel Stability Evaluation	
1 Total Station, Tripods, Prism Rod, 300 Ft Surveyor's Tape, Rental	0.7
1 metal detector for tracer gravel, 1 meter depth sensitivity, and tracer gravel expendables, rental	0.4
1 Additional Pressure Transducer, Hastelloy diaphragm-stainless casing, rental	0.2
Contractual Total	$3.3

Description	FY 2000
1 project-specific insurance cost	0.7
Commodities Total	$0.7

FY00

Prepared:

Project Number: 00139-A2
Project Title: Port Dick Creek Tributary Restoration
Name: Coble Geophysical Services

FORM 4B
Contractual & Commodities DETAIL

2000 EXXON VALDEZ TRI :E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

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

Existing Equipment Usage: Des	Number of Units
Datalogger, rugged full bridge, half bridge and pulse measurements	3
Pressure transducer, Hastelloy diaphragm-stainless casing, 0,01 ft accuracy	3
thermistors, 0.4 degree C accuracy, soil and water measurement	4
data downloading equipment (laptop, optical interface, keypad etc.)	1
data field enclosures for datalogging equipment	4
temperature and conductivity instrument for field calibrations	1
conductivity sensors	2
Helly-Smith bedload sampler, with bags and expendables	1
rotating laser level, stadia rod, detector and 300 ft surveyors tape	1
scour chains, stainless, and installation equipment	1
metal detector for tracer gravel, 1 meter depth sensitivity	1
installation supplies (mounting brackets, conduit for exposed cable, expendables	1

FY00

Project Number: 00139-A2
Project Title: Port Dick Creek Tributary Restoration
Name: Coble Geophysical Services

FORM 4B
Equipment
DETAIL

Prepared:

Common Murre Population Monitoring

Project Number:	00144
Restoration Category:	Restoration Monitoring
Proposer:	DOI-FWS
Lead Trustee Agency:	USFWS
Cooperating Agencies:	None
Alaska SeaLife Center:	No
Duration:	1 year
Cost FY 00:	$15.4K
Geographic Area:	Data are from the Barren Islands in lower Cook Inlet and the proposed work will be conducted in Homer, Alaska.
Injured Resource/Service:	Common murres

ABSTRACT

This proposed common murre restoration monitoring project is a close-out study designed to analyze Barren Islands murre census data collected by Project 99144 in FY 99 and prepare a final report comparing FY 99 results with counts made during the 1993-1997 Barren Islands murre population monitoring studies (Projects 93049, 94039, 96144, and 97144), the 1989-1992 damage assessment and restoration projects (Bird Study No. 3, Restoration Project No. 11), and 1990-1992 Exxon-sponsored studies. The final report will contain information on murre productivity at the Barren Islands in 1989-1999 and discuss these data in relation to trends in population size that have developed during the same interval of time. It will also discuss changes in numbers of birds that may have occured at the nesting colonies because of the recent El Niño and La Niña events.

INTRODUCTION

The Barren Islands, in the northwestern Gulf of Alaska, supported one of the largest breeding concentrations of common murres *(Uria aalge)* in the path of the T/V *Exxon Valdez* oil spill (e.g., Sowls *et al.* 1978, Piatt *et al.* 1990, FWS 1994). When winds and currents swept oil through the region during April-May 1989, many of these seabirds were killed: they comprised 74% of 30,000 bird carcasses recovered by 1 August (see Piatt *et al.* 1990). Based on this information and a computer modeling study, estimates of total bird mortality suggested that 74,000-315,000 murres died after contacting floating oil (see Piatt *et al.* 1990, ECI 1991).

Because mortality of murres appeared to be high, the U.S. Fish and Wildlife Service (FWS) counted murres at the Barren Islands colonies during the *Exxon Valdez* Oil Spill Trustee Council-sponsored damage assessment and restoration studies in 1989-1991 and 1992-1994, respectively (see Nysewander and Dipple 1990, 1991; Dipple and Nysewander 1992; Nysewander *et al.* 1993; Dragoo *et al.* 1995; Roseneau *et al.* 1995, 1996a). Other research groups also collected data on murre numbers at the Barren Islands during the early 1990's. University of Washington (UW) investigators counted birds at East Amatuli Island - Light Rock in 1990-1992, during Exxon- and Minerals Management Service-funded studies (see Boersma *et al.* 1995), and Dames & Moore (D&M) biologists censused this nesting complex and the Nord Island - Northwest Islet colony in 1991 during an Exxon-supported project (see Erikson 1995).

We censused murres at the Barren Islands in 1996-1997 (Projects 96144 and 97144; see Roseneau *et al.* 1997a, 1998a). Analyses of FY 97 data in combination with population counts made during previous postspill studies indicated that a positive trend in numbers of birds first noted on a small East Amatuli Island - Light Rock plot set in 1994 had strengthened, and that numbers of birds had also increased significantly on the larger Light Rock section of the East Amatuli Island - Light Rock colony. This information and the fact that the 1997 counts on six of the seven East Amatuli Island - Light Rock and Nord Island - Northwest Islet plot sets were significantly higher than the averages of previous postspill estimates provided the first convincing evidence that murre populations were increasing at the Barren Islands colonies. *The high 1997 counts were associated with the presence of large numbers of nonbreeding birds at the colonies, almost certainly 3- and 4-year-old subadults belonging to the strong 1993-1994 chick cohorts—see Roseneau et al. 1995, 1996a, 1996b, 1997a, 1997b, 1998a, 1998b.*

We will census the Barren Islands murre colonies once more in FY 99, a year when 3-, 4-, 5-, and 6-year-old birds from the strong 1993-1996 chick cohorts are likely to present at the nesting cliffs (see the Project 99144 DPD). Analyzing and comparing these data with counts made during the 1993-1997 murre population monitoring studies (Projects 93049, 94039, 96144, and 97144), the 1989-1992 damage assessment and restoration projects (Bird Study No. 3, Restoration Project No. 11), and 1990-1992 University of Washington and Dames & Moore Exxon-sponsored studies (see Boersma *et al.* 1995, Erikson 1995) will provide information needed to determine if common murres have met the remaining population recovery goal established for this injured species in the spill area. After analyses are complete, we will prepare a final report that will discuss postspill changes in murre productivity and population size at the Barren Islands colonies in relation to recovery goals and recent El Niño and La Niña events.

NEED FOR THE PROJECT

A. Statement of Problem

Common murres are listed as recovering in the spill area. Although FY 92 - FY 98 data clearly demonstrate that this injured species has met productivity criteria for recovery (five consecutive years of productivity within normal bounds; see Roseneau *et al.* 1995, 1996a, 1996b, 1997b, 1998b. 1999), information is still needed to show that breeding populations are indeed increasing in the spill area (i.e., the positive population trends found at the Barren Islands in FY 97 were encouraging; however, evidence that numbers are continuing to increase at satisfactory rates over several years time is needed before murres can be declared fully recovered in the spill area).

B. Rationale/Link to Restoration

This proposed close-out study will compile and analyze common murre population numbers data collected by Project 99144 in FY 99. It will also compare the results of these analyses with counts made during the 1993-1997 murre population monitoring studies (Projects 93049, 94039, 96144, and 97144), the 1989-1992 damage assessment and restoration projects (Bird Study No. 3, Restoration Project No. 11), and the 1990-1992 University of Washington and Dames & Moore Exxon-sponsored studies (see Boersma *et al.* 1995, Erikson 1995). Information generated by the proposed project will help determine if common murres have met the remaining population recovery goal established for this injured species in the spill area (i.e., that numbers must increase at satisfactory rates over several years time). Results from the work will also help document changes in numbers of birds that may have occurred because of recent El Niño and La Niña events.

C. Location

The proposed FY 00 close-out work will be conducted in Homer, Alaska. No communities will be affected by the study.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

A large format, computer-generated color poster summarizing postspill results will be prepared and submitted to the Trustee Council for public display after data are analyzed. The poster is transportable and can be used by Trustee Council staff for a variety of purposes, including public displays at oil spill community meetings and schools. The poster will also be available on-disk for inclusion in any on-line products that the Trustee Council may develop for public use. Photographs of field work will be compiled for Trustee Council use at community meetings and in public newsletters, displays, and on-line information services. Copies of the final report will be available to the public in Homer and Anchorage, and project results will also be presented at public Trustee Council-sponsored meetings and workshops, and other scientific conferences.

