19.07.01 (8 of 9)

98300

Approved TC 8-6-97

Synthesis of the Scientific Findings from the *Exxon Valdez* Oil Spill Restoration Program

Project Number:	98300
Restoration Category:	
Proposer:	R. Spies/Applied Marine Sciences
Lead Trustee Agency:	ADNR
Cooperating Agencies:	
Alaska SeaLife Center:	
New or Continued:	Cont'd
Duration:	2nd. yr 3 yr. project
Cost FY 98:	$81.3
Cost FY 99:	$80.0
Cost FY 2000:	
Cost FY 01:	
Cost FY 02:	
Geographic Area:	
Injured Resource/Service:	

ABSTRACT

Research sponsored by the Trustee Council has provided an astonishing amount of information on the ecology of the spill area and represents the largest single infusion of data on natural resources in the northern Gulf of Alaska. The goal of this project is to synthesize this information across projects to realize its maximum benefit to the public and management agencies. The specific objectives involve coordinating the work of principal investigators on synthesis products, facilitating the efforts to apply food-web models of the spill area ecosystem, and facilitating the translation of valuable scientific findings into new management tools for use by natural resource agencies in Alaska.

INTRODUCTION

The 1989 *Exxon Valdez* oil spill was the largest oil spill in US history and occurred in an environment renowned for its fisheries and wildlife. Documenting damage and recovery of natural resources from the spill required an unprecedented scientific effort that has continued through the present Restoration Program. This effort has included numerous studies of fish, birds, intertidal and subtidal communities, and marine mammals. The 1993 Trustee Council-sponsored Symposium addressed the damage from the oil spill as it was understood at the time. As the Trustee Council approaches the end of the 10-year Restoration Program it is time to consider how all of these scientific studies have: (1) further documented injury and recovery of natural resources, especially for those resources that have been slow to recover, (2) provided insight into the ecology of the marine and coastal ecosystems of the spill area, (3) provided data and information useful for management of natural resources in northern Gulf of Alaska, and (4) provided a predictive understanding of how the ecosystem responds to natural and anthropogenic perturbations. This represents a major synthetic effort that will involve principal investigators, peer reviewers, ecosystem modelers, and management agency personnel. Careful planning, coordination, and facilitation is required to assure the success of such a program.

NEED FOR THE PROJECT

A. Statement of Problem

The Restoration Program produces annual reports, individual technical reports, proposals and workplan documents that are available through the Oil Spill Information Center. The sheer volume of these documents makes it difficult for those unfamiliar with the program to easily obtain study results. Even those familiar with the program find it challenging to understand the larger picture emerging from the various scientific projects sponsored by the Trustee Council. The public in particular is eager for scientific results that are presented in a simple and straight forward manner. We propose to address this need through continuing the development of the Restoration Notebook Series (3-5 page summaries of injury and recovery of particular resources).

In addition, there is also a need for a basic scientific synthesis that (1) integrates findings from different projects to summarize the injury and recovery of resources for the scientific community, (2) documents the expanding understanding of the spill area ecosystem being established by the large interdisciplinary research projects, (3) uses that understanding to guide the development of mathematical models that will refine our knowledge and establish predictive capability, (4) contributes to identifying the features of an ongoing monitoring program, and (5) identifies the scientific information and tools developed by EVOS-sponsored projects with potential management application.

B. Rationale/Link to Restoration

Synthesis of the research and monitoring conducted by the Trustee Council will be essential for completion of the restoration program. Due to the magnitude of the effort undertaken, integration and synthesis of scientific findings will be essential to provide the public and management agencies with an accessible source of information regarding restoration and recovery of the damages from the oil spill. Synthesis products will also be valuable summaries of the Restoration Program to scientists and members of the public in the future. Finally, these products will be essential as the scientific foundation for any utilization of the restoration reserve for research and monitoring.

Developing more effective linkages between Trustee Council-sponsored science and management efforts is important in order to achieve the Council's goals of enhancing injured resources and services through developing more sophisticated and effective management programs.

C. Location

This work will be conducted by principal investigators in Alaska, by the Chief Scientist in Alaska and California, and by scientific reviewers throughout North America.

Community Involvement and Traditional Ecological Knowledge

Traditional Ecological Knowledge will be appear in the synthesis products to the extent that this knowledge is an essential part of the findings of research and monitoring programs. Although little community involvement is foreseen in the development of synthesis products, the Restoration Notebook Series will likely be of great interest to members of local communities in the oil spill area, as will overall predictions of resource variation (if available) from modeling studies.

PROJECT DESIGN

A. Objectives:

1. Continue to review draft accounts for the Restoration Notebook Series, as requested by the Science Coordinator and the Communications Director.

2. Coordinate and facilitate the construction of food web models (Project 98330).

Based upon the results of the modeling workshop conducted as part of project 97300 in Anchorage in January, 1997, it is likely that the Chief Scientist will recommend that a food web modeling project be initiated in FY98 (see project 98330). This project will utilize the results of many different investigators to produce a set of relatively simple models that integrate much of the data developed to date regarding biological populations in Prince William Sound. These models can then be used to highlight important parameters for which we need more information, and can be used to provide tests of large-scale perturbations in the system.

The discussion in the workshop (and prior to the workshop), and the comments of peer reviewers, made it clear that the interactions of the food web modeling group with EVOS PIs must be carefully coordinated. There is a significant sensitivity among principal investigators regarding use of preliminary data by others, and about the effectiveness of simple modeling approaches. The enthusiasm generated by the workshop suggests that these issues can be addressed, but consistent planning and attention by the Chief Scientist and Science Coordinator will be required to successfully construct the models.

In addition, depending upon the success at validating the predictive capability of the food web models, these models may be valuable new tools for application by management agencies. An active role by the science program is required to identify the meaningful scenarios to be run by Dr. Pimm's model.

3. Oversee the production of integrative scientific papers than synthesize the results of damage assessment and restoration projects.

4. Develop a plan for improving the interaction between management agency personnel and principal investigators that leads to applied research useful to management, and better integration of existing research findings into management programs.

The Trustee Council has clearly indicated that one of the purposes of the science program is to enhance injured resources by providing information for improved management. Based upon conversations with both managers and PIs, it is clear that such "technology transfer" is unlikely to occur on its own. The scientists lack a precise understanding of what the managers require, and the managers may not be familiar enough with the features of the scientific program to identify and guide the development of management tools. It is therefore apparent that a proactive effort on the part of the Chief Scientist is necessary to achieve the Council's goal of enhancing resource management.

B. Methods

This project will be coordinated through the Chief Scientist's office using established administrative procedures. Different approaches will be taken to pursue each of the objectives.

1. Restoration Notebook Series

These moderate-length summaries (3-5 pages) of the scientific findings from the studies of injured resources are being produced by the restoration office with technical input by the Chief Scientist and reviewers. Subject outlines were prepared and distributed by the Chief Scientist and Science Coordinator in 1997 with feedback from the proposed authors of the chapters. Drafts prepared by the authors (principal investigators) will be reviewed for content and style and the description of findings will be finalized.

2. Coordination and Facilitation of Food Web Modeling

The methods used in facilitating and coordinating the development of these models are very straightforward, and essentially involve establishing and maintaining adequate communication among all parties. The modelers and their technical staff members must be made aware of which research groups have data of interest, what publications already exist, how to effectively contact these organizations, and the identity of the key contacts. Existing principal investigators must be acquainted with the goals of the modeling program, the extent and magnitude of their participation and cooperation that is expected, the commitment of the restoration program to the fair and professional use of unpublished or preliminary data.

The first major watershed of the modeling program will be a workshop during the winter of 1998 at which various principal investigators will present summaries of their data regarding biological populations and processes in the oil spill region. These data will be used to establish the parameters of the food web models and will be edited into a book for

publication. It is anticipated that much of the facilitation and coordination efforts will occur in planning for this workshop and following-up on decisions made at the workshop.

3. Production of scientific synthesis papers

There are more potential synthesis papers to produce than the restoration program has the time and resources to support. The first task under this objective is to consult with the Scientific Coordinator, Executive Director, Communications Director, and reviewers to develop a prioritized list of synthesis papers. Examples of papers that could be produced include (1) a description of the damage assessment and restoration process that reviews the evolution and rationale of the restoration program and derives general themes and ideas to be applied in other restoration programs, (2) a synthesis of the results of damage assessment and restoration studies of fishery resources, or (3) a synthesis of the results of damage assessment and restoration of intertidal resources and the species trophically dependent on the intertidal. Wherever possible, it will be important to attempt to address discrepancies between the results of projects sponsored by the Trustee Council and those of Exxon contractors.

There also may be a need to respond to scientific critiques of the restoration program in the literature. These responses have been mostly completed, although there may be more to develop in the future.

The Chief Scientist will also work closely with any principal investigators being funded independently to produce synthesis papers. Proposals were submitted in this regard to the Trustee Council for funding in FY98 for salmon (98329), herring (98328), and common murres (98144b).

4. Integrating Science and Management

The process of integrating new scientific findings with existing government management programs is a challenging issue due to technical, political, fiscal, and administrative complexities. This must be a long-term effort, as was recognized by many participants in the FY97 annual workshop. In FY98, the goal of project would be to determine which EVOS projects have the best potential to provide valuable tools and information to address those needs, and present a general description of necessary steps to make the tools and information available to the agencies. These steps will be identified through discussions with management agency personnel and principal investigators regarding specific issues surrounding each potential application of Trustee Council-sponsored science.

This process would also identify a set of parameters for long-term ecosystem monitoring as defined by the needs of managers, the discoveries of the researchers, and the economics of long-term funding. This information will be valuable for the design and implementation of the FY98 annual meeting, which is expected to have long-term monitoring as its organizing theme.

C. Cooperating agencies, contracts and other agency assistance.

The cooperation of the following agencies are clearly key to the success of this effort: Alaska Department of Fish and Game, National Oceanographic and Atmospheric Administration/National Marine Fisheries Service, Department of the Interior (Biological Resources Division of the U.S. Geological Survey and the U.S. Fish and Wildlife Service). Principal investigators of many past and ongoing research and monitoring programs, and modeling project personnel, will also be key cooperators in this project. Contracts and consulting agreements will be renewed or established for scientific reviewers involved in the project.

SCHEDULE

A. Measurable Project Tasks for FY98

1. Completion of contributions for the Research Notebook Series.
2. Successful planning, preparation, and implementation of the workshop to specify model parameters for project 98330.
3. Preparation of draft synthesis manuscripts for submission to scientific journals.
4. Develop a strategy for integration of scientific research and management requirements.

B. Project Milestones and Endpoints

Provide technical review of draft Restoration Notebook Series contributions as requested by the Restoration Office.

Finalize list of invitees to the food-web modeling workshop sponsored by Project 98330 (November 1997)

Finalize agenda for food web modeling workshop (December 1997)

Submit list of proposed scientific synthesis papers to Executive Director (December 1997)

Conduct workshop to food web modeling workshop (February 1998)

Draft strategy for integrating science and management submitted to Executive Director (April 1998)

Complete preliminary draft of first scientific synthesis paper (September 1998)

C. Completion Date

This project is scheduled for completion in FY99, although might be continued depending upon the needs of the Trustee Council and the Executive Director.

PUBLICATIONS AND REPORTS

At least two scientific synthesis papers are expected, with the preliminary draft of the first paper completed before the end of FY98. It is planned with the help of EVOS staff to publish the collected resource summaries in a loose-leaf notebook.

NORMAL AGENCY MANAGEMENT

This exercise is dealing with some of the end products of the oil spill scientific research program is clearly outside the scope of normal agency management.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This purpose of this project is to coordinate and integrate many of the activities or the Restoration Program.

Principal Investigators

Robert B. Spies, Ph.D.
Andrew J. Gunther, Ph.D.

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Approved TC 8-6-97

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$76.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$76.0
General Administration		$5.3
Project Total	$0.0	$81.3
Full-time Equivalents (FTE)		0.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002
$75.0			

Dollar amounts are shown in thousands of dollars.

Comments:

1998

Prepared:

Project Number: 98300
Project Title: Synthesis of Scientific Findings from the *Exxon Valdez* Oil Spill
Agency: Department of Natural Resources

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$21
Travel		$7
Contractual		$30
Commodities		$1
Equipment		$0
Subtotal	$0.0	$59
Indirect		$17
Project Total	$0.0	$76
Full-time Equivalents (FTE)		3.5
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
	$75.0				

Dollar amounts are shown in thousands of dollars.

Comments:

1. Except single fixed-price subcontract, project will be billed on a time and materials basis, with budget serving as not to exceed amount.
2. Sevices of Chief Scientist provided as necessary through administrative budget.

1998

Prepared:

Project Number: 98300
Project Title: Synthesis of Scientific Findings from the *Exxon Valdez* Oil Spill
Name: Applied Marine Sciences

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs: Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
A. Gunther	Assistant Chief Scientist		3.5	5946.0		20,811.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.5	5946.0	0.0	
					Personnel Total	$20,811.0

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
Pre-workshop planning session (Gunther)	650.0	1	4	125.0	1,150.0
Model Development Workshop					0.0
Gunther	650.0	1	6	125.0	1,400.0
Peterson	1000.0	1	5	125.0	1,625.0
Mundy	650.0	1	5	125.0	1,275.0
					0.0
					0.0
Task 2 Assessment meeting (Gunther)	650.0	1	4	125.0	1,150.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$6,600.0

1998

Prepared:

Project Number: 98300
Project Title: Synthesis of Scientific Findings from the Exxon Valdez Oil Spill
Name: Applied Marine Sciences

FORM 4B
Personnel
& Travel
DETAIL

5/20/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed FY 1998
Description	
Peer Reviewer activities for Tasks 1, 2, and 4	9,600.0
Synthesis paper preparation (fixed price contract)	20,000.0
Contractual Total	$29,600.0

Commodities Costs:	Proposed FY 1998
Description	
shipping & communications ($75/month for 12 months)	900.0
miscellaneous	250.0
Commodities Total	$1,150.0

1998

Prepared:

Project Number: 98300
Project Title: Synthesis of Scientific Findings from the Exxon Valdez Oil Spill
Name: Applied Marine Sciences

FORM 4B
Contractual & Commodities DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
			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	

1998

Prepared:

Project Number: 98300
Project Title: Synthesis of Scientific Findings from the Exxon Valdez Oil Spill
Name: Applied Marine Sciences

FORM 4B
Equipment
DETAIL

Approved TC 8-6-97

Prince William Sound Cutthroat Trout, Dolly Varden Char Inventory

Project Number:	98302 - CLO
Restoration Category:	Monitoring
Proposer:	USFS, Cordova Ranger District
Lead Trustee Agency:	USFS
Alaska SeaLife Center:	
Duration:	Second year, 2-year project
Cost FY 97:	$12,800
Cost FY 98:	$ 4,100
Geographic Area:	Prince William Sound
Injured Resource:	Dolly Varden char, cutthroat trout

ABSTRACT

This is the closeout of monitoring project 97302. This proposal is for the funding of the writing of the final report.

The status of cutthroat trout and Dolly Varden char following the *Exxon Valdez* oil spill is unknown, and little baseline information exists. One specific problem is the lack of information concerning the existence of these species in various watersheds. So far in FY 1997, the main researcher has interviewed local residents and other knowledgeable persons and conducted literature searches to document the locations of cutthroat trout and Dolly Varden char populations. A number of previously undocumented populations have been discovered. Additional work and some field sampling will occur during the rest of FY 1997 to verify unsubstantiated reports.

INTRODUCTION

There is little information available on the presence of Dolly Varden char (*Salvelinus malma*) and cutthroat trout *(Oncorhynchus clarki)* in various watersheds in Prince William Sound. Other studies have stated that there are only 14 lacustrine systems in Prince William Sound that have anadromous Dolly Varden char and only 10 with anadromous cutthroat trout (Hepler et al. 1993). Recent consultations with local residents indicate, however, that there may be many other lacustrine systems with these species. There are also a number of lacustrine and non-lacustrine systems with these species which have not been recorded in the Alaska Department of Fish and Game Anadromous Waters Catalog (1994 revision).

By conducting a more complete inventory of the lake and stream systems in Prince William Sound, we should get a better understanding of the distribution of these species, their abundance, and the magnitude of the effects of the oil spill on these species. If there are substantially more systems with large populations than had been previously reported, the spill may not have had a substantial impact on the overall health of the species and enhancement work may be unnecessary. On the other hand, if the number of systems are limited and populations are small, additional measures may be needed to protect these species and their habitat.

In FY 1997, researchers have conducted interviews with local residents and other knowledgeable persons and have reviewed the literature, agency reports, and other sources of information. So far a number of undocumented populations of both species have been discovered. Additional interviews and literature searches, as well as some field sampling, will be conducted during the remainder of FY 1997. The final report will be written in FY 1998.

NEED FOR THE PROJECT

A. Statement of Problem

The status of anadromous Dolly Varden char and cutthroat trout in Prince William Sound is currently unknown. One of the problems is that basic information, such as the stream systems which have these species, now appears to be incomplete. Without knowing how many stocks are present in the Sound or knowing whether large populations exist in remote streams or lakes, it is difficult to say whether further enhancement work is necessary to boost the populations or whether the species have recovered.

B. Rationale/Link to Restoration

This project will identify those systems with Dolly Varden char and cutthroat trout populations and provide an idea as to the relative numbers. If there are substantially more stocks than previously believed, or with greater numbers, we may be able to conclude that these species have recovered sufficiently, or that there is no need for further enhancement. If there are still some

uncertainties, more intensive population studies could be carried out, presumably by the Alaska Department of Fish and Game Sportfish Division, which is responsible for population management of these species.

The information from this project can also be combined with the results of *EVOS* project 96145 to help determine the relative status of these species. If project 96145 determines that the populations throughout the Sound are genetically similar, and this project finds numerous streams with these species, there may be less need for concern. If, however, the populations are few, isolated, and genetically distinct, there may be a greater need for habitat protection or enhancement.

C. Location

A number of potential sites have been identified in the Valdez Arm area, Hinchinbrook Island, northern Montague Island, and Knight Island. A better understanding of these species would benefit all users of the Sound, but particularly the residents of Valdez, Tatitlek, Cordova, and Chenega.

COMMUNITY INVOLVEMENT

The idea for this project originated out of information we received from local residents regarding stocks of Dolly Varden char and cutthroat trout. We learned that there are a number of stream systems with these species which are not listed in the Anadromous Waters Catalog and were apparently not known to other researchers. Thus, one of the primary methods for conducting this project will be to contact local residents in the communities of the Sound and ask for information on stream systems with these species. Questionnaires, telephone calls, or other methods would be used to contact various tribal groups, sportfishing clubs, or persons who might have knowledge of the local streams.

PROJECT DESIGN

A. Objectives

1. Determine the presence or absence of cutthroat trout and Dolly Varden char populations in stream systems in Prince William Sound, using interviews, literature searches and other written information, and field sampling.

2. Compile the information on population locations from this project and other studies for inclusion in the Alaska Department of Fish and Game Anadromous Catalog.

B. Methods

The basic hypothesis is that there are a number of undocumented anadromous cutthroat trout and Dolly Varden char populations in Prince William Sound, some of which could have large numbers of fish. This project will require a thorough investigation of past studies by other agencies, and equally as important, a gathering of information from local residents and organizations. Field sampling may be needed to verify some reports or to determine the presence of these species in systems which appear suitable but have no information available.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

We would ask the Alaska Department of Fish and Game to provide information from past studies, but otherwise no other agency assistance is anticipated. The need for contracts with the private sector is not foreseen.

SCHEDULE

A. Measurable Project Tasks for FY 98

Writing and completion of final report: October, November 1997.

B. Project Milestones and Endpoints

Objective 1. Determine presence or absence of species: August 31, 1997.

Objective 2. Provide information to ADF&G for inclusion in the Anadromous Waters Catalog: November 30, 1997.

C. Completion Date

The field work should be finished by October 15, 1997, and the final report by November 30, 1997 (FY 98).

PUBLICATIONS AND REPORTS

There are no plans to submit the results of this study or the final report for publication.

PROFESSIONAL CONFERENCES

There are no plans to present this study at professional conferences. This information could be shared informally at USFS biologists meetings or other local meetings, such as the Cordova Flyfishers, but no additional travel or preparation funding would be required.

NORMAL AGENCY MANAGEMENT

The U.S. Forest Service has conducted similar surveys in the past, but only in conjunction with major projects, such as the road that was constructed around the south end of Montague Island. The other surveys did not attempt to estimate numbers of fish, only the presence or absence. Generally, the Forest Service only manages habitat, not populations. The Forest Service is not mandated by statute or regulation to conduct projects such as this. This project might also include studies on streams that are not on Forest Service land.

Without this project there would be no further injury to the affected species, but the project should provide a better basis for determining the status of the populations and their recovery. With this information we should also get a better understanding of habitat requirements for these species, which will improve the long-term management of the watersheds where they exist. This could help guide future land acquisitions if key habitats are threatened by timber harvest or other activities.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The need for this project became apparent while we were working with the investigators for *EVOS* project 96145. There was little information available on the location or size of cutthroat trout and Dolly Varden char stocks in Prince William Sound. We would hope to be able to coordinate some boat trips with them and, if needed, provide information to them on possible sampling sites for their project. We have not tried to obtain matching funding from other sources, but the U.S. Forest Service would provide the use of a boat and other services.

PROPOSED PRINCIPAL INVESTIGATOR

Merlyn Schelske
U.S. Forest Service
P.O. Box 280 Cordova, AK. 99574
907-424-7661
907-424-7214 (fax)

LITERATURE CITED

Hepler, K., P.A. Hansen, and D.R. Bernard. 1993. Impact of oil spilled from the *Exxon Valdez* on survival and growth of Dolly Varden and cutthroat trout in Prince William Sound, Alaska. Alaska Department of Fish and Game, Sportfish Division. 39 pp.

Approved TC 5-6-97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel	$9.4	$3.6
Travel	$0.9	$0.0
Contractual	$0.0	$0.0
Commodities	$1.1	$0.0
Equipment	$0.0	$0.0
Subtotal	$11.4	$3.6
General Administration	$1.4	$0.5
Project Total	$12.8	$4.1
Full-time Equivalents (FTE)		0.1
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	

Dollar amounts are shown in thousands of dollars.

Comments: Continuation of project 97302

1998

Project Number: 98302
Project Title: PWS Cutthroat Trout, Dolly Varden Char Inventory
Agency: US Forest Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: 4/15, K.Holbrook of 4

4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1998
K.Hodges	Fish Biologist	GS-9	0.3	3.9		1.2
M.Schelske	Bio Tech	GS-7	0.7	3.4		2.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.0	7.3	0.0	
					Personnel Total	$3.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

1998

Prepared:

Project Number: 98302
Project Title: PWS Cutthroat Trout, Dolly Varden Char Inventory
Agency: US Forest Service

FORM 3B
Personnel
& Travel
DETAIL

4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FY 1998
Commodities Total	$0.0

1998

Project Number: 98302
Project Title: PWS Cutthroat Trout, Dolly Varden Char Inventory
Agency: US Forest Service

FORM 3B
Contractual & Commodities DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
			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

1998

Project Number: 98302
Project Title: PWS Cutthroat Trout, Dolly Varden Char Inventory
Agency: US Forest Service

FORM 3B
Equipment
DETAIL

Prepared: 4/15/97

approved TC 8-6-97

Ecology and Demographics of Pacific Sand Lance, *Ammodytes hexapterus* Pallas, in Lower Cook Inlet, Alaska

Project Number:	98306
Restoration Category:	Research
Proposer:	USGS Biological Resources Division
Lead Trustee Agency:	DOI
Cooperative Agencies:	ADF&G
Duration:	3years (1998, 1999, 2000)
Cost FY 98:	$32,800
Cost FY 99:	$30,000
Cost FY 00:	$20,000
Geographic Area:	Kenai Peninsula, Lower Cook Inlet, Chisik Island, Barren Islands, Kachemak Bay
Injured Resource:	Multiple (forage fish and upper trophic Level predators)

ABSTRACT

The purpose of this study is to characterize the basic ecology, distribution, and demographics of sand lance in lower Cook Inlet. Recent declines of upper trophic level species in the Northern Gulf of Alaska have been linked to decreasing availability of forage fishes. Sand lance is the most important forage fish in most nearshore areas of the northern Gulf. Despite its importance to commercial fish, seabirds, and marine mammals, little is known or published on the basic biology of this key prey species.

INTRODUCTION

An estimated 250,000 seabirds were killed by *Exxon Valdez* oil pollution. Based on comparisons of pre-spill (1970s) and post-spill (1989-1995) data, long-term effects on seabirds attributed to oil pollution included: i)population declines, ii) reduced breeding success, and, iii) delayed breeding phenology.

However, some purported effects of the spill may have been due in large part to natural changes in the Gulf of Alaska marine ecosystem-- in particular, declines in forage fish abundance (Piatt and Anderson 1996). The rate at which seabird populations will recover from effects of oil mortality are unknown, but is probably linked to population dynamics of forage fish species, of which sandlance is the most important.

Sand lance (genus *Ammodytes*) are zooplanktivorous, semi-demersal, schooling perciforms. They are ubiquitous to the boreo-arctic regions of the North Atlantic and North Pacific and are particularly abundant in coastal regions. There are three genera of sand lance; Hyperoplus sp., Gymnammodytes sp., and Ammodytes sp. distributed in the Northeast Atlantic from Novaya Zemblya to Spain. Ammodytes sp. is also distributed in the Northwestern Atlantic from West Greenland to Cape Hatteras, North Carolina (Leim and Scott 1966, Winters and Dalley 1988) and in the North Pacific from the Bering Sea to southern California (Wilimovsky et al. 1988). Although several species of *Ammodytes* have been described for the North Atlantic, a different species, *Ammodytes hexapterus* is the only species found in the Gulf of Alaska.

Sand lance serve as an important trophic link between zooplankton and marine vertebrate piscivores (Winters 1983) particularly on continental shelf ecosystems (Springer et al. 1996). In the North Pacific, sandlance are forage for fish, seabirds, and marine mammals. Seabirds consuming sand lance include red-faced cormorant (Hunt et al. 1981), black-legged kittiwake, common murre, thick-billed murre, pigeon guillemot, horned puffin, tufted puffin, brachyramphus murrelets, and rhinoceros auklet (Wilimovsky et al. 1988, Springer 1991, Piatt and Anderson 1996). Marine mammals consuming sand lance include Stellar sea lion, minke, sei, and humpback whales (Wilimovsky et al. 1988). Commercially important fish preying on sand lance include Pacific cod, halibut, lingcod, rockfish, and salmon (Wilimovsky et al. 1988).

Due to the commercial fishery for sand lance in the North Atlantic, much is known about sand lance in this region. In the North Pacific, however, sand lance are of little commercial importance. Despite their role as a forage species, there is a paucity of published information on their biology and population dynamics in this area.

Physical factors such as temperature and bottom substrate have been shown to have a marked affect on distribution of Atlantic sand lance species. Sand lance move out from nearshore areas of lower Cook Inlet during July, perhaps in response to fluctuations in sea temperature and changing physiological requirements. Therefore an investigation of sand lance behavior and biology in relation to the environment is critical to a complete understanding of relationships between upper trophic level predators and sand lance.

NEED FOR THE PROJECT

A. Statement of Problem

Lack of recovery of species injured in the *Exxon Valdez* oil spill is currently thought to be linked to changes in forage fish abundance or composition. Changes in species composition or abundance of forage fish will have marked effects on predators, in terms of the time needed to find and consume fish,

as well as in the relative energy value of that fish once consumed. Therefore, an understanding of the factors affecting forage fish distribution, abundance, and quality is vital to an understanding of predator distribution, abundance and recovery.

B. Rationale

It is important to study the ecology and demographics of sand lance because i) sand lance are one of the most important prey species consumed by seabirds, marine mammals, and commercial fish in Alaska; ii) changes in sand lance abundance and distribution therefore have direct effects on predators; and, iii) natural environmental changes may have reduced sand lance populations in recent years. These population changes may limit the ability of higher predators to recover from oil spill impacts.

C. Summary of Major Hypotheses and Objectives

Our major hypothesis is that sand lance availability to higher predators is governed by behavioral and biological responses of sand lance to their environment. Predation on sand lance by various seabirds is being studied as part of the APEX program (Project 96163 M). This project will focus on sand lance in Kachemak Bay, lower Cook Inlet.

The major objectives are:

1. To establish how seasonal and diel movements of sand lance impact their availability as a food source for marine piscivores.

2. To assess or measure physical parameters (e.g., temperature, substrate type, salinity, and turbidity) that are associated with feeding and spawning habitats.

3. To measure caloric content of sand lance throughout the year and assess their overall food value to marine piscivores. Food value will be compared with other forage fish collected in Lower Cook Inlet.

4. To investigate Meristic and genetic characteristics to establish if distinct populations of sand lance occur within the Cook Inlet and northern Gulf of Alaska.

5. To estimate acoustic abundance and productivity (e.g., larvae production, habitat use) of sand lance in different areas of Cook Inlet.

6. To complete compilation of a bibliography of sand lance literature from published and unpublished sources.

D. Completion Date

Field work for this project will be completed in FY 99. Compilation and analysis of all data and production of a final report will be finalized in FY00.

COMMUNITY INVOLVEMENT

Local knowledge of sand lance spawning sites, and areas where found buried at low tide will be invaluable to this project. Communications with local residents during the summers of 1995 and 1996 have provided information on at least two sites where sand lance spawn. Spawning was observed and documented by this project at one of these sites in the fall of 1996.

FY 97 BUDGET

Contractual	$30,700
G. Admin.	2,100
Total	32,800

The entire working budget (30.7K) will be transferred to Memorial University of Newfoundland through a Cooperative Agreement. These funds will be used to support the graduate student conducting the research (stipend, benefits, tuition, & fees = 29.3K), and to cover travel for the student to attend APEX meetings in Alaska (Nfld to AK, 1.4K). Travel funds are being transferred directly to Memorial, because the BRD has no mechanism by which we can arrange travel for a non-employee working in a foreign country.

Conferences and Meetings

Money has been budgeted for the graduate research assistant to attend the EVOS Annual Restoration Workshop and the APEX Annual Peer Review Meeting. Because of possible restriction of academic requirements, these meetings will only be attended if time allows.

Publications

At this time it is projected that results from this study will be fully prepared and submitted to peer review journals by October 2000. It is expected that papers will be prepared each year and submitted covering different aspects of the research. Journals that would be a good forum to present results from this project include Copeia, Fisheries Bulletin, Journal of Marine Science, and Canadian Journal of Zoology. The bibliography will be made available in report form, and in electronic format (Pro-Cite).

PROJECT DESIGN

A. Objectives

1. To establish how seasonal and diel movements of sand lance impact their availability as a food source for marine piscivores.