PROJECT DESIGN

A. Objectives

The project is designed to test the null hypotheses that murre populations have not increased at the Barren Islands colonies since 1989, the year of the spill. Specific objectives are to analyze FY 99 Project 99144 population count data; compare these results with estimates from the 1989-1997 FWS, 1990-1992 University of Washington (UW), and 1991 Dames & Moore (D&M) studies; and evaluate final postspill results in relation to recovery criteria.

B. Methods

The close-out study will be conducted in Homer, Alaska. Methods used to analyze FY 99 Project 99144 data and compare these results with information from earlier Barren Islands postspill studies follow standard Alaska Maritime National Wildlife Refuge (AMNWR) protocols. They have been described in the FY 96 - FY 97 common murre population monitoring reports and are summarized below.

Data Analysis

To analyze the FY 99 data, one-day totals will be calculated for each monitoring plot set (see Roseneau *et al.* 1995, 1996a, 1997a, 1998a). Results will be pooled and averaged with counts made during the 1989-1997 FWS, 1990-1992 UW, and 1991 D&M postspill studies (i.e., Nysewander and Dipple 1990, 1991; Dipple and Nysewander 1992; Nysewander *et al.* 1993; Dragoo *et al.* 1995; Roseneau *et al.* 1995, 1996a, 1997a, 1998a; Boersma *et al.* 1995; Erikson 1995). Linear regressions will be run to check for trends and differences among years will be tested with ANOVA. The 0.1 significance level will be used to increase the power of the tests and reduce Type II error (the 0.9 confidence interval will adequate for our purposes; also see Appendix 1 for a power analysis).

C. Cooperating Agencies, Contracts and Other Agency Assistance

The Alaska Maritime National Wildlife Refuge will furnish all office space and computers needed for the close-out study. The refuge will also donate up to 1 month of the project manager's time (G.V. Byrd) to the project. Contracts or other agency assistance are not required to perform the work.

SCHEDULE

A. Measurable Project Tasks for FY 00 (1 October 1999 - 30 September 2000)

1-30 Oct 1999:	Compile, enter, and analyze FY 99 data.
1-30 Nov 1999:	Combine FY 99 and FY 89 - FY 97 results and analyze for trends and differences among years.

1-15 Dec 1999:	Finalize manuscript using combined FY 89 - FY 99 results and submit to journal.
16 Dec 1999 - 31 Jan 2000:	Prepare poster for public display, attend EVOS workshop, prepare for and attend PSG conference (if held in January).
1 Feb - 25 Mar 2000:	Attend PSG conferance (if held in February), prepare draft final report of combined 1989-1999 results, submit draft final report for in-house review.
26 Mar - 10 Apr 2000:	Finalize final report of 1989-1999 results.
12 Apr 2000:	Submit completed final report of 1989-1999 results to Chief Scientist and Science Coordinator.

B. Project Milestones and Endpoints

Late October 1999	FY 99 data analysis completed.
Late November 1999	Analyses of combined FY 89 - FY 99 results completed.
Mid-Dec 1999	Manuscript completed and submitted to journal.
Late March 2000	Draft final report completed.
Mid-April 2000	Final report submitted to Chief Scientist and Science Coordinator.

C. Completion Date

A manuscript reporting and discussing 1989-1999 results will be submitted to a peer-reviewed journal by 15 December 1999. A final report that includes both the manuscript and more detailed information on the 1989-1999 murre population counts will be submitted to the Chief Scientist by 15 April 2000.

PUBLICATIONS AND REPORTS

A final project report discussing combined 1989-1999 results will be prepared and submitted to the EVOS Trustee Council Chief Scientist and Science Coordinator by 15 April 2000. A manuscript on postspill trends in murre population numbers is nearing completion. It will be

submitted to a peer-reviewed journal (Colonial Waterbirds) by 15 December 1999, after FY 99 Barren Islands data have been analyzed and compared with counts made during 1989-1997. The manuscript will serve as part of the final report; it will also provide information for a presentation on murre population recovery in the spill area at the annual Trustee Council workshop in January 2000.

PROFESSIONAL CONFERENCES

Results from the FY 00 close-out study will be presented at the Pacific Seabird conference in January-February 2000 (1989-1997 results were presented at the PSG 25th anniversary meeting in Monterey, California in January 1998). Travel and lodging costs for attending the meeting are included in the budget. Also, results from the work may be presented at other conferences and symposiums held in 2000, if they are appropriate forums for the work (e.g., Alaska Bird Conference).

NORMAL AGENCY MANAGEMENT

The proposed common murre population census close-out study is not something that AMNWR or the FWS is required to do by statute or regulation. Until recently, the Barren Islands were listed as an intermittent monitoring site for tufted puffins and fork-tailed storm-petrels *(Oceanodroma furcata)* under the refuge's seabird monitoring program. In 1994, these islands were designated an annual population monitoring site for murres and kittiwakes, primarily because the 1993-1994 EVOS-sponsored restoration studies (Projects 93049 and 94039) demonstrated that data could be safely collected at them that satisfied standard refuge monitoring protocols for these species. Designating the Barren Islands as an annual monitoring site has improved the refuge's chances of obtaining funds for collecting and analyzing murre population data from them. However, because the islands are not part of the FWS's highest priority ecosystem, the Bering Sea, monetary support for conducting the proposed work will not be available until overall FWS priorities change (i.e., from the Bering Sea to other officially designated ecosystems within Alaska).

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The proposed FY 00 close-out work is coordinated with other Alaska Maritime National Wildlife Refuge murre population studies in Alaska. The refuge will provide office space and computers for the work.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

The proposed FY 00 work is a close-out study. Study design and schedules remain the same as proposed in the FY 99 Barren Islands common murre population monitoring DPD (Project 99144). However, the schedule listed in the FY 98 Chiswell Islands murre population

monitoring DPD (Project 98144) for submitting a manuscript on postspill trends in murre population numbers has been modified to allow incorporation of FY 99 Barren Islands data in the paper. We believe including the 1999 Barren Islands population counts in the manuscript makes good sense, because all of the postspill population numbers data will be presented together in one place, and using this information will strengthen the results and conclusions, and markedly improve the paper.

PROPOSED PRINCIPAL INVESTIGATOR, IF KNOWN

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PRINCIPAL INVESTIGATOR

David G. Roseneau (Principal Investigator)

Mr. Roseneau will be responsible for the overall day-to-day operation of the project. He will supervise personnel, review and approve expenditures, and ensure that work stays on schedule. He will also be in charge of data analysis and interpretation, preparing posters and presentations for scientific conferences and meetings, and writing the final report and a manuscript for publication. Mr. Roseneau received his B.S. degree in wildlife management and M.S. degree in biology from the University of Alaska - Fairbanks in 1967 and 1972, respectively. His thesis research was on the numbers and distribution of gyrfalcons, *Falco rusticolus* on the Seward Peninsula, Alaska. He joined the U.S. Fish and Wildlife Service in January 1993, and was project leader for EVOS-sponsored Barren Islands common murre restoration studies in 1993-1994 (Projects 93049 and 94039). Mr. Roseneau was also co-principal investigator of the APEX Barren Islands seabird studies (Projects 95163J, 96163J, 97163J, 98163J) and principal investigator of the APEX large fish as samplers projects (Projects 95163K, 97163K, 98163K) during 1995-1998, and principal investigator of the 1996-1997 Barren Islands and 1998 Chiswell Islands murre population monitoring studies (Projects 96144, 97144, 98144). Currently, he is co-principal and principal investigator of the FY 99 APEX Barren Islands seabird and large fish as samplers studies, respectively (Projects 99163J and 99163K). Prior to 1993, Mr. Roseneau worked as a consulting biologist for 20 years, conducting and managing marine bird, raptor, and large mammal projects in Alaska and Canada for government agencies and private-sector clients. He has been involved in several large- scale murre *(Uria* spp.*)* monitoring projects. During 1976-1983, as co-principal investigator of NOAA/OCSEAP Research Unit 460, he conducted monitoring studies of murres and black-legged kittiwakes (Rissa tridactyla) at capes Lisburne, Lewis, and Thompson in the Chukchi Sea, and St. Lawrence, St. Matthew, and Hall islands in the Bering Sea. He also studied auklets *(Aethia* spp.*)* at St. Lawrence and St. Matthew islands, and participated in murre and kittiwake projects at