2. Measure demographic parameters of sand lance including age composition, growth rate, patterns of growth, and sex ratios.

3. Meristic and genetic characteristics will be used to establish if distinct populations of sand lance occur within Cook Inlet and throughout the northern Gulf of Alaska.

4. Critical feeding and spawning habitat of sand lance will be described in relation to physical parameters (e.g., temperature, substrate type, salinity, and turbidity).

5. Estimates will be made of sand lance productivity and abundance within the Cook Inlet.

6. The caloric content of sand lance will be investigated throughout the year to evaluate their value as forage for marine piscivores.

B. Methods

FIELD COLLECTIONS:

Sand lance will be caught using a variety of nets to sample beaches, nearshore areas, and offshore waters:

Beach Seines:
A beach seine (37m long, 28.6mm stretch mesh tapered wings, 6mm stretch mesh cod end in middle) will be used for all beach seining. Two types of beach seine will be used; a standard net with netting uninterrupted from the float line to the lead line, and a modified seine with a lined lower section. The modified type of seine can be used on rocky bottoms or where there are mussels beds. This will allow for collection of sand lance from a wide variety of locations within the study area. Seines will be made in sets of two at each location at least every two weeks during the summer (May to October), and once a month during the winter (November to April), conditions and light permitting. Seines will be made at high and low tide until a comprehensive dataset is established to evaluate differences in sand lance catch between the tidal states.

Permanent sample locations within Kachemak Bay will be at Halibut Cove, Peterson Bay, China Poot Spit (winter samples), and Eldred Passage, Yukon Island, and Seldovia Bay (winter and summer samples). These sites provide a wide range of physical conditions (exposure, water regimes, substrates etc.) with which to evaluate physical conditions preferred by sand lance. Comparative collections of sand lance will also be made in the Barren Islands (East Amatuli Cove) and Chisik Island (Snug Harbor). Sand lance will also be obtained from APEX colleagues working in Prince William Sound, and opportunistically from other locations in Alaska.

Fish Stomachs:
Halibut stomach contents will be used to establish presence of sand lance in deeper offshore waters. This method uses stomachs from halibut caught by charter boats during the summer. Results from 1996 show larger sand lance to disappear from the nearshore during July (a critical month for chick-rearing seabirds), however, these fish were not found in mid-water trawls or cast net samples. Using halibut will provide valuable information to the summer movements of sand lance.

Trawls:

Nearshore Areas:

A 42.5 feet long, 200 ft^2 opening, 3.2mm mesh cod end Kodiak Trawl will be used to sample the nearshore, outside the area covered by the beach seine. This net will be pulled by two boats (Sand lance and David Gray).

Offshore Waters:

University of Alaska, Fairbanks flatfish trawls (Brenda Norcross) as well as Alaska Department of Fish and Game shrimp and herring trawls (Paul Desjardin) are made routinely in Kachemak Bay. The location and depth of any sand lance caught in these trawls is routinely collected, and these data will be made available to us. Sand lance caught will be frozen and provided to us for later analysis.

Historical data from NOAA plankton trawls currently being compiled by Paul Anderson (NMFS) will be made available to us. This data will provide valuable information on the early distribution and abundance of sand lance larvae.

Digging:

Sand lance bury themselves in sandy substrates although the timing and reasons for such behavior and not fully understood. We will dig for sand lance on "clamming" tides in Halibut Cove, Peterson Bay, and in China Poot Bay as well as at other sites discovered through interaction with local clam diggers. This method of collection is important in winter months when sand lance are not found in beach seine samples. Critical substrate parameters (grain size, substrate composition etc.) will be measured at the same time as collections are made.

Hydroacoustics:

Surveys of the nearshore using hydroacoustic equipment (DT4000) will be used to estimate biomass of sand lance in these areas, and examine seasonal and diel variability in sand lance abundance nearshore. These surveys will be made over a fine scale grid in the nearshore areas in conjunction with the two-weekly beach seinings and cast netting. In conjunction with other data collected, we will be able to estimate the total abundance of sand lance in the nearshore zones of the study area. Hydroacoustic data will also be analyzed for bottom type using new Biosonic analysis software. This will allow us to investigate substrate preferences for sand lance and available habitat.

Cast Netting:

During 1996, pilot studies using cast nets on schooled fish at sites of seabird feeding mellées proved highly effective. This method will be fully integrated into this study during the summer of 1997 providing information on age structure, abundance, and timing of availability for sand lance to seabirds.

Other methods:

Underwater video was used in Prince Willian Sound for the assessment of forage fish schools during 1996. Dependent on the availability of this equipment and water visibility we will use this method to study sand lance schooling behavior, movements, and distribution in 1997.

LABORATORY ANALYSIS:

Lengths and weights of sand lance will be noted for 100 individuals (minimum if possible) collected at each site. These results will be used to establish length-weight relationships as well as growth over time.

Age determinations will be based on otolith interpretations according to the methodology of Macer (1966) and Scott (1968, 1973). Otoliths with poorly defined annuli will be omitted from the age determinations.

Gonad development and stage of maturity will be classified according to the following stages; 0, immature; 1, maturing (developing); 2, ripe; 3, running; 4, spent; and 5, recovering. Specimens will be assigned these categories according to gonad condition described by Macer (1966).

Meristic parameters will be noted for populations of sand lance collected from different geographic areas within Alaska. These values will be compared with each other as well as to other *Hexapterus* species found in the North Pacific. Genetic comparisons between different populations will be done by a collaborator.

Caloric content will be established in collaboration with Dan Roby at Oregon State University. This work will be used to assess the relative value of sand lance to marine predators over a season as well in comparison to other forage species.

BIBLIOGRAPHY:

Available literature in the form of published papers and reports will be searched using on-line search facilities at Memorial University of Newfoundland and BRD (Anchorage). References will be compiled using Pro-Cite and published as a report, and in electronic format. Pro-Cite will allow other researchers to easily search the bibliography for individual specific needs.

C. Contracts and Other Agency Assistance

The project will be carried out by a Ph.D. student. A Cooperative Agreement has been established to provide funding for this student at Memorial University of Newfoundland under supervision from Dr. George Rose.

D. Location

The project is a portion of an ecosystem study of lower Cook Inlet (EVOS APEX project 96163 M). Sand lance research will be focused on Kachemak Bay because they are common there, and the area is logistically easy to work in. Comparative collections of sand lance will be attempted at Chisik Island and the Barren Islands. Sand lance will also be collected from sites in the center of the Cook Inlet. These collections will be from the stomachs of halibut and from incidental catches in ADF&G or UAF shrimp, herring, and flatfish trawls. Opportunistic samples of sand lance will also be kept for this project from the Western Aleutians and Bering Sea from trawls made by the R.V. Tiglax (through cooperation with AMNWR).

SCHEDULE

A. Measurable Project Tasks for FY 98

1. Bibliography will be finalized and delivered at the 1998 APEX Review Meeting.

2. Reports on sand lance maturity, spawning, and age structure will be submitted for publication.

B. Project Milestones and Endpoints

For FY 98:

1. Consolidate all information collected in 1995, 1996, and 1997.

2. Establish areas where information in the literature and prior work of this project are weak and develop protocols to fill these gaps.

3. Collect fish as per research plans through December of FY98.

4. Based on results of 1997 field season, develop modified plan for the 1998 field season, particularly in regard to hydroacoustic surveys.

5. Prepare results of seasonal proximate analysis of sand lance for publication.

Work in FY99 will be a continuation of the FY 98 work. The major objective of the FY 99 field work will be to establish productivity of sand lance in the Cook Inlet area based on hydroacoustic and fishing information. These results will be contrasted between different areas to assess how environmental conditions and regimes impact productivity and ultimately the availability of sand lance to marine predators. Field work will finish for this study in the winter of FY99/FY00 and a final report will be prepared.

C. Project Reports

The first reports will be produced in 1998 in the form of peer reviewed manuscripts in scientific journals. Subsequently, all manuscripts from this project will be collectively submitted as a Ph.D. thesis in FY00.

The bibliography will be available by March, 1998.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Close coordination has, and will continue to be developed between ADF&G, UAF, NMFS, and USFWS for collections of sand lance offshore and in other areas of Alaska. Work on sand lance will also continue to be coordinated with other APEX investigators working in Prince William Sound such as Dan Roby, Bill Ostrand, and David Irons.

ENVIRONMENTAL COMPLIANCE

Alaska Department of Fish and Game will provide collection permits for fish within the study area.

PERSONNEL

John Piatt- Research Biologist, Alaska Science Center, National Biological Service, Anchorage. Responsible for overall coordination of research project.

Martin Robards- Research Student, Memorial University of Newfoundland. Project Manager responsible for coordinating fishing effort, analysis of fish, data analysis, and report preparation.

Signed: _____

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Date prepared: _____

1998 EXXON VALDEZ TRUSTEE ...UNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

approved TC 8-6-97

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$30.7
Commodities		$0.0
Equipment		$0.0
Subtotal	$29.4	$30.7
General Administration	$3.5	$2.1
Project Total	$32.9	$32.8
Full-time Equivalents (FTE)		0.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
	$30.0	$20.0	$0.0		

Dollar amounts are shown in thousands of dollars.

Comments: Contract to support Cooperative Agreement with Memorial University of Newfoundland

1998

Prepared: 1 of 4

Project Number: 98306
Project Title: Ecology and demographics of Pacific Sand Lance, Ammodytes hexapterus, Pallas, in lower Cook Inlet,. Alaska
Agency: USGS (BRD)

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/9/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1998
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

1998

Project Number: 98306
Project Title: Ecology and demographics of Pacific Sand Lance, Ammodytes hexapterus, Pallas, in lower Cook Inlet,. Alaska
Agency: USGS (BRD)

FORM 3B
Personnel
& Travel
DETAIL

4/9/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed FY 1998
Description	
Cooperative Agreements with Memorial University of Newfoundland (entire amount is transferred to facilitate support of graduate student, and to make it easier for travel arrangements to be made from Newfoundland. The breakdown for use of these funds is as follows: Student support (stipend, benefits, tuition, other fees) - 29.3 K Travel (Nfld to AK for APEX meetings) - 1.4 K	30.7
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$30.7

Commodities Costs:	Proposed FY 1998
Description	
Commodities Total	$0.0

1998

Project Number: 98306
Project Title: Ecology and demographics of Pacific Sand Lance, Ammodytes hexapterus, Pallas, in lower Cook Inlet,. Alaska
Agency: USGS (BRD)

FORM 3B
Contractual & Commodities DETAIL

4/9/97

1998 EXXON VALDEZ TR[illegible]E COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
			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

1998

Project Number: 98306
Project Title: Ecology and demographics of Pacific Sand Lance, Ammodytes hexapterus, Pallas, in lower Cook Inlet,. Alaska
Agency: USGS (BRD)

FORM 3B
Equipment
DETAIL

Prepared: 4 of 4

4/9/97

Approved TC 8-6-97

Pacific Herring Productivity Dependencies in the Prince William Sound Ecosystem Determined With Natural Stable Isotope Tracers

Project Number:	98311
Restoration Category:	Research
Proposer:	Prince William Sound Science Center Cordova, Alaska
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	
Alaska SeaLife Center:	
Duration:	Year 1, 2-year project
Cost FY 98:	$ 119.3 K
Cost FY 99:	$ 80.6 K
Cost FY 00:	$
Cost FY 01:	$
Cost FY 02:	$
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pacific herring, Commercial Fishing,

ABSTRACT

The advective regime connecting the northern Gulf of Alaska (GOA) with Prince William Sound (PWS) may affect recruitment and nutritional processes in Pacific herring (*Clupea pallasi*). Research of the Sound Ecosystem Assessment (SEA) program has shown that herring have significant dependence on GOA carbon. Accordingly, herring are subject to changes in carbon flow occurring between GOA and PWS. The first step in understanding of how this fundamental environmental process affects herring recruitment is to isotopically analyze a time series of herring for which energetic data have been collected. This will expand upon the data series available from SEA providing a total four-year time period corresponding to one period in the cyclicity of herring population abundance in PWS.

INTRODUCTION

Stable isotope ratios of carbon, which have been shown to serve as effective tracers of energy supply in the Prince William Sound study area (Kline and Paul, MS submitted for publication, Appendix 1), is due to conservative transfer of carbon isotope ratios between the lower tropic levels (phytoplankton to zooplankton to forage fishes, etc.) of Prince William Sound and adjacent Gulf of Alaska waters up to the top consumers, and the naturally occurring gradient in ^{13}C between productivity generated in the Gulf compared with the Sound. Herring acquire these isotope ratios in response to the importance of the food in bulk body tissues (muscle and fat). Isotope ratio analysis of these tissues can provide insight into both habitat usage and assist in quantifying amounts derived from various areas. For example, Kline and Paul (Appendix 1) suggested a relationship between carbon source determined with $^{13}C/^{12}C$ and somatic energy content in relation to size of age-0 herring. Nitrogen isotope ratios, in turn, provide excellent definition of relative trophic level. The heavy isotope of nitrogen is enriched by about 0.3 % with each trophic level and thus can accurately indicate the relative trophic status of species within an ecosystem (Minagawa and Wada 1984, Fry 1988) and is useful for $^{13}C/^{12}C$ data modeling (Kline and Paul, Appendix 1).

RESULTS FROM PRIOR WORK

Juvenile herring and pollock are the dominant pelagic fishes in PWS and both consume zooplankton. Samples of juvenile herring and pollock collected between 1994 and 1996 shifted in $^{13}C/^{12}C$ content from which a change in carbon source dependency was inferred (Fig. 1) [data came from samples of opportunity in 1994, from Kline and Paul (Appendix 1), and samples collected during broadscale surveys in 1995 and 1996]. Although both species shifted in concert to greater GOA dependency in 1995 than 1994, pollock were consistently less dependent on GOA carbon. Juvenile pollock and herring occupy different levels in the water column, have different schooling behavior, and recruit from the larval stage at different times, effecting access to a different forage-base as confirmed by the data. This difference may not be reflected in the species composition of diet but instead the where and when of the production cycle is integrated into the isotopic signature which reflects the assimilated carbon pool in the fish. Pollock may be at an advantage since they metamorphose earlier and thus have first access to prey. The greater reliance on GOA-derived carbon in herring may reflect their dependence on carbon generated later in the season during the time when advection of GOA production was nearly the sole carbon source in 1995 as implied by the data (Fig. 1). The concordant shift to greater GOA dependency by both species in 1995 implies system-wide bottom-up effects permeating the whole ecosystem due oceanographic processes.

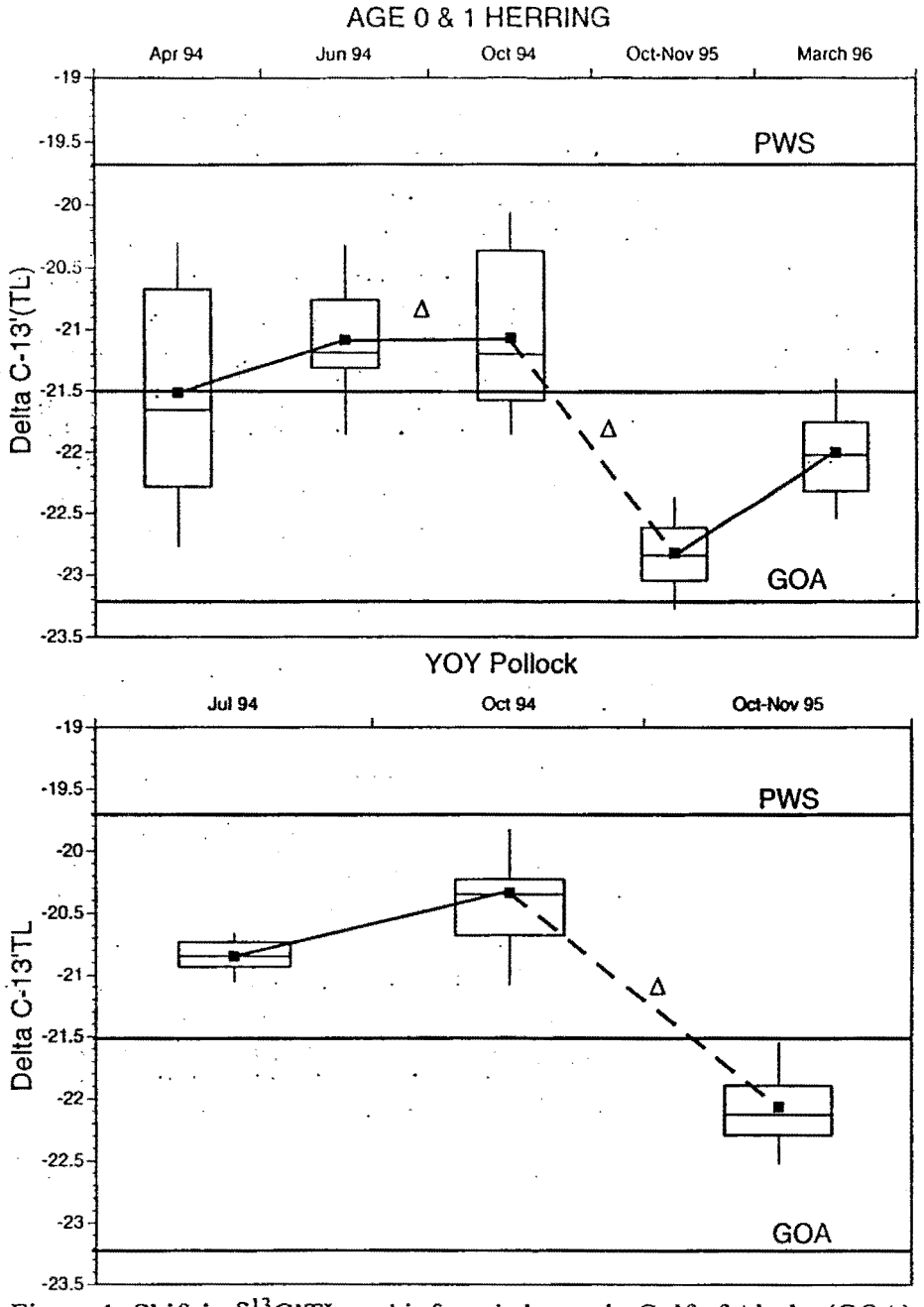

Figure 1. Shift in $\delta^{13}C$'TL and inferred change in Gulf of Alaska (GOA) vs. Prince William Sound (PWS) carbon dependency (see Kline and Paul, Appendix 1, for explanation of delta notation and method of data interpretation) of juvenile herring (above) and pollock (below) in 1994 - 6 (from Kline in prep.). The distribution of values are shown as box and whisker plots that denote the 10th, 25th, 50th, 75th, and 90th percentiles; means shown as symbols. The upper-case deltas indicate recruitment in and out of the juvenile populations. There was a large shift to greater GOA carbon dependency in 1995 for both species as indicated by the dashed lines.

NEED FOR THE PROJECT

A. Statement of Problem

The Problem: Declining Production of Herring in PWS.

The availability of macrozooplankton forage for herring varies in space and time because of changes in physical processes in PWS. Results from the SEA project suggest that interannual differences can be quite large. These differences, in the SEA context, are due to postulated Lake/River processes. The data suggest that 1995 was more of a "river" year than 1994. In 1994, when Gulf of Alaska carbon was apparently not transported into PWS to the same extent, there was more spatial variability than 1995. Herring were energetically in better condition in 1994 (A.J. Paul, pers. comm.). The relative poor condition of herring when Gulf carbon dominates parallels the existing downturn in Kittwake productivity in the Gulf area (APEX project results) that may be related to a regime shift phenomenon. Accordingly, when production in the Gulf improves, herring production when principally dependent on Gulf carbon may also improve.

B. Rationale/Link to Restoration

This proposal is submitted under the New Projects: Distribution and Turnover in Juvenile Pacific Perring Populations initiative described on page ten of the Invitation to Submit Restoration Proposals for Fedearl Fiscal Year 1998 (*Exxon Valdez* Trustee Council 1997). A better understanding, particularly a quantitative understanding, is a prerequisite to determining protocols for restoration and recovery of these species. The shifts in carbon flow occurring as a result in variations in the physical environment represent fundamental changes in the way the PWS ecosystem supports commercially important species. Because a quantitative understanding of these phenomena is a prerequisite to determining protocols for restoration and recovery of these species, these results will have direct application to all future rehabilitation and restoration efforts. The stable isotope approach is unique in its ability to integrate time and spatial scales at mesoscale levels. No other technique currently available can generate such results. The natural tracer aspects of the approach emulates artificial tracer experiments without the burden of needing to generate signals or experimental artifacts. Tracking the effect of Gulf carbon inflow on herring production that appears to vary between years will be used to resolve the question of how oceanographic process affect herring recruitment. The results obtained thus far indicate important temporal shifts in carbon source dependency in herring and their probable principal competitor, juvenile pollock. The level of sampling will be improved to resolve finer temporal shifts than shown in Fig. 1. Fewer sites with more frequent sampling will resolve when shifts occur particularly in the late summer to fall period. Energetic data form A.J. Paul (pers. comm.) suggest the continuation of material uptake until at least

December which may explain the large isotopic shift that occurred beween November 1995 and March 1996 (Fig. 1).

C. Location

Prince William Sound

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Community involvement and traditional ecological knowledge was incorporated into the sampling regime developed by collaborator E. Brown used for acquisition of samples being analyzed in this work.

PROJECT DESIGN

Natural stable isotope abundances reflect (1) trophic level and (2) source of assimilated matter and are thus a proxy for the change in diet specified in the Lake/River and Predator/Prey Relationships hypotheses. Stable isotope ratios will thus be used as a biomonitor of salmon and herring production and shifts in predation as tests of the SEA hypotheses. Hypothesis tests using stable isotope data were presented in the SEA DPD. The proposed study will build upon our existing data base and add new data to construct and test conceptual food webs supporting herring (and other species dependent upon herring) in Prince William Sound. The goal is to determine the trophic positions and to define the natural history parameters accessible from isotope ratio data in light of the observed declines in their populations. These include changes in trophic level over the lives of herring, habitat dependencies, seasonal energetics and trophic dynamics relative to other community organisms. As part of this goal, we will integrate our analytical work with the field and laboratory studies of other investigators looking at food web structure, productivity of lower trophic levels, and provide validation data for assessment of conceptual and quantitative models.

A. Objectives

1. Analysis of archived samples
2. Analysis of new as they become available following SEC determination by AJ Paul
3. Data synthesis
4. Disseminate results

B. Methods

Hypothesis: Herring do better (i.e., have a higher somatic energy content, see Appendix 1) when carbon source is ~50% from GOA and PWS (this is the case based upon data from 1994-5, discussed above).

1. To determine the $^{15}N/^{14}N$ and $^{13}C/^{12}C$ of juvenile herring collected from the Prince William Sound, juvenile herring and pollock (when obtainable) will be matched with regional isotope abundances in zooplankton to allocate food sources and to assess trophic transfer efficiencies in specific areas of the sound.

Analysis of archived samples consisting of 100 fish samples each from 14 sampling periods from the four-bay time series collected in May, June, August, October, November, December 1996, March, May, July, August, October, November, December 1997, March 1998 for which energetic and AWL data are or will be available (AJ Paul, pers. comm.)

Time series data obtained from these samples will be compared with our existing database which starts in 1994 and includes samples of opportunity collected in April, June, and October and as part of the Herring Group sampling in October-November 1995, March 1996 (shown in Fig. 1).

2. Synthesize the data obtained in context with conceptual food webs to validate feeding models and expand the natural history information.

3. Contribute stable isotope results to formal tests of the Lake/River-driven prey switching hypothesis developed by SEA to explain herring production trends, and the hypothesis given above through collaboration with AJ Paul of the Herring Group.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

SCHEDULE

A. MEASURABLE PROJECT TASKS for FY 98 (October 1, 1997 - September 30, 1998)

Oct-Dec 1997: Preparation of archived samples for mass spectrometry
Jan-July 1998: Preparation of new samples for mass spectrometry as they become available following energetic determination by A.J. Paul
Jun-Sept 1998: Process new isotope data

B. Project Milestones and Endpoints

Oct-Dec 1997:	Preparation of archived samples for mass spectrometry
Jan-July 1998:	Preparation of new samples for mass spectrometry
Jan 1998	Attend Annual Restoration Workshop
Jun-Sept 1998:	Process new isotope data
Oct-Dec 1998:	Data, receipt (from mass spect lab), integration and synthesis
Jan-April 1999:	Preparation for and dissemination of results at 10th Anniversary Symposium
May-Sept 1999:	Data synthesis and assessment, final report preparation

C. Completion Date

September 1999

PUBLICATIONS AND REPORTS

The following manuscripts dealing with Pacific herring in Prince William Sound are planned in preparation (journals CJFAS= Canadian Journal of Fisheries and Aquatic Science, Fish. Ocean. = Fisheries Oceanography, TAFS = Transactions of the American Fisheries Society)

Fall isotopic and somatic energy signatures of young of the year Pacific herring at two sites in Prince William Sound Alaska: Implications for trophic studies.
T. C. Kline and A. J. Paul
for CJFAS
resubmitted following peer review

Spatial patterns of Gulf of Alaska carbon in Prince William Sound pelagic food webs determined by $^{13}C/^{12}C$. T. C. Kline.
for TAFS: *In* Brandt and Mason (eds) Spatial Patterns and Processes in Aquatic Environments
in prep

Interannual variability of the dependance of juvenile Pacific herring in Prince William Sound, Alaska on Gulf of Alaska shelf-derived secondary productivity
Kline
Fish. Ocean.
planned publication

Relationship between feeding regime, inferred from natural stable isotope abundance, and whole body energetics of Pacific herring in PWS.

Kline & Paul
CJFAS
outline conceptualized by authors, analytical work in progress

PROFESSIONAL CONFERENCES

1998: American Fisheries Society or American Society of Ichthyology and Herpetology

NORMAL AGENCY MANAGEMENT

None

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Herring Group workshops and meetings with other EVOS P.I.s will be conducted to facilitate collaboration and to direct analysis efforts. Results of analyses will be exchanged at workshops and by telecommunications. Preliminary analysis from the integrated effort will be used to direct retrospective analysis of archived samples.

Collaboration with AJ Paul will continue and facilitate relating carbon-source dependency with somatic energy content (Kline and Paul, Appendix 1).

PROPOSED PRINCIPAL INVESTIGATOR

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1998 EXXON VALDEZ TRUSTEE C[illegible]CIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Approved R 8-6-97

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$111.5
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$111.5
General Administration		$7.8
Project Total	$0.0	$119.3
Full-time Equivalents (FTE)		0.8
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
	$80.6				

Dollar amounts are shown in thousands of dollars.

Comments:

1998

Prepared:
10Ap97/wjh

1 of 5

Project Number: 98311
Project Title: Pacific Herring Productivity Dependencies in the Prince William Sound Ecosystem Determined With Natural Stable Isotope Tracers
Name: Prince William Sound Science Center (ADFG)

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/10/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$53.3						
Travel		$2.3						
Contractual		$35.0						
Commodities		$2.3						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$92.9		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect		$18.6						
Project Total	$0.0	$111.5		$80.6				
Full-time Equivalents (FTE)		0.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998

Prepared:

Project Number: 98311
Project Title: Pacific Herring Productivity Dependencies in the Prince William Sound Ecosystem Determined With Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

4/10/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
Kline	Principal Investigator		4.0	7608.5		30,434.0
Williams	Fish Biologist		6.00	3804.2		22,825.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		10.0	11412.7	0.0	[illegible]
					Personnel Total	$53,259.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
Herring Review / R/T CDV-Anch	200.0	1	5	141.0	905.0
Herring Group Workshop/ R/T CDV-Fbx	400.0	1	5	141.0	1,105.0
Car rental			5	50.0	250.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2,260.0

1998

Project Number: 98311
Project Title:Project Title: Pacific Herring Productivity Dependencies in the Prince William Sound Ecosystem Determined With Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Prepared:

4/10/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:		Proposed
Description		FY 1998
Stable Isotope Analytical Services @ UAF	1200 2 $25	30000
Freeze-drier use	1200 @ $3	3600
Photocopying		250.0
Shipping		250.0
Posters for annual workshops 1@ $200		200.0
Communications		300.0
Page charges/ 1 @ $400		400.0
	Contractual Total	$35,000.0

Commodities Costs:	Proposed
Description	FY 1998
Lab supplies (vials, scalpels, blades, chemicals, etc.)	1,500.0
Office and Computer supplies	350.0
Dye Sub materials 1 @$300 each & miscl.	450.0
Commodities Total	$2,300.0

1998

Prepared:

Project Number: 98311
Project Title:Project Title: Pacific Herring Productivity Dependencies in the Prince William Sound Ecosystem Determined With Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4B
Contractual & Commodities DETAIL

4/10/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
			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	

1998

Project Number: 98311
Project Title:Project Title: Pacific Herring Productivity Dependencies in the Prince William Sound Ecosystem Determined With Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Prepared: 4/10/97

98314

HOLD
(deper)

HOMER MARINER PARK HABITAT ASSESSMENT & RESTORATION DESIGN PROJECT

Project Number:	98314
Restoration Category:	Intertidal Community, Recreation and Tourism
Proposer:	City of Homer
Lead Trustee Agency:	Alaska Department of Natural Resources
Cooperating Agencies:	Alaska Department of Fish and Game Department of Interior, Fish and Wildlife Service
Alaska SeaLife Center:	No
Duration:	1 year
Cost FY 98:	$95,350
Geographic Area:	Kenai Peninsula, Homer
Injured Resource/Service:	Intertidal Organisms, Recreation and Tourism

ABSTRACT

In its present state, Mariner Park is a highly stressed marine habitat in decline. The area is experiencing a dramatic reduction in marine biota and shorebird population while incompatible and environmentally destructive human uses flourish. From the results of a comprehensive feasibility study that includes botanical, biological, and hydrological field studies coupled to community information it is possible to develop a comprehensive habitat restoration and enhancement plan. This plan will establish the optimal hands-on restoration program to increase and diversify the intertidal fauna; which, in turn, will benefit migrating shorebirds and promote recreationally compatible use of the area by residents and tourists.

INTRODUCTION

Kachemak Bay is the premier marine ecosystem in Cook Inlet. It is important for its fertile intertidal, nearshore, and subtidal waters. These estuarine areas support a richly diverse biosystem. In particular, the Bay nurtures a thriving marine bird habitat by providing important feeding, nesting, rearing, and migratory staging throughout the year. Central to this critical habitat, as an ecosystem and a destination for resident and non-resident recreational visitors, is Homer Spit.