Bluff in Norton Sound. In 1984-1986, he participated in follow-up studies of murres and kittiwakes in the northeastern Chukchi Sea, and during 1987-1988, 1991-1992, and 1995-1997 he helped conduct additional murre and kittiwake work at Chamisso and Puffin islands and capes Thompson and Lisburne. Mr. Roseneau is experienced in collecting and analyzing data on numbers, productivity, and food habits of seabirds; relating trends in numbers and productivity to changes in food webs and environmental parameters (e.g., air and sea temperatures, current patterns); and assessing potential impacts of petroleum exploration and development on nesting and foraging marine birds. He has broad knowledge of rock climbing techniques and has operated inflatable rafts and other outboard-powered boats in the Bering, Chukchi, and Beaufort seas and on various Alaskan rivers in excess of 3,000 hrs. Mr. Roseneau has also accrued several hundred additional hours operating time in small boats and larger, more powerful vessels (e.g. 25 ft, 300-400 hp HydroSports and Boston Whalers) in Kachemak Bay, Prince William Sound, and Kenai Peninsula and Barren Island waters. During his career, Mr. Roseneau has authored and co-authored over 75 reports and publications, including about 25 on Alaskan seabirds.

Selected Seabird Publications

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

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

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

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

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

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OTHER KEY PERSONNEL

1. G. Vernon Byrd (Project Manager)

Mr. Byrd will supply overall guidance to the project, including providing advice during data analysis and report writing. He will also review the final report and help prepare a manuscript for publication. Mr. Byrd received a B.S. degree in wildlife management from the University of Georgia in 1968, did post-graduate studies in wildlife biology at the University of Alaska - Fairbanks in 1975, and completed his M.S. degree in wildlife resources management at the University of Idaho in 1989. His thesis, entitled "Seabirds in the Pribilof Islands, Alaska: Trends and monitoring methods", explored statistical procedures for analyzing kittiwake *(Rissa*

spp.) and murre *(Uria* spp.) population data. Mr. Byrd has worked for the U.S. Fish and Wildlife Service for over 20 years, focusing on studies of marine birds in Alaska and Hawaii. His major interests center around monitoring long-term trends in seabird populations, including numbers of birds and reproductive performance at colonies. He has worked at murre colonies in the Aleutian Islands, the Bering and Chukchi seas, and western Gulf of Alaska. Mr. Byrd was co- author of the final T/V *Exxon Valdez* oil spill damage assessment report for murres. Also, he was project manager of the 1993-1994 common murre restoration monitoring studies (Projects 93049 and 94039), projects to remove predators from islands containing seabird colonies (Projects 94041 and 95041), the 1995-1997 APEX and murre monitoring studies (Projects 95163J, 95163K, 96163J, 96144, 97163J, 97163K, 97144, 98163J, 98163K, and 98144). Mr. Byrd is currently serving as project manager for FY 99 APEX projects 99163J and 99163K, and the FY 99 Barren Islands murre population monitoring study (Project 99144). He has authored over 55 scientific papers and 65 U.S. Fish and Wildlife Service reports on field studies, and has made about 30 presentations on seabirds at scientific meetings. Mr. Byrd is the supervisory wildlife biologist at the Alaska Maritime National Wildlife Refuge, the premier seabird nesting area in the national public land system.

Selected Seabird Publications

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

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

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

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

2. Arthur B. Kettle (Biological Technician)

Mr. Kettle will help compile and analyze the data, and help prepare the final report and a manuscript for publication. Mr. Kettle received his B.A. degree in Human Ecology from the College of the Atlantic in 1984. Since that time, he has participated in several large-scale seabird projects at remote locations. He joined the U.S. Fish and Wildlife Service in May 1993, and was camp leader for the 1993-1994 EVOS Barren Islands common murre restoration studies (Projects 93049 and 94039). He also served as field team leader and co-principal investigator during the 1995-1998 APEX Barren Islands seabird studies (Projects 95163J, 96163J, 97163J, 98163J), and he participated in the 1996-1997 Barren Islands and 1998 Chiswell Islands murre population monitoring projects (Projects 96144, 97144, 98144). Mr. Kettle is currently co-principal investigator of FY 99 APEX project 99163J and a participant in the FY 99 Barren Islands murre population monitoring study (Project 99144). During Mr. Kettle's 1993-1997 work at the Barren Islands, he was responsible for logistics and data collection at Amatuli Cove camp, and for

ensuring that data were obtained according to study design. His broad knowledge of boat-mooring systems and technical rock climbing techniques allowed him to safely collect productivity and chronology data from a series of study plots he established on East Amatuli Island (a difficult technical task not accomplished during any previous pre- or postspill study). Mr. Kettle also collected productivity data and censused birds at East Amatuli Island during Exxon-sponsored University of Washington studies in 1990-1992. In addition to this work, he participated in large- scale University of Washington studies of magellanic penguins *(Spheniscus magellanicus)* in Argentina during 1987-1991, and tufted puffins *(Fratercula cirrhata)* and fork-tailed storm-petrels *(Oceanodroma furcata)* at the Barren Islands colonies in 1990-1992. Mr. Kettle has over 18 years experience safely operating small boats in the north Atlantic and Pacific oceans (e.g., Maine and Alaska), including 9 consecutive field seasons running outboard-powered craft in Barren Islands waters.

Selected Seabird Publications

Boersma, P.D., J.K. Parrish, and A.B. Kettle. 1995. Common murre abundance, phenology, and productivity on the Barren Islands, Alaska: The *Exxon Valdez* oil spill and long-term environmental change. Pp. 820-853 *in Exxon Valdez* Oil Spill: Fate and effects in Alaskan waters, ASTM STP 1219, P.G. Wells, J.N. Butler, and J.S. Hughes (eds.), Amer. Soc. for Testing and Materials, Philadelphia, PA.

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Byrd, G.V. 1989. Seabirds in the Pribilof Islands, Alaska: Trends and monitoring methods. M.S. thesis. Univ. of Idaho.

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Piatt, J.F, C.J. Lensink, W. Butler, M. Kendziorek, and D.R. Nysewander. 1990. Immediate impact of the "Exxon Valdez" oil spill on marine birds. Auk 107:387-397.

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Appendix 1. Power analysis of common murre counts in the Barren Islands, Alaska.[1]

We know from prior work that a total of about 5-7 counts made on separate days are needed in each year to detect among-year differences of 20% at the $P = 0.1$ level with 90% power (see Byrd 1989, Hatch and Hatch 1989). Using a computer program called "TRENDIO" written by T. Gerrodette (i.e., Gerrodette 1987), we ran a series of simulations to predict the number of surveys needed and the number of years required at different survey intervals to detect a significant positive trend in murre populations with the following assumptions:

1. *Rate of Change*: 2 levels (8% yr- and 13% yr^{-1}) — these levels were chosen because they represent the normal range of values reported in the literature for common murres.

2. *Coefficient of Variation CV)*: 15% was used because that is the average value recorded for counts made in the Barren Islands during 1992-1994.

3. Alpha ($\acute{\alpha}$) and Beta (B) Levels: We were more concerned about Type II errors than Type I errors; therefore we relaxed Alpha to 0.1 and set the power at 0.9.

4. *Model Selection*: Murre populations are expected to grow exponentially rather than in a linear fashion.

Table 1. Summary of power analysis simulation for detecting a significant positive trend (1-tailed) in murre populations in the Barren Islands.

Rate of Change ($year^{-1}$)	Years Between Surveys	CV	$\acute{\alpha}$	B	Number of Surveys Required[a]	Number of Years Required to Detect Trends
0.8	1	0.15	0.1	0.9	7	7
	2	0.15	0.1	0.9	5	10
	3	0.15	0.1	0.9	4	12
	4	0.15	0.1	0.9	4	16
	5	0.15	0.1	0.9	4	20
0.13	1	0.15	0.1	0.9	5	5
	2	0.15	0.1	0.9	4	8
	3	0.15	0.1	0.9	4	12
	4	0.15	0.1	0.9	3	12
	5	0.15	0.1	0.9	3	15

[a]Each survey would include 5 replicate counts. Increasing the number of replicate counts to 10 would reduce the CV to 0.10 and generally reduce the number of surveys needed by 1 in each category.

Conclusions: If murre populations in the T/V *Exxon Valdez* oil spill area are increasing at 8% yr^{-1}, it would require 7 years of annual surveys (at 5 replicate counts yr^{-1}) to detect a significant trend at the 0.1 level with 90% power. However, if the number of replicates yr^{-1} were increased to 10, it would take only 6 years of annual surveys to detect a significant trend at the same level. If populations were increasing at 13% yr^{-1}, the same comparisons listed above would require 4 and 5 years, respectively. If surveys were conducted every 3 years (5 replicate counts yr^{-1}), it would take 12 years, whether the rate of increase was 8% or 13% (rounding in the reason the values are the same), but increasing the number of replicates yr^{-1} to 10 would reduce the time required to detect a trend to 9 years. Surveys conducted at 5-year intervals would take 15 to 20 years (at 5 replicate counts yr^{-1}) to detect a significant trend in population size.

[1] Copies of this power analysis can be obtained from D.G. Roseneau or G.V. Byrd at (907) 235-6546.

1999 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET

October 1, 1999 - September 30, 2000

Budget Category:	Authorized FY 1999	Proposed FY 2000
Personnel	$16.7	$11.0
Travel	$3.0	$2.3
Contractual	$43.2	$0.0
Commodities	$2.6	$0.4
Equipment	$1.2	$0.0
Subtotal	$66.7	$13.7
General Administration	$5.5	$1.7
Project Total	$72.2	$15.4
Full-time Equivalents (FTE)	0.5	0.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2000	Estimated FY 2001				
$15.4	$0.0				

Dollar amounts are shown in thousands of dollars.

Comments:

This is a close-out project designed to analyze FY 99 Barren Islands common murre population monitoring Project 99144 data; compare the results with information from 1989-1997 FWS, 1990-1992 University of Washington, and 1991 Dames & Moore studies; and prepare a final report discussing postspill trends in population size and potential influences of recent El Nino and La Nina events.

FY 00

Project Number: 00144
Project Title: Common Murre Population Monitoring
Agency: DOI-FWS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: 04/01/99

04/05/1999

1999 EXXON VALDEZ TRU E 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
David G. Roseneau	Project Leader (Principal Investigator)	GS11/5	1.5	5.1	0.0	7.7
Arthur B. Kettle	Biological Science Tech. (Wildlife)	GS7/1	1.0	3.3	0.0	3.3
G. Vernon Byrd	Project Manager	GS13/2	1.0	0.0	0.0	0.0
C. Berg	Program Manager	GS12	0.2	0.0	0.0	0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.7	8.4	0.0	
					Personnel Total	$11.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2000
Travel to Anchorage EVOS workshop (1 person)	0.2	1	3	0.2	0.8
					0.0
Travel to Pacific Seabird Group (PSG) conference (1 person)	0.7	1	4	0.2	1.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.3

FY 00

Project Number: 00144
Project Title: Common Murre Population Monitoring
Agency: DOI-FWS

FORM 3B
Personnel
& Travel
DETAIL

Prepared: 04/01/99

Contractual Costs:	Proposed FY 2000
Description	
(No contracual costs are required by this project)	0.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed FY 2000
Description	
Costs of producing & printing 1 large format poster for public display of project results	0.4
	0.0
Commodities Total	$0.4

FY 00

Project Number: 00144
Project Title: CommonMurre Population Monitoring
Agency: DOI-FWS

FORM 3B
Contractual & Commodities DETAIL

Prepared: 04/01/99

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2000
(No equipment purchases are required by this project)			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
(FWS will supply all of the office space, computers, and office supplies needed by the project)		

FY 00

Project Number: 00144
Project Title: Common Murre Population Monitoring
Agency: DOI-FWS

FORM 3B
Equipment
DETAIL

Prepared: 04/01/99

Project Title: Surveys to Monitor Marine Bird Abundance in Prince William Sound during Winter and Summer 2000

Project Number:	00159
Restoration Category:	Monitoring
Proposer:	Migratory Bird Management, U. S. Fish and Wildlife Service
Lead Trustee Agency:	U. S. Department of the Interior, Fish and Wildlife Service
Cooperating Agencies:	None
Alaska SeaLife Center:	
Duration:	Every other year until recovered
Cost FY 00:	$~ 299.6
Cost FY 01:	$~ 48.7
Cost FY 02:	$~ 233.6
Geographic Area:	Prince William Sound
Injured Resource/Service:	marine birds and sea otters

ABSTRACT

We propose to conduct small boat surveys to monitor abundance of marine birds and sea otters (*Enhydra lutris*) in Prince William Sound, Alaska during March and July 2000. Six previous surveys have monitored population trends for >65 bird and 8 marine mammal species in Prince William Sound. We will use data collected in 2000 to continue to examine trends from summer 1989-2000 and from winter 1990-2000 by determining whether populations in the oiled zone changed at the same rate as those in the unoiled zone. We will also examine overall population trends for the Sound from 1989-2000. Due to the lack of data prior to the *Exxon Valdez* oil spill, continued monitoring of marine birds and sea otters is needed to determine whether populations injured by the spill are recovering. Data collected in 1998 indicated that based on the Homogeneity of slopes test, none of the designated injured species showed evidence of recovery in either winter or summer populations from 1989-1998. Winter densities, however, of three of the designated injured species, harlequin ducks (*Histrionicus histrionicus*), bald eagles (*Haliaeetus leucocephalus*), and murrelets (*Brachyramphus* sp.) showed an increasing trend in the oiled areas of PWS. Summer populations of bald eagles (*Haliaeetus leucocephalus*), a injured species designated as recovered was also showing an oil spill effect, using the Homogeneity of Slopes test, however, densities in the oiled area of PWS showed an increasing trend. No other injured species or species groups showed any positive significant trends in the oiled areas of PWS. Densities of 5 other species previously not considered injured (scoters, mergansers, black-legged kittiwakes, oldsquaw, and goldeneye) showed trends consistent with an oil spill effect. Lack of significant trends would indicate that these populations have not fully recovered (Lance et al. in review).

INTRODUCTION

The waters and shorelines of Prince William Sound support abundant marine bird and sea otter populations throughout the year (Isleib and Kessel 1973, Hogan and Murk 1982, Irons et al. 1988a). Potential injuries to marine birds from exposure to the *T/V Exxon Valdez* oil spill included, but were not limited to, death, changes in behavior, and decreased productivity. U. S. Fish and Wildlife Service, Migratory Bird Management conducted boat surveys in Prince William Sound prior to the *Exxon Valdez* oil spill in 1972-73 (Dwyer et al. 1976) and 1984-85 (Irons et al. 1988a,b). After the oil spill, Natural Resource Damage Assessment Bird Study Number 2 (Burn 1994, Klosiewski and Laing 1994) was initiated to document damage from the oil spill on the marine bird and sea otter populations of Prince William Sound. Data from these surveys indicated that populations of sea otters (Burn 1994) and several marine bird species (Klosiewski and Laing 1994) declined in the oil spill area. Thus, restoration projects 93045 (Agler et al. 1994a), 94159 (Agler et al. 1995a), 96159 (Agler and Kendall 1997), and 98159 (Lance et al. In review) were initiated to continue monitoring marine bird and sea otter population abundance to assess recovery of injured species. Restoration projects 93045, 94159, 96159, and 98159 continued the original *Exxon Valdez* oil spill damage assessment study (Bird Study Number 2, Burn 1994, Klosiewski and Laing 1994) from 1989-91.

Using small boat surveys, this project will collect additional information to monitor the distribution and abundance of marine birds and sea otters in Prince William Sound. These data will be combined with data collected in 1989-91 (Klosiewski and Laing 1994), 1993 (Agler et al. 1994a), 1994 (Agler et al. 1995a), 1996 (Agler and Kendall 1997), and 1998 (Lance et al. In review) to examine trends in marine bird and sea otter distribution and abundance. This project will benefit restoration of Prince William Sound by determining whether populations that declined due to the spill are recovering and by identifying what species are still of concern.