Located at the base of the Spit and east of the Sterling Highway (Spit Road), is Mud Bay. This bountiful habitat is one of the most biologically diverse and active areas in the spectrum of northeast Pacific shallow-water estuaries, [Shimek, 1979]. From a biological perspective, Mud Bay is a classical thriving northern mud flat site. It is home to a collection of worms, bivalves, crustaceans, and other intertidal life. These organisms are food for birds, crabs, and fish. Once an integral part of Mud Bay with all of the important habitat characteristics of its host ecosystem, the area west of the road, referred to in this proposal as Mariner Park, redefined itself.

Mariner Park, a 109 acre parcel of which 71 acres are owned by the Alaska Department of Natural Resources, 32 acres by the City of Homer, and 6 acres in private hands, faces west toward Cook Inlet. Approximately fifty years ago, prior to the construction of the Homer Spit Road and Airport, Mariner Park was contiguous with the habitat rich, Mud Bay. Today, Mud Bay, (a.k.a. Coal Bay), continues as a productive estuary, a fate not shared by its estranged neighbor, Mariner Park.

Once a mudflat, Mariner Park, emerged as a sand beach ecosystem with a complex intertidal habitat. It consists of a high tide line saltwater wetlands, inshore tidal lagoon, and protective sand berm. Outer Kachemak Bay water enters the lagoon through a breach in the protective sand berm via a tidal stream. Since most of the lagoon area is relatively high, actual flooding occurs for short periods only during high tides; consequently, water exchanges are infrequent and the area is submerged only briefly. As a consequence Mariner Park has lost most of its diversity and density of infaunal organisms. It has become far less attractive for migratory shorebirds and folks who frequent the Spit to enjoy recreational opportunities. This decline in the vitality of the habitat was exasperated by protective actions taken in response to the *Exxon Valdez* Oil Spill *(EVOS)* incident.

During the *Exxon Valdez* incident the tidal stream inlet to Mariner Park was raised to lessen the potential for oil to enter the habitat. The tidal stream, which supplied critical nutrients to the intertidal lagoon and marsh was, per governmental directive, dammed to protect the intertidal wetlands from oil. During the closure the wetlands dried and biota rich portions of the habitat were greatly reduced. With the inability of the intertidal community to sustain itself the area was unable to effectively support migrating shorebirds. Correlationally, the dry area attracted inappropriate use by residents and visitors. This human disturbance, which included trampling of vegetation by off-road vehicles, removing drift wood from the storm berm, and deforming the protective sand barrier, translated into a loss of nesting area for Common Eiders, harassment of shorebirds during migration, disturbance to shorebirds and sparrows nesting in the dunes area, and the over-all degradation of the habitat.

The effort encumbered in this proposal is to perform a feasibility study for a project to restore the intertidal community injured by *EVOS*. The study, in the form of a National Environmental Policy Act (NEPA)-Environmental Assessment (EA), will delineate the feasibility of a follow-on construction project to restore and enhance the intertidal wetland community in Mariner Park. With botanical, biological, and hydrological studies, coupled to community and historical information, providing the foundation of the EA, predictions are that a comprehensive restoration construction program will return the area to the rich wetland status it once was. The eventual enhancement potential is to provide, preserve, and protect intertidal feeding habitat for migrating shorebirds, which in turn will help restore recreation and tourism services injured by *EVOS*.

NEED FOR THE PROJECT

A. Statement of Problem

Historically, as the head of Mud Bay, Mariner Park was a classical northern mud flat. The contiguous area supported a diverse biomass with dominant organisms to include polychaete worms and small bivalves. The small organisms were food for larger, transient organisms: shorebirds, crabs, and fish. The density of infaunal organisms at this site was high; consequently, even a small portion of habitat was a productive location supporting a relatively large number of important organisms.

While Mud Bay continues to prosper in intertidal and avian diversity, Mariner Park has not faired as well. With excavation of the area for fill used to construct the airport and the road segregating the area from its naturally connected ecosystem, Mariner Park's habitat has morphased into an intertidal area with complex sedimentary and biological relationships.

Mariner Park's sedimentary characteristics now resemble a sand beach versus mud flat ecosystem. Sediment carried via long-shore transport was deposited in the intermittently flooded lagoon area. Generally, the soil profile is sand, to a depth as shallow as four feet, over silty clay. Higher elevations have coarser sediment than lower areas. The subtidal cobble area is partially covered by moving patches of sand. The tidal stream habitat is composed of sandy gravel with cobbles and the saltwater marsh area, being farthest from the current flow, contains finer sediments. [USF&W, 1991 and Land Design North, 1980]

The site consists of a high tide line saltwater wetlands and lower inshore area which behaves as a tidal lagoon. The lagoon is separated from the outer Kachemak Bay by a storm berm. Historically, a tidal stream breaches the storm berm. Since most of the lagoon area is relatively high, it fills only at high tides, during which actual flooding occurs for short periods. Frequently, water becomes trapped in the lagoon area for long periods because the tidal stream channel is not sufficiently deep and the inshore lagoon too high to permit frequent exchange of water. The only remaining vegetation is located at the base of the bluff, which is primarily private property.

The areas above mean high tide line on both sides of the Spit Road are covered with grasses. These areas are interlaced with tidal channels and occasional tidal basins which are classified as saltwater wetlands, [Kenai Peninsula Borough Coastal Management Program, 1990]. Vegetation of the small saltwater marshes at the base of the Spit are mainly Lyngbye sedge and arrow grass, with alkali grass at the lower tidal levels. These marshes are prime feeding habitats for the less

common shorebirds as well as secondary feeding and loafing areas for the principal shorebird migrants. [ADF&G, 1992 and West, 1990]

Not only has natural sediment transport processes affected Mariner Park, but consequences due to human use have depleted the habitat. As Homer grew the Spit became a very desirable recreation and tourist area. To address the demands for Spit development, in the late 1970's through the early 1990's, various proposals to address the ever growing need for campground and recreational areas on the Spit were written. It was the belief of various proposers, as a consequence of their site investigations, that the area at the base of the Spit and west of the road be partially filled and made into a park. The proposals suggested allowances be made to protect the saltwater lagoon and tidal stream. [Land Design North 1980, Dames & Moore 1981, and City of Homer 1984, 1990]

Responding to various ideas expressed in the proposals, in 1985, a phased development of a portion of the site was begun. Specifically, to support open space/recreational use, approximately 20,000 cubic yards of fill material was placed in a 2.6 acre area south of the tidal stream by 1989. The area, Phase I of a three phase park concept, was partially filled, graded, and safety/sanitation upgrades made. It was during this period that Mariner Park got its name.

Concurrent with the Park's development, a chorus of concerned Homer residents voiced their opposition while extolling the virtues of habitat protection. In 1985 a petition against filling the area gathered 400 signatures. After the *Exxon Valdez* incident which caused the closure of the tidal lagoon, in 1990 the residents of property adjoining Mariner Park signed a joint letter to the US Army Corps of Engineers (COE) expressing their continued opposition to the development of Mariner Park and encouraging its prompt return to a natural habitat.

In response to the degraded habitat in Mariner Park, the City of Homer's Spit Campground Task Force, in 1990, revised the partially implemented 1984 park development plan. The Task Force proposed a scaled-down development plan that incorporated a lagoon flushing and enhancement program for the area. Further development of the area, to include the filling of an additional 2.0 acres adjacent to Phase I was withdrawn by the City of Homer. Subsequently, as a consequence of the *EVOS* incident, community sentiment, and concerns voiced by recreational users of the area to preserve and enhance the habitat, the COE denied a permit application to continue development of Mariner Park.

With the partial reopening of the breach in 1992, the tidal stream resumed transport, at lower levels, of nutrients into the intertidal lagoon. The refreshed lagoon and raised gravel plain attracted a small number of waterfowl and cranes. The breach was again closed in 1994 during a severe storm and was partially re-opened in 1996. As a consequence of the tidal stream closures, Mariner Park has experienced a noticeable increase in the rate of habitat degradation.

B. Rationale/Link to Restoration

As a protective measure against oil entering Mariner Park's wetlands during the *Exxon Valdez* incident, the tidal stream inlet was closed. The result of the closure was that critical nutrients were prevented from entering the intertidal lagoon. By cutting-off the stream from the outer bay and tides, the saltwater lagoon and marshes dried, thus, biologically rich portions of Mariner Park were not able to sustain themselves.

With the inability of Mariner Park to sustain a vibrant intertidal community, the feeding habitat for shorebirds was injured. This transformed a once thriving habitat viewing area into an unattractive and unavailable tourist and recreation destination.

In addition to directly restoring the injury caused by the response to *EVOS* (i.e., closing the tidal stream inlet), this proposal is also justified as replacement for, and enhancement of, injured intertidal resources. Intertidal wetlands on the Homer Spit must be protected, as much as reasonably possible, if we are to maintain a healthy and productive ecosystem for populations of shorebirds and provide residents and tourists unique wildlife experiences.

C. Location

The environmental assessment project will be undertaken in Homer, Alaska. The flora, fauna, and hydrological studies will be conducted at the base of Homer Spit to include both sides of the Spit Road, (Mariner Park and the nearshore portions of Mud Bay).

The project will directly benefit the Homer area. Additionally, given the international interest in the ecosystem of Kackemak Bay, the environmental assessment will provide invaluable information to the scientific community on the integration of wetland restoration in high use areas. An eventual product of a restoration project is increased tourism to observe the unique habitat and shorebird migration. This will benefit the Cook Inlet region, specifically, and the State, generally.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

This project is a collaborative venture. Its success is predicated on a collegial relation where the interests of individuals, community groups, and governmental bodies are woven with scientific findings and Trustee Council concerns into tapestry for an optimal restoration outcome which is in the best interest of Homer and the environment. Frequent, open, and candid dialogue is the effective mechanism to achieve this goal.

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

Homer is a community blessed with residents who possess a broad spectrum of knowledge and represent a myriad of talents. It is assumed the project will call on this talent to provide project support. For example, Homer is home to renowned biologists who have studied the intricacies of the bio-diverse Kachemak Bay and the effects of change on ecosystems and habitats. These respected "birders" have intimate knowledge of the area which translates into project effectiveness and cost savings. They are expected to be an integral component of the planning, assessment, and design team. As to the nuts 'n bolts issues of the project, depending on

availability, the assessment team will use local labor and resources, such as equipment and vessels, to assist in collecting data.

PROJECT DESIGN

A. Objectives

The eventual restoration goal, for which this proposal is a critical element, is to restore the intertidal community. The principal objective of this project proposal is to develop a National Environmental Policy Act - Environmental Assessment that will provide a feasible project to restore the intertidal community of Mariner Park. In turn, the restoration project is to restore and rehabilitate the area in such a way as to increase, preserve, and protect a diverse feeding habitat for migrating shorebirds. Correspondingly, due to the fact that Mariner Park is on the flight approach to the airport, the plan will address the issue of how to discourage geese and cranes from frequenting the area, (i.e. inhibit the growth of submergent and emergent vegetation). Additionally, the plan establishes mechanisms to enhance the recreational use of the area in an environmentally compatible manner.

The restoration construction project, the topic of a follow-on proposal to the Trustee Council, is meant to enhance the spectacle of the spring shorebird migration. This translates into increased resident and tourist interest in the area especially during the annual Kackemak Bay Shorebird Festival. With the implementation of an optimal restoration design, Mariner Park will be a show case of wetlands rehabilitation in a high use area.

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

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

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

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

3. Measure the diversity, frequency, and abundance of flora and fauna in Mariner Park.

4. Determine the geophysical characteristics of Mariner Park and the head of Mud Bay.

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

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

B. Methods

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

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

2. Conduct field studies to catalogue the flora and fauna presently in Mariner Park. The data will establish a baseline for comparing historical data in an effort to delineate changes in the project area.

3. Conduct a hydrological study of Mariner Park and Mud Bay. Perform hydraulic, soil classification (test hole), and sediment transport studies.

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

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The City of Homer is the sponsoring, coordinating, and responsible agency for this project. The lead Trustee agency is the Alaska Department of Natural Resources (ADNR). Aside from providing technical expertise on environmental restoration issues, as property owner of a significant portion of the project area, the ADNR has land use interests in the Mariner Park. Additionally, during discussions with ADNR and ADF&G it was suggested that the project may best be served if the agencies act in the role of co-lead Trustees. This is a viable option that would facilitate the efficient prosecution of the project.

A restoration project in Mariner Park directly impacts and interfaces with several state and federal agencies. Of the many agencies touched by the project, the primary Trustee cooperating agencies are the Alaska Department of Fish and Game (ADF&G) and the US Department of Interior, Fish and Wildlife Service (USF&WS). Both agencies have technical knowledge and vested interest in projects that purport to restore and protect habitat. By providing key insight on biological relationships, the agencies can provide valuable support during the analysis of field data, the developing of restoration alternatives, and the selection of the preferred alternative.

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

The Alaska Department of Transportation and Public Facilities (ADOT&PF), US Army Corps of Engineers (COE), and Federal Aviation Administration (FAA) possess significant technical

knowledge of the area. Additionally, these agencies have vested interest in a Mariner Park restoration construction project because the area is in proximity to their spheres of influence and responsibility: the Homer Spit Road is an ADOT&PF facility, the airport is the privy of FAA, and the COE is a permitting agency representing coastal water concerns. Other agencies with peripheral interest are the Alaska Department of Environmental Conservation (ADEC - State Water Quality Certification) and the Alaska Office of Management and Budget: Division of Governmental Coordination (Certification of Consistency with the Alaska Coastal Management Program). In all cases, the EA will provide a basis for understanding the relationship of the project to the environment and be a mechanism to critique the potential of the project in meeting the established restoration goals.

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

SCHEDULE

A. Measurable Project Tasks for FY 98

October 1 - November 15:	Collect and review historic information and data.
	Develop contract proposals for consultant(s) effort, advertise for cost proposals, and evaluate proposals.
	Conduct community involvement, (education and information gathering), component of project.
November 15 - December 1:	Analyze proposals.
December 10:	Award contracts.
December 11 - January 1:	Assist contractors in logistics for field efforts.
January 1 - March 27:	Assist with winter field surveys.
	Analyze historic information and data.
	Prepare portions of EA.
January 15 ~ January 24:	Attend Annual Restoration Workshop, (3 day workshop).
February 1 - March 15:	Conduct community involvement component of project.
March 16 - April 14:	Prepare annual report of activities to date.
April 15:	Submit annual report.
April 15 - September 30:	Consultant(s) conduct spring, summer, and fall field efforts and analyze data.
	Conduct formal community involvement component of project.
	Produce EA.

B. Project Milestones and Endpoints

December 1:	Collect and analyze historic data.
January 15:	Initiate EA process.
September 1:	Complete EA field studies and analysis of data..
September 30:	Submit EA and Report of Project to Trustee Council.

C. Completion Date

Substantial completion of the project is September 30, 1998. The principal objective to be completed by this date is the production of a NEPA-EA. Elements encumbered by this objective are historic and community perspectives, field studies, restoration design alternatives, no action alternative, comparative study of alternatives, preferred alternative, and final draft of the environmental assessment document.

PUBLICATIONS AND REPORTS

The project does not, at this writing, plan to submit manuscript(s) for peer-reviewed publication(s) in FY 98.

The project will submit to the Council an annual progress report on April 15, 1998 and a final project report on September 30, 1998.

PROFESSIONAL CONFERENCES

The project does not plan to present at professional conferences in FY 98.