NEED FOR THE PROJECT

A. Statement of the Problem

Almost 30,000 marine bird (Piatt et al. 1990) and 900 sea otter (DeGange and Lensink 1990) carcasses were recovered following the *Exxon Valdez* oil spill. Based on modeling studies using carcass search effort and population data, an estimated 250,000 marine birds were killed in Prince William Sound and the northern Gulf of Alaska (Piatt and Ford 1996). Garrott et al. (1993) estimated that 2,800 sea otters also were killed. These estimates are probably low, because they only include direct mortality occurring in the first five months after the spill.

The U. S. Fish and Wildlife Service conducted boat surveys of marine bird and sea otter populations in Prince William Sound in 1972-73 (Dwyer et al. 1976), 1984-85 (Irons et al. 1988b), and several years following the spill (1989, 1990, 1991, Klosiewski and Laing 1994; 1993, Agler et al. 1994a; 1994, Agler et al., 1995a; 1996, Agler and Kendall, 1997; and 1998, Lance et al., in review). Klosiewski and Laing (1994) documented overall declines in 15 species or species groups between 1972-73 (Dwyer et al. 1976) and the years after the spill. When comparing population estimates with 1984-85 data, Klosiewski and Laing (1994) documented

decline of 6 species or species groups.

Burn (1994), using data from the boat surveys, documented declines in sea otter abundance in shoreline habitats of Prince William Sound following the spill. Burn (1994) detected a continuing pattern of significantly lower sea otter densities in oiled coastal areas, suggesting mortality in or displacement of sea otters from these areas.

Lance et al. (in review) examined whether marine bird and mammal species designated as injured by the *EVOS* trustee council had shown signs of recovery by 1998. Using the Homogeneity of Slopes test they found that none of the designated injured species showed evidence of recovery in either winter or summer. They did find, however, that winter densities of three of the designated injured species, harlequin ducks (*Histrionicus histrionicus*), bald eagles (*Haliaeetus leucocephalus*), and murrelets (*Brachyramphus* sp.) showed an increasing trend in the oiled areas of PWS. Bald eagles (*Haliaeetus leucocephalus*), an injured species designated as recovered, also showed an increasing trend in oiled areas of PWS. No other injured species or species groups showed any significant trends in the oiled areas of PWS. Densities of 5 other species previously not considered injured (scoters, mergansers, black-legged kittiwakes, oldsquaw, and goldeneye) showed trends consistent with an oil spill effect. Lack of significant trends would indicate that these populations have not fully recovered (Lance et al. in review).

B. Rationale/Link to Restoration

Restoration of marine bird and sea otter populations requires population estimates to determine whether recovery is occurring or if species are still affected by the oil spill. This project will benefit marine birds and sea otters by revealing species that show continuing injury due to the *T/V Exxon Valdez* oil spill. Agler et al. (1994a, 1995a), Agler and Kendall 1997, and Lance et al. (in review) found additional populations that were not previously shown to be injured. Survey data from this project have also been used by investigators of other studies on pigeon guillemots (Greg Golet, pers. comm.), marbled murrelets (K. Kuletz, pers. comm.), Kittlitz's murrelets (B. Day, per comm.), harlequin ducks (D. Rosenberg and D. Esler, pers. comm.), sea ducks (K. Laing and D. Esler, pers. comm.), black oystercatchers (B. Andres, pers. comm.), birds and forage fish (W. Ostrand, pers. comm.), herring (E. Brown, pers. comm.), and sea otters (Burn 1994).

This project relates to the restoration objectives of several species. The *Exxon Valdez Oil Spill Restoration Plan* (*Exxon Valdez* Oil Spill Trustee Council 1994) lists each species' restoration objectives separately, and we have only included objectives relating to this project:

> Cormorants - "will have recovered when their populations return to prespill levels in the oil-spill area. An increasing population trend in Prince William Sound will indicate that recovery is underway."
>
> Harlequin duck - "will have recovered when breeding and postbreeding season densities and production of young have returned to estimated pre-spill levels, or when there are no differences in these parameters between oiled and unoiled areas."

Bald eagle -"will have recovered when their population and productivity return to pre-spill levels."

Black oystercatchers - "will have recovered when populations attain pre-spill levels"

Marbled murrelet - "will have recovered when population trends are increasing."

Pigeon guillemot - "will have recovered when populations are stable or increasing."

Sea otter - "will be considered recovered when population abundance and distribution are comparable to pre-spill abundance and distribution"

All of the above recovery objectives relate to determining the population abundance of injured species. This is critical to determining recovery for most species. Common loons and Kittlitz's murrelets were also designated as injured species, but no recovery objective has been developed due to lack of information on their populations. We propose to sample the entirety of Prince William Sound during March and July 2000 to estimate population abundance and distribution of marine birds and sea otters. Data will be comparable with pre- and post-spill data collected by the U. S. Fish and Wildlife Service (Dwyer et al. 1976, Irons et al. 1988a,b, Agler et al. 1994a, Klosiewski and Laing 1994, Agler et al. 1995a, Agler and Kendall 1997, Lance et al. in review) and can be used to examine trends in abundance for these species. There are currently no other studies monitoring the populations of loons, cormorants, and black oystercatchers.

Additionally, Klosiewski and Laing (1994) found evidence of oil spill damage for scoters (*Melanitta* spp.), mew gull (*Larus canus*), arctic tern (*Sterna paradisaea*), and northwestern crow (*Corvus caurinus*). These species have never been added to the list of injured species and do not have restoration objectives. At the present time, this proposed study is the only study continuing to consider these species and track their populations.

By using data from previous surveys we have conducted power analyses to examine the power to detect trends in population abundance (Taylor and Gerrodette 1993). If all other parameters are equal, power is determined by the number of surveys conducted in a given period of time. As the number of surveys increases the ability to detect a trend increases. For example if a population had a coefficient of variation (C.V.) of 0.30 (this is higher than that of 73% of the injured species; Agler and Kendall in review) the ability to detect an average annual 10 % change in population is 40% with 6 surveys (Fig. 1). By conducting surveys in 2000 the number of surveys increases to 7 and the power to detect same population change increases to ~ 55% (Fig. 1). If we continue biannual surveys, when we have completed 10 surveys the power to detect this change would be 90% (Fig 1). Thus we feel it is important to continue these surveys to enable us to increase the ability to detect population trends.

C. Location

This study will be conducted in Prince William Sound. The study area includes all water within Prince William Sound, as well as land within 100 m of the shore.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

We would be happy to provide informational meetings in communities within Prince William Sound, as permitted by our survey schedule. We will use a charter vessel(s) from communities within the Sound or adjacent regions (Homer or Seward).

PROJECT DESIGN

A. Objectives

The purpose of this study is to obtain population estimates of marine birds and sea otters in Prince William Sound to monitor the recovery of species whose populations may have declined due to the *T/V Exxon Valdez* oil spill and to determine whether additional species may still be affected by the oil spill. The specific objectives of this project include:

1. To determine distribution and estimate population abundance, with 95% confidence limits, of marine bird and sea otter populations in Prince William Sound during March and July 1998;

2. To determine whether the marine bird species whose populations declined more in oiled areas than in non-oiled areas of Prince William Sound have recovered;

3. To determine whether additional species show any oil spill effects;

4. To support restoration studies on harlequin duck, black oystercatcher, pigeon guillemot, marbled murrelet, Kittlitz's murrelet, sea ducks, and sea otter by providing data on population changes, distribution, and habitat use of Prince William Sound populations.

B. Methods

1. Study Area

Our study area includes all waters within Prince William Sound and all land within 100 m of shore (Fig. 2). We exclude Orca Inlet, near Cordova, Alaska and the southern sides of Montague, Hinchinbrook, and Hawkins Islands (Klosiewski and Laing 1994).

2. Sampling Methods

Survey methodology and design will remain identical to that of post-spill surveys conducted by the U. S. Fish and Wildlife Service in 1989, 1990, 1991, (Klosiewski and Laing 1994), March and July 1993 (Agler et al. 1994a), March 1994 (Agler et al. 1995a), March and July 1996 (Agler and Kendall 1997, and March and July 1998 (Lance et al. in review). We will conduct two surveys: one during March and another during July 2000. We will use three 7.7 m fiberglass boats traveling at speeds of 10-20 km/hr to survey transects over two 3-week periods. For each survey,

two observers will survey a sampling window 100 m on either side, ahead of, and above the vessel (Klosiewski and Laing 1994). When surveying shoreline transects, observers will also record sightings on land within 100 m of shore. Observers will sample continuously and use binoculars to aid in species identification. Observers will practice estimating distances with a duck decoy, and radars on the survey vessels will be used to assist in determining our distance from land on shoreline transects. We will survey most transects when wave height is <30 cm, and we will not survey when wave height is >60 cm.

We will continue to use a stratified random sampling design containing three strata: shoreline, coastal-pelagic, and pelagic (Klosiewski and Laing 1994). The shoreline stratum will consist of waters within 200 m of land. Irons et al. (1988b) divided this stratum, by habitat, into 742 transects with a total area of 820.74 km^2. We will locate shoreline transects by geographic features, such as points of land, to facilitate orientation in the field and to separate the shoreline by habitat (Irons et al. 1988a,b). Shoreline transects will vary in size, ranging from small islands with <1 km of coastline to sections of the mainland with over 30 km of coastline. Mean transect length will be 5.55 km. During winter, we plan to survey 99 shoreline transects, but this number varies among years, due to weather conditions and ice blockage. During summer, we plan to survey 212 shoreline transects. All transects were randomly chosen, and the same transects are used each survey (Klosiewski and Laing 1994).

To sample the coastal-pelagic and pelagic strata of Prince William Sound, we will divide the study area into 5-minute latitude-longitude blocks. When a block includes >1.8 km of shoreline, we will classify it in the coastal-pelagic stratum, and we will classify blocks with ≤1.8 km of shoreline in the pelagic stratum (Klosiewski and Laing 1994). When coastal-pelagic or pelagic blocks intersect the 200 m shoreline stratum, they will be truncated to avoid overlap. We plan to survey 2 north-south transect lines, 200 m wide each, located 1 minute inside the east and west boundaries of each coastal-pelagic and pelagic block. We will use Global Positioning Systems and nautical compasses to navigate transect lines. In the coastal-pelagic stratum, we plan to survey ≤29 blocks in the winter and ≤46 blocks in the summer. In the pelagic stratum, we plan to survey ≤25 blocks during both seasons.

3. Poststratification by Oiling

To examine population trends over time and to determine if populations injured by the spill are recovering, we will poststratify Prince William Sound into two zones, oiled and unoiled, based upon the pattern of oiling by the *Exxon Valdez* oil spill (Klosiewski and Laing 1994).

4. Statistical Analyses

As in previous surveys (Klosiewski and Laing 1994, Agler et al. 1994a,b,c, 1995a,b, Agler and Kendall 1997, Lance et al. In review), we will use a ratio estimator (Cochran 1977) to estimate population abundance. Shoreline transects will be treated as a simple random sample; whereas, the coastal-pelagic and pelagic transects will be analyzed as two-stage cluster samples of unequal size (Cochran 1977). To do this, we will estimate the density of birds counted on the combined transects for a block and multiply by the area of the sampled block to obtain a population estimate for each block. We then will add the estimates from all blocks surveyed and divide by the sum of

the areas of all blocks surveyed. We will calculate the population estimate for a stratum by multiplying this estimate by the area of all blocks in the strata. Population estimates for each species and for all birds in Prince William Sound will be calculated by adding the estimates from the three strata, and we will calculate 95% confidence intervals for these estimates from the sum of the variances of each stratum (Klosiewski and Laing 1994).

Population estimates for each species will be combined with other post-oil spill population estimates to determine population trends. We plan to use a homogeneity of slopes test (Freud and Littell 1981) to compare population trends between the oiled and unoiled zones of Prince William Sound to examine whether species with population estimates of >500 individuals have changed over time. To do this, we must assume that marine bird and sea otter populations increase at the same rate in the oiled and unoiled zones of Prince William Sound. The $\log_{10}$ of each population estimate will be calculated after adding 0.5 to the estimate to prevent effects from using log 0. Significantly different slopes would indicate that population abundance of a species or species group changed at different rates. For species or species groups showing a significant difference in slopes or ratios, we will determine the rate of change in each zone by linear regression analyses.

5. Statistical Justification for Proposed Monitoring Schedule

Currently, these surveys are scheduled to occur every 2 years over an unspecified time period. This schedule should be considered in light of the results of a power analysis.

To determine optimum survey frequency, we conducted a power analysis to estimate the probability of detecting trends in abundance using linear regression from a given number of samples (Taylor and Gerrodette 1993). We examined our power to detect trends when coefficient of variation (CV) of the population was 0.30 (greater than the mean CV from previous surveys for 73% of the injured species; Fig. 1) and when the CV = 0.13 (the mean summer CV for *Brachyramphus* murrelets, an injured species; Fig. 3). Models of seabird population growth predict most species increase no more than 12% per year (Nur and Ainley 1992), so we used 10% for our comparisons.

With CV=0.30 the probability of detecting an average annual change of 10% would be 40% with the 6 surveys completed to date (Fig 1). The probability would increase to ~ 55% in 2000 (7 surveys). If we continue on a biannual survey schedule, 1 more survey would be completed by 2002. With 8 surveys the probability of detecting a trend would increase to 71%. If 10 surveys were completed the probability would be 92%. For murrelets the power to detect a 10% change is now 95% (Fig. 3). This would increase to 100% with the completion of the 2000 surveys (Fig. 3).

Based on these calculations, we recommend a monitoring schedule of every two years for these surveys.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This project includes two contracts for a vessel to provided logistical support. We will need a vessel large enough to provide lodging and meals for 9 people and carry fuel for the small boats. During the winter survey, we will need a support vessel for 10 days. During the summer survey we can reduce our need for a support vessel to 7 days as we can use field camps in PWS for logistical support.

SCHEDULE

A. Measurable Project Tasks for FY 00 (October 1, 1999-September 30, 2000)

October-January:	Arrange logistics for surveys, train personnel
February:	Final preparations for survey
March:	Conduct winter survey in Prince William Sound
April-May:	Return to Anchorage, enter and analyze data, and store equipment
June:	Hire and train personnel, arrange logistics for summer survey
July:	Conduct summer survey in Prince William Sound
August:	Return to Anchorage, enter and analyze data, and store equipment
September:	Continue analysis of data from surveys

B. Project Milestones and Endpoints

After each set of surveys, we will examine the data for differences in trends between the oiled and unoiled zone for all designated injured marine birds and sea otters.

C. Completion Date

This project will continue biannually until population trends for the injured species show recovery from injury.

PUBLICATIONS AND REPORTS

October 2000:	Prepare draft report of 2000 surveys
January 15, 2001:	Draft Report to Peer Review
April 15, 2001:	Final Report complete

PROFESSIONAL CONFERENCES

No funds are requested for attending meetings.

NORMAL AGENCY MANAGEMENT

This project is not a part of normal agency management for the U. S. Fish and Wildlife Service in Alaska. Although considered an important ecosystem within Alaska, surveys of Prince William Sound would not be as high a priority as funding for projects within other areas of the state.

This year, Migratory Bird Management, U. S. Fish and Wildlife Service plans to provide 8 permanent personnel during the March survey to help reduce costs, but such personnel are unavailable during the July survey, because they are involved in other projects.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Principle investigators from other EVOS trustee council funded projects have used our survey data in the past. Data from these surveys would be helpful for the sea otter, harlequin duck, and pigeon guillemot portions of the nearshore vertebrate predator project (\025); the black-legged kittiwake, marbled murrelet (/231), and seabird foraging portions of the Alaska predator ecosystem experiment (\163); and harbor seal monitoring (\064).

EXPLANATION OF CHANGES TO CONTINUING PROJECTS

The 2000 surveys will be identical to previous Prince William Sound Surveys. This year it will be necessary to purchase 6 outboard motors (~ $10,000/each for a total of $60,000) for the 3 Boston Whalers used to conduct marine bird surveys. Our present outboard motors have been used in surveys over the last several years and are not in adequate condition to safely and efficiently conduct surveys in marine waters.