NORMAL AGENCY MANAGEMENT

N/A

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

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

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

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

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

EXPLANATION OF CHANGES IN CONTINUING PROJECT

N/A

PROPOSED PRINCIPAL INVESTIGATOR

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

PRINCIPAL INVESTIGATOR

Not Known

OTHER KEY PERSONNEL

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

Poppy Benson, U. S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge
Technical resource person

Mike Bennet, Alaska Department of Natural Resources, Division of Lands
Technical resource person

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

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

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

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

Dave Erikson
Biology resource person

William Hauser, Alaska Department of Fish and Game, Habitat Restoration Division
Representative of Cooperating Agency and technical resource person

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

Don McKay, Alaska Department of Fish and Game, Habitat Restoration Division
Representative of Lead Trustee Agency and technical resource

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

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

Art Weiner, Alaska Department of Natural Resources, Wetlands Restoration
Representative of Lead Trustee Agency

George West, Birchside Studios
Biology resource person

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1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FFY 1997	Proposed FFY 1998						
Personnel		$14,400.0						
Travel		$2,710.0						
Contractual		$60,000.0						
Commodities		$0.0						
Equipment		$2,350.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$79,460.0		Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Indirect		$15,890.0						
Project Total	$0.0	$95,350.0						
Full-time Equivalents (FTE)		12.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

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

1998

Prepared:

Project Number: 98
Project Title: Homer Mariner Park Habitat Assessment & Restoration Design Project
Name: City of Homer

FORM 4A
Non-Trustee
SUMMARY

4/4/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

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

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FFY 1998
Project Coordinator: meetings and research in Anchorage		130.0	3	8	100.0	1,190.0
Official(s) of the City of Homer: meetings in Anchorage		130.0	4	10	100.0	1,520.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$2,710.0

1998

Project Number: 98
Project Title: Homer Mariner Park Habitat Assessment & Restoration Design Project
Name: City of Homer

FORM 4B
Personnel
& Travel
DETAIL

Prepared:

'97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FFY 1998
Consultant(s) Firm to design and produce EA. Work includes biologic, botanical, and hydological field studies	56,000.0
Survey	2,000.0
Printing and Photographs	2,000.0
Contractual Total	$60,000.0

Commodities Costs:	Proposed
Description	FFY 1998
Cost associated with office materials, postage, utilities, etc. are addressed in the indirect rate.	
Commodities Total	$0.0

1998

Prepared:

Project Number: 98
Project Title: Homer Mariner Park Habitat Assessment & Restoration Design Project
Name: City of Homer

FORM 4B
Contractual & Commodities DETAIL

4/4/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FFY 1998
Computer (IBM: price per COMP USA)			1,800.0
Fax/copier/printer (HP: price per COMP USA)			550.0
			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	$2,350.0

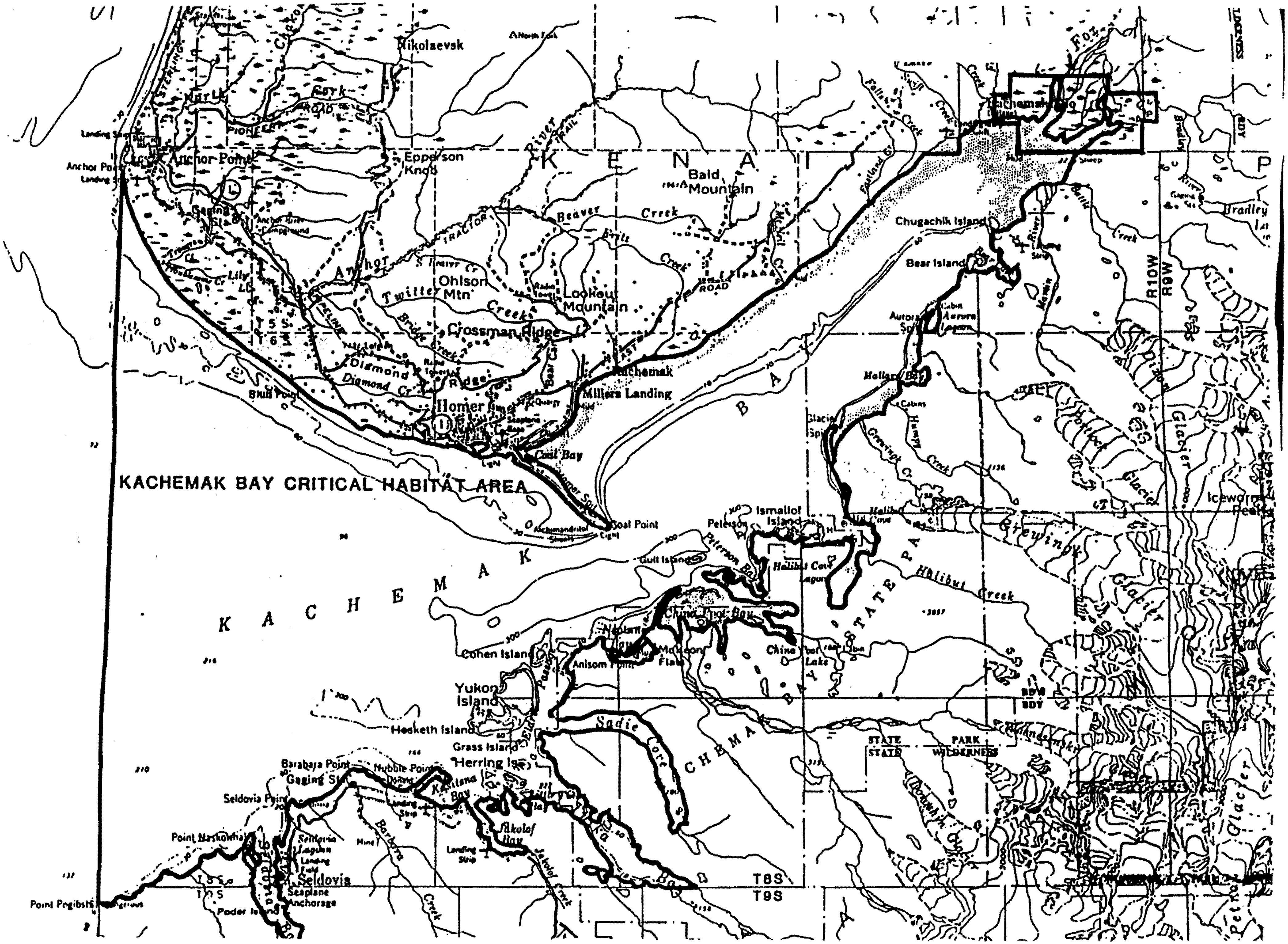
Existing Equipment Usage:	Number	
Description	of Units	

1998

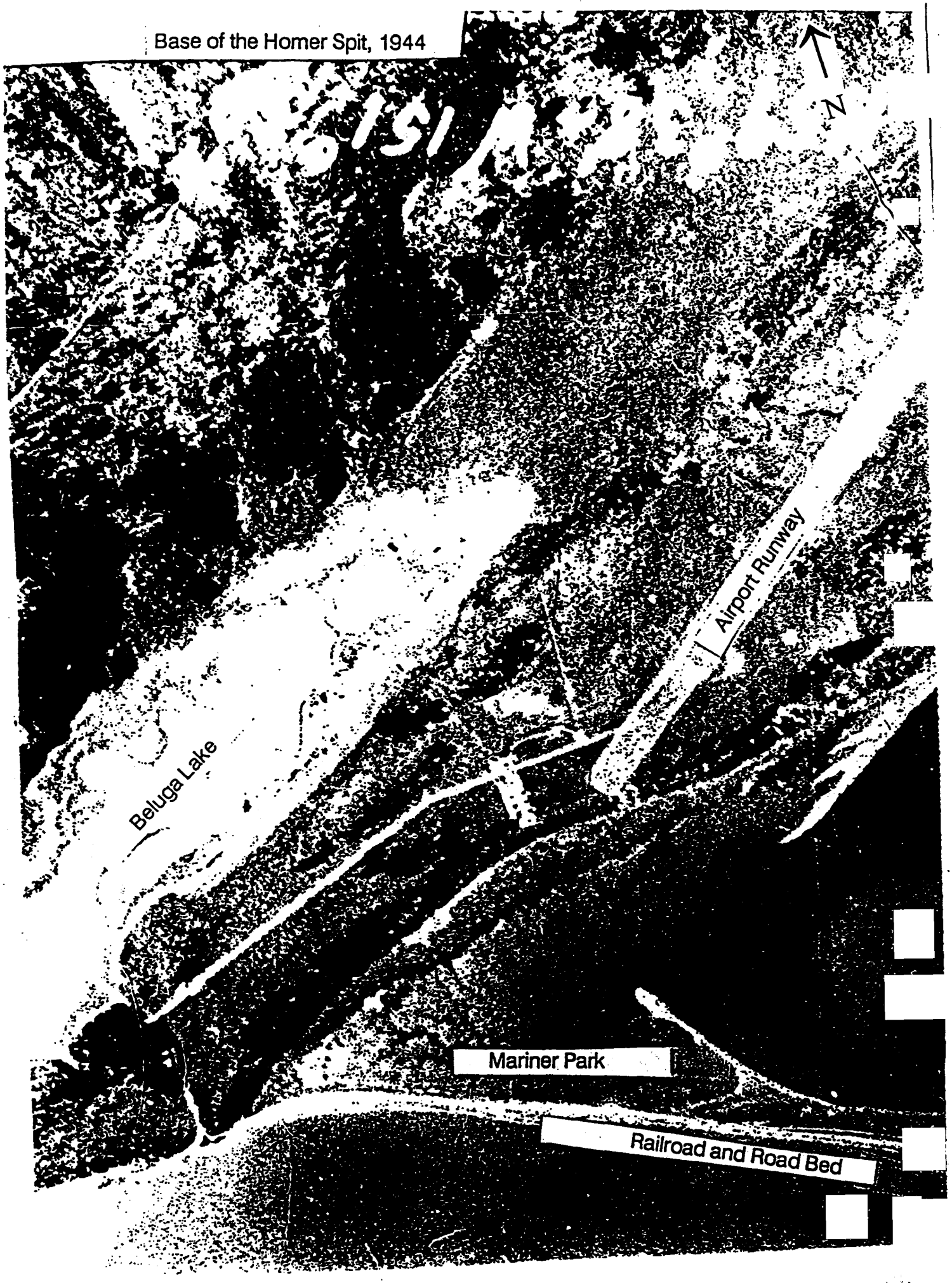
Project Number: 98
Project Title: Homer Mariner Park Habitat Assessment & Resroration Design Project
Name: City of Homer

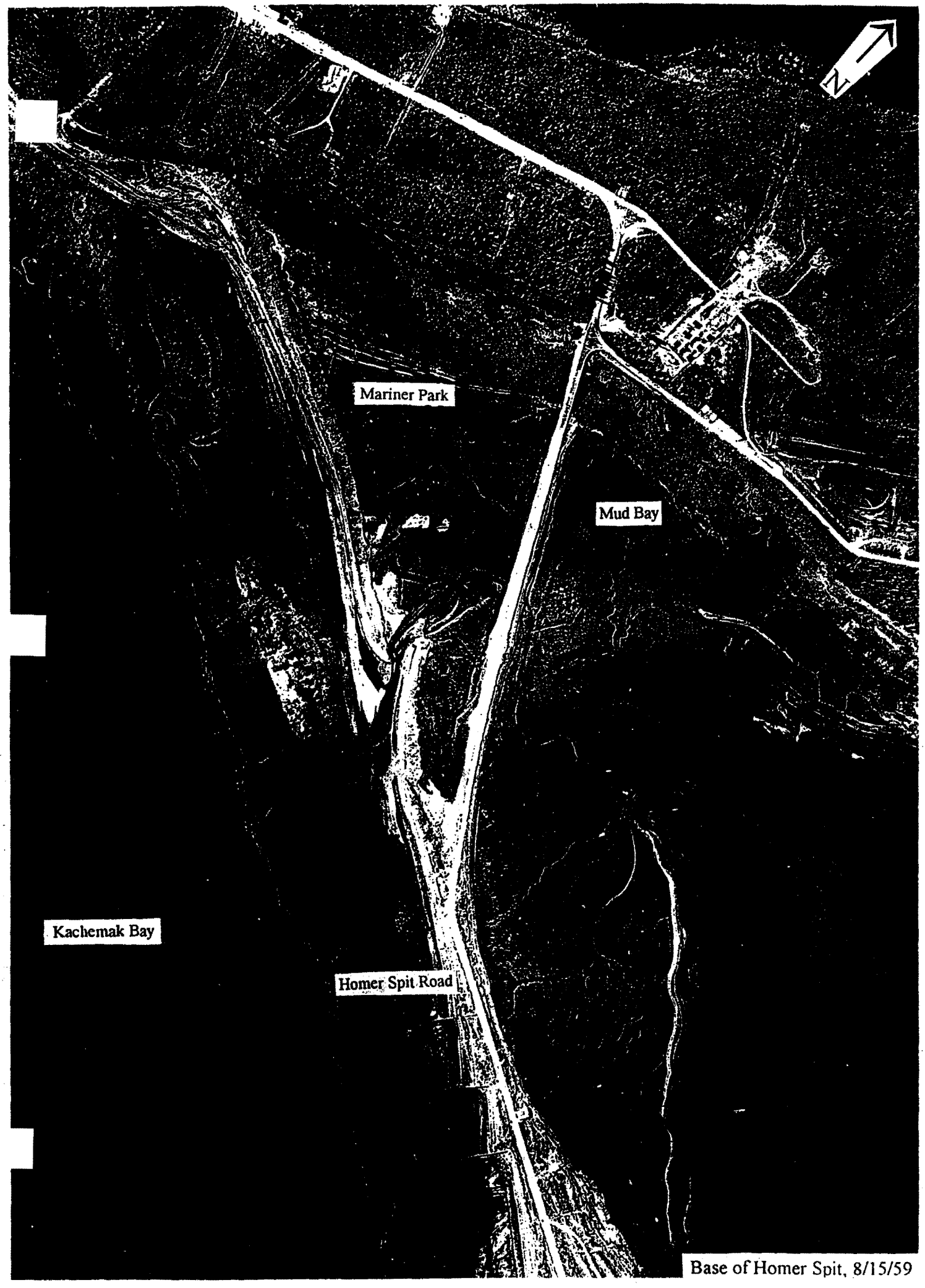
FORM 4B
Equipment
DETAIL

Prepared:


KACHEMAK BAY CRITICAL HABITAT AREA
Nikolaevsk
Anchor Point
Epperson Knob
Bald Mountain
Ohlson Mtn
Lookout Mountain
Crossman Ridge
Diamond Ridge
Homer
Kachemak
Millers Landing
Coal Bay
Homer Spit
Coal Point
Bluff Point
Chugachik Island
Bear Island
Aurora Spit
Mallard Bay
Glacier Spit
Ismailof Island
Peterson Pt
Gull Island
Halibut Cove
China Poot Bay
China Poot Lake
McKeon Flats
Anisom Point
Cohen Island
Yukon Island
Hesketh Island
Grass Island
Herring Isl
Sadie Cove
Barabara Point
Nubble Point
Seldovia Point
Point Naskowhak
Seldovia
Seaplane Anchorage
Point Pogibshi
Kasitsna Bay
Jakolof Bay
Tutka Bay
Halibut Creek
Grewingk Glacier
Portlock Glacier
Iceworm Peak
STATE PARK
STATE WILDERNESS
K A C H E M A K B A Y
K E N A I
KACHEMAK BAY STATE PARK
R10W R9W
T8S T9S

Base of the Homer Spit, 1944





Base of Homer Spit, 8/15/59

Base of Homer Spit, 6/6/96

Approved TC 8-6-97

Sound Ecosystem Assessment (SEA)

Project Number:	98320
Restoration Category:	Research
Proposer:	T. Cooney, et al/UAF
Lead Trustee Agency:	ADFG
Cooperating Agencies:	NOAA
Alaska SeaLife Center:	No
New or Continued:	Cont'd
Duration:	5th yr. 6 yr. project
Cost FY 98:	$2,383.4
Cost FY 99:	$755.2
Cost FY 2000:	$0.0
Cost FY 01:	$0.0
Cost FY 02:	$0.0
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pink salmon, Pacific herring

ABSTRACT

This project is an integrated, multi-component study of processes influencing the annual survival of juvenile pink salmon and herring rearing in Prince William Sound. An emerging understanding of mechanisms of loss at this life stage is being captured by linked numerical simulations of ocean state, plankton dynamics, fish energetics, and prey/predator relationships. FY 98 will be the final fully-funded year of SEA, a period of reduced field work but accelerated data analysis and application of results to management models.