PROPOSED PRINCIPAL INVESTIGATORS

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PROPOSED PRINCIPLE INVESTIGATORS

1. Co-Project Leader - Brian K. Lance, Wildlife Biologist, GS-9.

Brian Lance received his M.S. degree in Wildlife Biology from the University of Alaska, Fairbanks in 1996 and his B.S. degree in Wildlife and Fisheries Biology from Texas A&M University in 1981. He joined the U. S. Fish and Wildlife Service, Office of Migratory Bird Management in March 1998 as a Wildlife Biologist. Mr. Lance has conducted surveys of Prince William Sound and Lower Cook Inlet to determine abundance of marine birds and sea otters. Prior to joining Migratory Birds, he studied diet and nestling growth in Red-legged and Black-legged kittiwakes on St. George Island in the Bering Sea. Brian has been involved with numerous seabird studies in Alaska including: Nearshore Vertebrate Predator Program: Avian Predation on Blue Mussel and seabird colony surveys on the Pribilof Islands.

Brian has presented papers on diet and nestling growth in Red-legged and Black-legged kittiwakes at Pacific Seabird Group meetings and the Alaska Cooperative Fish and Wildlife Research Unit meetings in Fairbanks.

Boat Survey Publications:

Bishop, M. A., B. K. Lance, S. P. Green, J. Mason, and E. W. Lance. 1997. Results of avian and marine mammal surveys in the nearshore waters of northeast Orca Inlet. Unpupl. manuscript, Prince William Sound Science Center.

Irons, D. B., S. J. Kendall, W. P. Erickson, L. L. McDonald, and B. K. Lance. In review. Chronic effects of the *Exxon Valdez* oil spill on summer marine birds in Prince William Sound, Alaska. Condor.

Lance, B. K., D. B. Irons, S. J. Kendall, and L. L. McDonald. Submitted. Marine Bird Population Abundance of Prince William Sound, Alaska: Trends following the *Exxon Valdez* oil spill. Restoration Project No. 98159. Final Rep., U.S. Fish and Wildl. Serv., Anchorage, Alas.

Seabird Publications:

Lance, B. K. 1996. Diet and nestling growth in Red-legged and Black-legged kittiwakes: an interspecies cross-fostering experiment. Unpubl. Master's Thesis, University of Alaska, Fairbanks. 127 pp.

Lance, B. K. and D. D. Roby. In press. Diet and postnatal growth in Red-legged and Black-legged kittiwakes (*Rissa brevirostris* and *Rissa tridactyla*): an interspecies comparison. Colonial Waterbirds.

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2. Co-Project Leader - David B. Irons, Ph.D., Wildlife Biologist, GS-12.

Dr. David Irons received his Ph.D from the University of California, Irvine in 1992. His dissertation was on the foraging ecology and breeding biology of the black-legged kittiwake in Prince William Sound. He received his M.S. from Oregon State University in 1982 where he studied foraging behavior of glaucous-winged gulls in relation to the presence of sea otters. Dr. Irons conducted marine birds and sea otter surveys in Prince William Sound in 1984 and 1985. He has been studying kittiwakes in Prince William Sound for 11 years and completed the *Exxon Valdez* oil spill kittiwake damage assessment study. Dr. Irons has overseen several seabird studies in the past few years, including marine bird and sea otter surveys of Prince William Sound and Cook Inlet, a seabird monitoring study on Little Diomede Island, and a cost of reproduction study on kittiwakes.

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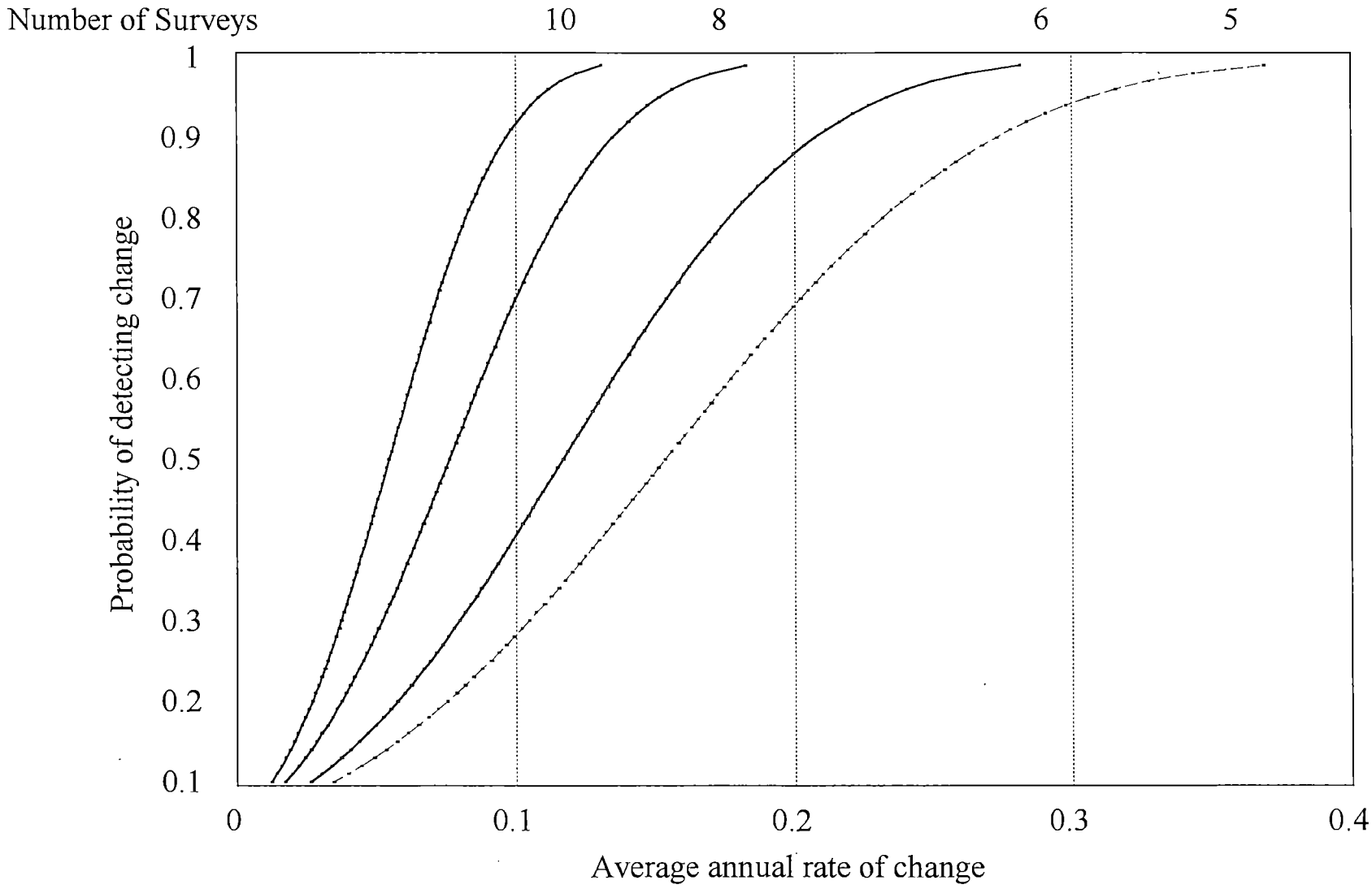

Figure 1. Estimated power (probability of detection) based on number of surveys conducted to detect a trend of marine bird and sea otter populations in Prince William Sound when CV = 0.30.

Figure 2. Transects and blocks surveyed during July small boat surveys of Prince William Sound. Transects were classified into 3 strata; the shoreline stratum, (<200 m from land), the coastal-pelagic stratum (lighter shaded blocks), and the pelagic stratum (darker shaded blocks).