INTRODUCTION

The SEA program (320) was designed in 1993 and funded in April 1994, as a five-year, multi-project investigation of factors influencing the production of pink salmon and herring in Prince William Sound, Alaska. The herring and salmon literature suggested at the time that most of the mortality occurs in the earliest life stages of these species, the larval and juvenile forms. During this time, both species are resident in the region, are sustained primarily by energy arising from plankton populations, and are believed to undergo high rates of loss associated primarily with predation and starvation. SEA argued that any understanding of the dynamics of recovery for these important commercial and ecological components of the Prince William Sound ecosystem must account for the combined affects of oil-induced change and limits placed on production by oceanographic and other variability in the marine environment. In the absence of substantial knowledge about how historical trends in pink salmon and herring production reflect environmental limitation, SEA developed a multi-year program of study to define the process of loss in juvenile populations of pink salmon and herring. The intent of the research is to provide information about these processes so that the Alaska Department of Fish and Game might better enhance, manage or otherwise restore pink salmon and herring production in the region.

The life histories of pink salmon and herring exhibit similarities and differences. Both species spawn demersal eggs in intertidal or coastal freshwater systems. Pink salmon are fall spawners and females deposit about 1,500 eggs each in the gravels of hundreds of short streams and small rivers that enter the periphery of Prince William Sound. A substantial percentage of females also deposit eggs in the intertidal reaches of these streams and rivers. Depending on water temperature, the large, yolky eggs incubate for a few weeks after which the larval salmon or alevins hatch and move deeper into the sediments of the natal areas. Both eggs and alevins are vulnerable in the fall when coastal storms generate sufficient rainfall to cause creek bed scouring, resulting in losses of embryos and larvae by washout. Surviving alevins encounter cooling water temperatures as the season progresses from fall into winter. Depending on winter temperatures, fluctuations in stream flow may cause dewatering, reduced oxygen and possibly freezing conditions with attendant mortalities to alevin populations. By late winter, the energy reserves of the non-feeding larvae are nearly exhausted. In March, a metamorphosis to the juvenile body form is completed for some and the annual fry out-migration into near-shore waters begins. Fry emergence into Prince William Sound generally occurs from late March through early June. Juveniles leave their natal habitats at approximately 30 mm in length and weighing 0.3 g.

Young pink salmon quickly adopt a pelagic feeding strategy, ingesting small, medium and large-sized copepods and other crustaceans as they school in shallow edge-zone nursery areas. Growth is influenced strongly by water temperature and modified by food availability, so rates of growth accelerate as the Sound experiences seasonal warming. During this life stage, fry are vulnerable to bird, fish and marine mammal predation. Later in the summer, at lengths between 50 and 70 mm, survivors begin migrating away from edge zone habitats into deeper passages. Pink salmon are bound by a strict two-year life history, so juveniles have little latitude to vary from their programmed migration to shelf and open ocean feeding grounds. By mid-July and early August, a time when adults from the previous brood year are returning to spawn, the juveniles begin leaving the region. Most have departed Prince William Sound by late September. SEA

hypothesizes that the number of surviving juveniles leaving the region in late summer and early fall will be highly predictive of the following year's adult return.

In contrast, Pacific herring are spring spawners, depositing large clusters of small demersal eggs on intertidal and shallow subtidal vegetation in April. Each female is capable of spawning between 15,000 and 30,000 eggs, some of which immediately become food for birds, fish and local mammals. Egg masses are also vulnerable to late season freezing and erosion from the beaches by intense storm activity. In some cases, unusually heavy spawning can produce thick layers of eggs causing oxygen transport problems for some embryos. The historical data from Prince William Sound suggest that most herring spawning is restricted to a few locations in the region, although our preliminary observations indicate lesser spawning over a much broader area.

In the seasonally warming edge-zone environment, tiny (6–10 mm), weakly swimming yoke-sac larvae begin emerging from egg masses in early to mid-May. This timing generally corresponds to a transitioning from strong coastal downwelling to stabilization or weak coastal upwelling in the northern Gulf of Alaska and may be an adaption to minimize the chance of washout from the region. As the larvae disperse from the natal habitats they immediately become vulnerable to a host of small, planktonic carnivores. Survivors have only a few days to adopt active feeding after yoke-sac absorption or they will starve. Egg mortality and losses of larvae to predation, starvation and washout from the region probably account for 95-99 percent of the "mortality" of a year-class.

Survivors of this "critical period" metamorphose to the juvenile form 60–90 days later and begin appearing in schools in shallow near-shore habitats. At present, it is not clear whether most of these juveniles re-invade the shallows following a deep-water drift or are remnants of populations that remain in the shallow water environments after hatching. These small fish (30–60 mm in length) continue to be food for other fish, birds and marine mammals.

Unlike pink salmon, surviving juvenile herring remain in Prince William Sound until they mature at age 2 or 3. This strategy requires survival during at least two winter periods of food deprivation and cold temperatures. Rather than putting energy into size (like pink salmon), herring commit to energy storage, presumably a strategy to address predictably varying seasonal forage resources. The degree to which the juveniles are prepared to successfully bridge the winter season probably reflects local growth conditions experienced during the previous summer and fall. Fall measurements of the whole-body energy content for juveniles in Prince William Sound demonstrate clear differences in pre-winter condition within schools and between years and locations. Based on these observations and laboratory studies, SEA investigators believe that winter starvation represents a significant survival risk for juveniles. Post-winter energy levels demonstrate significant draw-down on reserves. As an additional problem, it is possible that a delayed plankton bloom in the spring (observed in the SEA data) may extend the period of elevated risk for winter survivors whose weakened condition make them increasingly vulnerable to predation just prior to the production of seasonal food. Much of the present work focuses on defining factors of loss during the "winter season". Once the surviving juveniles mature, they enter a multi-year class spawning population and may contribute to production for 10–12 years.

These differences in life history between pink salmon and herring have dictated very different approaches to understanding variability in losses to juvenile populations. Studies of salmon mortality have focused primarily on the April–July period of juvenile residence, with predation hypothesized as the major factor of loss. Correspondence between the timing of the salmon fry out-migration and the peak of a consistent early season zooplankton bloom points toward food and predation sheltering as an evolutionary adaptation. Subsequent studies have demonstrated that springtime macrozooplankton does serve as a food source for many species that also prey on juvenile pink salmon like juvenile and adult walleye pollock, adult herring, juvenile Pacific cod, and tom cod. Evidence is building that levels of zooplankton can modulate a kind of prey switching that impacts losses in juvenile pink salmon populations each year. Unusually high macrozooplankton stocks in April and May can apparently shelter small fish from larger fish by providing an energetically more attractive forage base for the larger predators. Conversely, weak macrozooplankton stocks can leave the juveniles more vulnerable to predation. This general picture is complicated by interannual differences in springtime water temperatures and the composition and abundance of predator stocks. Plankton populations and water temperatures are tied to the oceanography of the region and vary from year to year in response to Gulf of Alaska–scale meteorological events driven by global weather. Local zooplankton production, seeding from the adjacent shelf, and flushing from the Sound all play roles in regulating planktonic forage stocks for consumers each year. Understanding the relative importance of these interacting factors under a variety of different conditions remains the principal focus of SEA juvenile pink salmon studies.

Because they represent a major forage resource for many consumers in Prince William Sound, juvenile herring populations are also impacted heavily by predators. However, if these losses are generally consistent from year to year, other factors could be responsible for regulating the overall recruitment of juveniles to the adult population. Overwintering mortalities driven by oceanographic conditions affecting food and growth during the summer, and winter temperatures may be significant in some years. Also, the degree to which massive larval populations are either retained or washed from the system each spring could set levels of recruitment independent of predation and starvation. It seems likely that these factors, individually or acting in concert, establish recruitment levels.

As the SEA program enters its last fully funded year, sufficient information is on hand to begin a serious exploration and testing of the ideas that originally led to the creation of the study. The validation of all models is expected to be completed by late FY97 or early FY98, so these products can be used to develop survival scenarios under a variety of "experimental conditions" (including historical weather patterns) in attempts to recreate the trends observed in time-series of herring and salmon production before and after the spill. To do this, most investigators will emphasize data analysis, interpretation, and application to the modelling (testing or validation) as the principal tasks in FY98.

Since the present SEA herring program began its efforts in FY95 but did not become fully functional until FY96, it is likely that some of the herring work (including aspects of the management models) will have to be pursued under a new program beginning in FY99. That eventuality is being examined under a set of plans that may include a future merger of SEA

herring studies with APEX. Also, the management model products being developed for ADF&G (pink salmon and herring) will need to be initialized each year for numbers of juvenile pink salmon and herring and their predators (large pelagic gaddids, herring, and others) as well as tuned to seasonally changing oceanography. This will have to be accomplished through a nominal monitoring program, also under development for support beginning in FY99. To assist with the application of results, SEA established a formal liaison with the regional office of ADF&G (Dr. James Brady) in September 1996 to stimulate interchange between the research, modelling and potential management applications of the 5-year program and the management of these species. This relationship is expected to define the interface between the long-term monitoring program and the management, enhancement, and restoration applications of the SEA models to pink salmon and herring in Prince William Sound.

NEED FOR THE PROJECT

A. Statement of the Problem

Injured and non-recovering pink salmon and herring populations in 1993 suggested that something other than oil might be constraining the recovery. SEA proposed that some aspect of ocean climate, perhaps temperature and/or food for juveniles might be responsible, or that an oil induced shift or other change in the composition of large fish predators was cause for prolonged reduced production. These conditions can only be examined comprehensively within the framework of a multi-disciplinary program designed specifically to define the processes of loss to juvenile pink salmon and herring populations in relation to bottom–up (oceanographic) and top–down (predation) control e .ch year.

Even though pink salmon is now listed as a recovering species, that process is not yet complete. Pacific herring continues to be listed as non-recovering, but signs of growing stock size warranted a harvest in the spring of 1997. These signs point to the eventual overall recovery of both species, although the process is likely to be slow. Only the bald eagle has been declared fully recovered by the EVOS Trustee Council, eight years after the spill.

B. Rationale/Link to Restoration

The SEA approach to pink salmon and herring restoration is to formulate a series of interacting numerical models designed to simulate the dynamic processes influencing the survival of juvenile pink salmon and herring rearing in Prince William Sound each year. Because pink salmon and herring populations are managed for a commercial fishery, there is a proactive means for manipulating stock size each year in response to levels of production and the commercial and substance needs of the region. SEA models will ultimately assist the managers of these important fisheries to understand how environmental factors affect production from year to year and on decadal-level time scales. Because they encompass both food-web dynamics and atmospherically forced ocean physics, these simulations will also allow retrospective analyses of past stock performance, now-casting (current status of juveniles in the system), and improved forecasting. By more fully understanding the factors that regulate juvenile herring and pink salmon survival,

appropriate levels of harvest can be applied to allow stock response in the face of ever changing natural conditions. In its maturation process, the work initiated by SEA in 1994 will transition from research (the development of management tools), to monitoring (the operation of management tools), and finally to general restoration (the application of management tools) to assist the recovery and improve the long term health of pink salmon and herring populations in Prince William Sound.

C. Location

The SEA program is being conducted in Prince William Sound and adjacent shelf and ocean waters.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Program 320 grew out of active regional community involvement which continues to the present time. Part of the study originates from the Prince William Sound Science Center, Cordova, Alaska and requires local services in that community. Prince William Sound vessels have been routinely charted for much of the SEA research. Each year SEA provides the citizens of the region with an update of research findings and current and planned studies. During the first two years of the program, SEA circulated a newsletter of accomplishments. Commercial fishermen in the region also learn about SEA results through a lecture series sponsored by the Prince William Sound Science Center. In FY97, SEA expanded the herring work to include incorporation of traditional ecological knowledge for this species (97320-T supplement).

PROJECT DESIGN

A. Objectives

1. Develop an ecosystem-level understanding of factors and mechanisms constraining the production of pink salmon and herring in Prince William Sound.

2. Use this information to create a series of numerical tools and a nominal monitoring program to assist with increasingly informed management, enhancement, and restoration of pink salmon and herring resources.

3. Establish a comprehensive database of SEA results for management and continuing scientific needs in the region.

B. Methods

Field and modelling activities in SEA have been designed to address a series of hypotheses about ecosystem function believed to be controlling the production of pink salmon and herring populations in Prince William Sound:

a. *The survival of juvenile pink salmon and herring is determined primarily by losses to bird, fish and marine mammal predators.*

b. *Predation losses are modified by the numbers and kinds of predators, and by the numbers, kinds and distributions of alternative prey for these predators. Macrozooplankton serves as alternative prey during some years and seasons.*

c. *Zooplankton stocks are established by local reproduction in relation to the timing and magnitude of the annual phytoplankton production and modified by currents that both flush and seed the region from adjacent shelf and oceanic populations.*

d. *Herring recruitment dynamics are driven primarily by larval retention, losses to predation, and winter survivals.*

e. *Larval herring retention is established each year in response to late spring flushing rates and transport relationships between near-shore natal areas and offshore currents.*

f. *Herring losses to predators and overwintering survivals are determined primarily by the size and somatic energy content of juveniles set by growth conditions each spring, summer and fall.*

g. *Pink salmon recruitment dynamics are driven primarily by the numbers of surviving juveniles leaving the sound each summer.*

SEA is a fully integrated, interdisciplinary, multi-component study. Methods used by each of the projects were described previously in the SEA95 DPD and other submissions on file with the EVOS Trustee Council, Alaska Department of Fish and Game, and NOAA as the result of previous proposals. Each SEA component project is required to submit an individual DPD to its appropriate sponsor for contracting purposes. These documents contain refinements to methods previously described (above).

In FY96, SEA organized internally to create a closer coupling between field and modelling studies in response to reviewer comments and an increasing need for internal focus. The new structure identifies three groups whose primary tasks are to create, through collaborations, the major SEA management numerical simulations (Appendix II). These groups are now working effectively alone, but will soon begin working together as the separate modelling efforts merge to address the ecosystem-level questions being pursued by SEA.