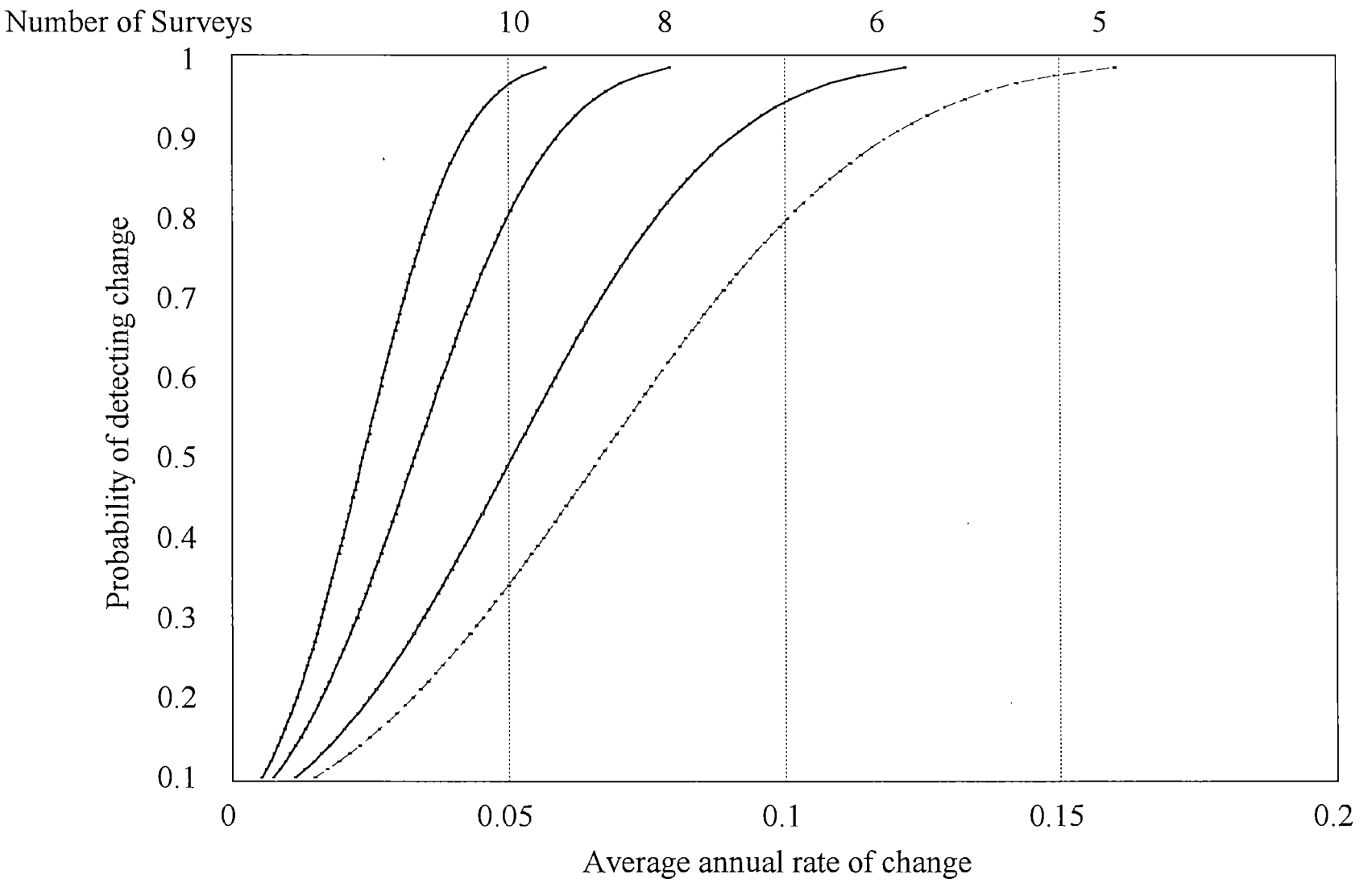

Figure 3. Estimated power (probability of detection) based on numbers of surveys conducted to detect a trend in the July *Brachyramphus* murrelet population in Prince William Sound. The CV = 0.13.

2000 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET
October 1, 199_ _eptember 30, 2000

Budget Category:	Authorized FFY 1999	Proposed FFY 2000	LONG RANGE FUNDING REQUIREMENTS			
			Estimated FFY 2001	Estimated FFY 2002		
Personnel	$31.3	$112.0				
Travel	$0.0	$12.6				
Contractual	$0.0	$51.3				
Commodities	$1.0	$35.8				
Equipment	$0.0	$67.5				
Subtotal	$32.3	$279.2				
General Administration	$4.7	$20.4				
Project Total	$37.0	$299.6	$48.7	$233.6		
Full-time Equivalents (FTE)	0.6	2.7				
	Dollar amounts are shown in thousands of dollars.					
Other Resources						

Comments: U. S. Fish and Wildlife Service will provide 8 people to conduct the winter survey.

2000

Prepared: 1 of 4

Project Number: 00159
Project Title: Marine Bird Boat Surveys
Agency: DOI - Fish and Wildlife Service

FORM 3A
AGENCY
PROJECT
DETAIL

4/14/99

Personnel Costs:			GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FFY 2000
PM	Name	Position Description					
	Irons	Co-Project Leader	GS12 - 6	0.5	7,200		3.6
	Lance	Co-Project Leader	GS11 - 1	12.0	5,200		62.4
	Unknown	Technician	GS5 - 1	7.0	2,300		16.1
	Unknown	Technician	GS5 - 1	4.0	2,300		9.2
	Unknown	Technician	GS5 - 1	3.0	2,300		6.9
	Unknown	Technician	GS5 - 1	3.0	2,300		6.9
	Unknown	Technician	GS5 - 1	3.0	2,300		6.9
		Subtotal		32.0	16,700	0	
Those costs associated with program management should be indicated by placement of an *.						**Personnel Total**	$112.0

Travel Costs:		Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FFY 1996
PM	Description					
	Truck and boat on train Portage - Whittier	714	3			2.1
	Passengers on train, Portage - Whittier (winter)	10	9			0.1
	Passengers on train, Portage - Whittier (summer)	16	10			0.2
	Per diem, (camp rate), 9 people, 30 days each survey			540	3	1.6
	Per diem, (travel rate), 9 people, 2 days winter, 7 days summer, 7 people, 3 days training			102	48	4.9
	Lodging, 5 nights, room @ $90/night total (Cordova)			5	90	0.5
	Lodging, 9 people, 6 nights winter (Whittier) @ $1000/week total			54		1.2
	Lodging, 9 people, 6 nights summer (Whittier) @ $1000/week total			54		1.2
	Lodging, 6 people, 3 nights (Whittier during boat training)			18	45	0.8
Those costs associated with program management should be indicated by placement of an *.					**Travel Total**	$12.6

2000

Project Number: 00159
Project Title: Marine Bird Boat Surveys
Agency: DOI - Fish and Wildlife Service

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 1996
Charter vessel (winter), 10 days	20.0
Charter vessel (summer), 7 days	14.0
Harbor fees	0.5
Boat repairs and parts	12.0
Training - ($550/person * 6 people)	3.3
Computer, printer, network repair and maintenance	0.5
Telephone services in office and field	0.7
Maintenance and repair of binoculars	0.3
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$51.3

Commodities Costs:	Proposed
Description	FFY 1996
Boat fuel (100 gal/day/boat) 3 boats for 50 days @ $1.50/gal	22.5
Outboard oil (2 gal/day/boat) 3 boats for 50 days @ $12.00/gal	3.6
Food ($12.00/person/day) 9 people for 50 days	5.4
Rain gear, rubber boots and gloves for 9 people @ $100/person	0.9
Scientific supplies (batteries for radios & other equipment, waterproof notebooks & paper, thermometers, wind guages)	1.2
Software updates for computers	0.2
First Aid kits	0.4
Lines, anchors and propellers for boats	1.5
Cleaning supplies	0.1
Commodities Total	$35.8

2000

Project Number:00159
Project Title: Marine Bird Boat Surveys
Agency: DOI - Fish and Wildlife Service

FORM 3B
Contractual & Commodities DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
Emergency replacement of equipment			1.5
Outboard motors for Boston Whalers	6	10,000	60.0
Installation of outboard motors: $ 2000 each boat	3	2,000	6.0
			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**	$67.5

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Camping supplies		DOI -FWS
Survival suits	9	DOI -FWS
Mustang suits	9	DOI -FWS
Float coats	9	DOI -FWS

2000

Project Number: 00159
Project Title: Marine Bird Boat Surveys
Agency: DOI - Fish and Wildlife Service

FORM 3B
Equipment
DETAIL