The **Ocean State and Plankton Dynamics workgroup** has responsibility for creating the simulations that model physical and lower trophic-level responses, both to flow fields (vertical and horizontal) and to physically constrained (light and mixing) local primary productivity. The SEA ocean state model has been tuned for seasonal wind and tidal forcing (manuscripts submitted), and the final refinement will involve the incorporation of freshwater input, a significant forcing factor in coastal Alaska. The present 1-dimensional plankton model is scheduled to be integrated with the 3-dimensional ocean state simulation to provide time/space

plankton fields (phyto and zoo) as input to both the herring and pink salmon recruitment models. Investigators working on these products include Drs. Vince Patrick, Chris Mooers, and Jai Wang (320-J SEA modelling), Dr. Shari Vaughan (320-M Physical Oceanography/Optical Plankton Counting), Dr. David Eslinger (320-R Biophysical Modelling), Dr. Peter McRoy (320-G Phytoplankton) and Dr. Ted Cooney (320-H Zooplankton). Additional input comes from Dr. Tom Kline (320-I Isotopes) and Dr. Gary Thomas (320-N Acoustics). This subgroup will be responsible for the formal testing of hypotheses relating early spring zooplankton population levels to seeding and flushing rates, and local production—the original "lake/river" conjecture.

The **Pink Salmon Recruitment Dynamics subgroup** focuses field and modelling studies on processes of loss affecting the survival of juveniles during their short stay in Prince William Sound. Contributing investigators include Drs. Vince Patrick and Doran Mason (320-J Modelling), Dr. Shari Vaughan (320-M Physical Oceanography), Dr. Ted Cooney (320-G Zooplankton), Dr. Tom Kline (320-I Isotopes), Dr. Gary Thomas (320-N Acoustics) and Mark Willette (320-E Predation). Emphasis in this group is on understanding and simulating mechanisms that promote coupling or decoupling of salmon fry and their predators. This subgroup and its numerical products establish the framework for formal tests of SEA's original "prey switching" hypothesis. A fully functional pink salmon recruitment model is expected to provide managers of this valuable resource with new information about annual juvenile survivals and forecasted levels of returns one year in advance of the fishery.

The **Pacific Herring Recruitment Dynamics subgroup** formed to coordinate field and modelling activities that will eventually provide formal tests of the larval retention hypothesis and the juvenile overwintering hypothesis—factors critical to the process of adult recruitment and production in Prince William Sound. Studies include investigating modelled larval drift, and measured juvenile summer growth and energy storage, overwintering bioenergetics, starvation, and predation. Investigators leading this effort include Drs. Brenda Norcross and Kevin Stokesbury (320-T Herring Habitats), Drs. Vince Patrick and Doran Mason (320-J Modelling), Dr. A. J. Paul (320-U Energetics), Dr. Tom Kline (320-I Isotopes), Dr. Shari Vaughan (320-M Physical Oceanography) and Dr. Gary Thomas (320-N Acoustics). A fully functional herring model will track and predict levels of juvenile recruitment to adult populations as a function of both bottom–up and top–down influences.

The numerical products arising from the activities of these three groups will be linked (as needed) to provide estimates of pink salmon and herring recruitment strength to fishable stocks, to evaluate fluctuations in stock production caused by interannual and decadal-scale fluctuations in ocean climate, and to explore opportunities for investigating the effects of different management strategies on modelled populations. These kinds of numerical tools are not routinely available to managers of fisheries anywhere. Their use is expected to substantially improve the information available to the stewards of pink salmon and herring resources in Prince William Sound.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Program 98320 is one of three ecosystem approaches sponsored by the EVOS Trustee Council in Prince William Sound. The integrated SEA study is administered by two agencies - ADF&G for projects housed at the University of Alaska Fairbanks and within ADF&G, and NOAA for projects conducted from the Prince William Sound Science Center, Cordova, Alaska.

SCHEDULE

A. Measurable project tasks for FY 98 (October 1, 1997 – September 30, 1998)

October 1 - December 31:	Analyze data collected from the FY97 field season Continue herring field studies Apply results to model formulation and hypothesis testing
January 15-24:	Attend the Annual Restoration Workshop
February 1 - April 10:	Prepare the FY99 DPD and FY97 Annual Report
April 15:	Submit the FY99 DPD and FY97 Annual Report
April 15 - September 30:	Collaborative research, model formulation, hypothesis testing.

B. Project Milestones and Endpoints

1. Complete the validation of coupled ocean state and plankton dynamics models.

2. Complete the final validation of the coupled juvenile pink salmon survival model.

3. Test a preliminary model of juvenile herring overwintering survivals with linkages to summer growth conditions.

4. Simulate losses of larval herring from the region under different conditions of springtime flow fields and temperatures in Prince William Sound.

5. Undertake and complete formal tests of the "lake/river" hypothesis. Describe the most probable causes for fluctuations in local macrozooplankton populations driven by the interacting processes of trophic coupling to phytoplankton and flushing and seeding to and from the adjacent Gulf of Alaska.

6. Undertake and complete formal tests of the "prey switching" hypothesis. Describe the most probable causes for fluctuations in fry survival under different conditions of predator species composition and abundance, alternative prey for predators, and temperature and food modulated growth of juvenile pink salmon.

7. Complete arrangements by which Alaska Department of Fish and Game interacts with the completed SEA management models and database to enhance the management of pink salmon and herring in the region.

8. Design the components of a nominally-funded, long-term, model-based monitoring program for implementation in FY99.

9. Design the components of continuing ecosystem-level herring studies in Prince William Sound with ties to the SEA models for implementation in FY99.

C. Completion Date

Program 320 is scheduled for closure of all field work at the end of FY98. The Trustee Council will provide nominal funding to prepare a final report/synthesis of the 5-year SEA study in FY99. Continuing herring studies and a model-based monitoring study will be proposed as new programs in FY99 under new names or affiliated with other ongoing ecosystem-level studies at that time.

PUBLICATIONS AND REPORTS

SEA will be responsible for submitting a single, integrated FY97 Annual Report and FY99 DPD by April 15, 1998. In addition, SEA investigators will all be actively publishing the results of research completed during FY97 and extending into FY98. These single-authored and collaborative manuscripts are expected to be used, in part, to assist with the preparation of a final SEA synthesis in FY99. The overall synthesis will include research completed in FY98, and draw upon all results since the program was established in 1994. The synthesis will focus on the resolution of hypotheses driving the SEA program since 1994.

PROFESSIONAL CONFERENCES

SEA will participate in the EVOS annual public workshop and program review in January 1998. Most principal investigators and many staff will also present invited and contributed papers to national and international science conferences such as those sponsored by the American Association for the Advancement of Science, the American Fisheries Society, the Society of Limnology and Oceanography, and the American Geophysical Union.

NORMAL AGENCY MANAGEMENT

Ecosystem-level studies of pink salmon and herring pursued in Prince William Sound, Alaska, are investigations of phenomena not normally conducted by the Alaska Department of Fish and Game or NOAA in this region.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

SEA program efforts are coordinated by a Lead Scientist (Ted Cooney) with assistance from an executive committee composed of David Eslinger, Vince Patrick, and Mark Willette. Each of the SEA modelling subgroups is chaired by a principal investigator with responsibility for coordination and integration within and between subgroups. SEA interacts with other EVOS-sponsored studies through collaborative research and analysis of data arranged primarily at the investigator level.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

The work proposed by SEA for FY98 represents a continuing shift in emphasis away from field collections to analyses and the application of results to hypothesis resolution and model formulation and application. These activities are consistent with plans signaled to the EVOS Trustee Council in FY95 in alignment with projected levels of funding and a closure data for SEA at the end of FY98. The only change to that agreement has been the willingness of the Council to fund a nominal synthesis effort for SEA in FY99 as a formal close-out task.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

Robert (Ted) Cooney serves as the Lead Scientist for SEA. Dr. Cooney has extensive experience with zooplankton in the Gulf of Alaska and Prince William Sound. His studies began in 1976 in response to questions from the local aquaculture corporation about the carrying capacity of the region to support enhanced populations of pink and other salmon species. He initiated a program of Cooperative Fisheries and Oceanographic Studies (CFOS) prior to the *Exxon Valdez* oil spill that yielded important information to initiate SEA studies of juvenile pink salmon survival. Dr. Cooney is professor of Marine Science at the University of Alaska Fairbanks, and an affiliated scientist with the Prince William Sound Science Center, Cordova.

OTHER KEY PERSONNEL

The interdisciplinary aspects of the FY98 SEA program are led by the following principal investigators:

Mark Willette – Alaska Department of Fish and Game, Cordova.
Peter McRoy – Institute of Marine Science, University of Alaska Fairbanks
Ted Cooney – Institute of Marine Science, University of Alaska Fairbanks
Brenda Norcross – Institute of Marine Science, University of Alaska Fairbanks
David Eslinger – Institute of Marine Science, University of Alaska Fairbanks
A. J. Paul – Institute of Marine Science, University of Alaska Fairbanks, Seward
Vince Patrick – Prince William Sound Science Center, Cordova
Gary Thomas – Prince William Sound Science Center, Cordova
Thomas Kline – Prince William Sound Science Center, Cordova
Shari Vaughan – Prince William Sound Science Center, Cordova

These investigators are assisted by staff personnel and students in Fairbanks, Cordova, and Seward, and at several institutions outside Alaska.

APPENDIX II–A

Ocean State and Plankton Dynamics

NOTE: Appendix I is detailed budget.

Ocean State and Plankton Dynamics Model

INTRODUCTION

The SEA Ocean State and Plankton Dynamics Modeling (OP group) group was formed to bring together the various SEA components involved in understanding the physical, chemical and lower trophic-level biological processes, and the interactions among those processes that affect pink salmon and Pacific herring dynamics in Prince William Sound (PWS), Alaska. This group functions in a collaborative way to devise, construct, calibrate and validate numerical models of the physical mixing, advection, and diffusion; nutrient dynamics; and phytoplankton and zooplankton growth, reproduction, and losses. The field components of the group will provide the *in situ* observations needed for the accurate estimation of parameters for the models and for the calibration and validation of the models. This group contains members of the other two modeling groups, and has members representing all trophic levels. The members of this modeling group are: David Eslinger, Chair, Ted Cooney, Tom Kline, Peter McRoy, Chris Mooers, Vince Patrick, Gary Thomas, Shari Vaughan, and Jia Wang.

The OP group is primarily examining the SEA Lake/River hypothesis. Of course, none of the SEA hypotheses are independent, and we will also be addressing the Prey Switching and Herring Overwintering hypotheses, although to a lesser extent. The pink salmon and Pacific herring modeling group will be examining those hypotheses, using information we are producing as part of the OP modeling effort.

Tests of the Lake/River notion relative to interannual differences in zooplankton biomass are probably only really testable using a tuned biophysical model. In FY98 and concluding in FY99, questions of retention and circulation will be explored and answered to the degree needed to achieve the prediction objectives of the combined SEA model. An important function of the group is cross-disciplinary collaboration. For example, late stage *Neocalanus* species observed on the R/V *Alpha Helix* cruise in or near the euphotic zone will provide field data to compare against modeled *Neocalanus* distributions.

GOALS

The SEA Ocean State and Plankton Dynamics modeling group seeks to achieve five goals, which can be broadly stated as:

- To create accurate, three-dimensional, time-varying models of the PWS physical and biological (up through plankton) environment;
- To investigate the role of the physical environment in structuring the lower trophic levels; *and*
- To provide physical and lower trophic level data fields to the salmon and herring modeling groups;

- To maintain and fully exploit the multi-source data sets needed to run the SEA models through the use of the SEA database;
- To foster interdisciplinary collaborative research and integration of SEA results through the use of the SEA intranet, a collection of web-based tools for scientific collaboration.

More specifically, the combined physical oceanography program is aimed at describing and understanding the circulation and mass field of PWS, and supporting the needs of the marine ecosystem and fisheries studies for physical information. Similarly, the phytoplankton and zooplankton field groups and the plankton modeling group are aimed at describing temporal and spatial changes in biomass and species composition and in understanding the physical, chemical and biological mechanisms which produce these changes. We expect to investigate and understand these processes at the spatial and temporal resolution sufficient for understanding pink salmon and Pacific herring dynamics. This will require the creation of models capable of simulating events on diurnal, seasonal, annual, and possibly interannual time scales and over spatial scales from the basin-wide mesoscale down to the near-shore meter or 10 meter scale.

We expect that these models will be developed and implemented separately, but with a large degree of coordination and interaction. Initially, there will be two different three-dimensional models, one of the physical dynamics and one for the plankton dynamics. This is a necessary consequence of the different dynamics of the biological and physical systems. The processes that are important in resolving the first order physical dynamics occur over different spatial and temporal scales than the processes essential to resolving the first order biological dynamics. For example, one of the main physical features to be simulated is the horizontal advective field, especially the degree to which Gulf of Alaska (GOA) waters extend into PWS. Simulation of this feature will require knowledge of the Alaska Coastal Current system, the GOA seasonal circulation patterns, tidal cycles, freshwater inflow, etc. These processes are variable over fairly large horizontal distances, roughly 50 km, and over time scales approximating two weeks. In contrast, one of the major biological events to be simulated is the phytoplankton spring bloom. The occurrence of the bloom is generally dependent on local winds, light, and nutrient conditions, and it is necessary to know these with a vertical resolution of 1–2 m, and at a time scale of 1–2 hours. The larger scale forcing mechanisms needed for the physical model are definitely important to the biological processes, but the primary phytoplankton dynamics occur at much smaller time and space scales. Therefore, we propose to model the physics with a three-dimensional model that can efficiently simulate the flow fields, and to model the biology with a three-dimensional model that can efficiently simulate the phytoplankton and zooplankton dynamics. The results of the physical model will be used as input into the plankton model, therefore the biological model will include **all** appropriate physics, but can proceed at the higher spatial resolution needed to simulate the biological dynamics.

As these models mature, there will be a gradual blending of processes included in both of them. For instance, some of the zooplankton drift/seeding modeling simulations may be done in the physical model, where advective effects are more efficiently modeled at the expense of reduced biological accuracy. These simulations will involve collaborations drawing on the pooled intellectual resources of the OP group to see that simulations do not violate our basic understanding of how the systems are working.

Running all the SEA models and verifying the results requires access to data from the entire SEA project. For convenience, we have formed two sub-groups under the OP modeling group to facilitate this. The first group, chaired by S. Vaughan and R. T. Cooney, will foster database utilization, oversee quality control, and guide additional developments, if needed, to improve the utility of the database. The second group, overseen by V. Patrick, J. Allen, and D. Eslinger; will encourage full exploitation of the intranet collaborative tools, monitor the use of the tools, and recommend additional enhancements to improve their efficiency.

WORK PLAN

The general strategy for achieving our Goals has been and continues to be:

1) to obtain the physical and biological measurements needed to force and verify the model,
2) to implement the models using forcing functions derived from field data,
3) to evaluate the model results,
4) to reassess/revise processes in the model and what field data are needed, and
5) to repeat this sequence until the model simulates the field data with acceptable accuracy.

We have been carrying out the field measurement strategies by a combination of time series measurements at limited, critical locations, and large-scale sound-wide surveys. The time series observations provide information on the phasing of the dynamics; and the surveys provide information on the spatial variability of the sound and the relative location/extent of the "river" versus the "lake".

Specific tasks to be performed are given below, organized under the SEA sub-project which will be performing and/or responsible for them. This is a somewhat artificial breakdown, because many of these tasks will involve participants from several SEA sub-projects. The designations arrayed below are not in anyway exclusive.

Physical field measurements will be made by the Observational Physical Oceanography sub-project (97320-M), Shari Vaughan, principal investigator. The work to be done in FY98 by the physical oceanography group will include:

- Continue data fusion of large scale oceanographic data into the numerical circulation model;
- Continue data analysis to identify physical "river" and "lake" signals and conditions;
- Design a cost-effective monitoring scheme for oceanographic and meteorological variables for these regions and times;
- Prepare collaborative manuscripts.

The physical model development and implementation will be continued by the Modeling and Information Services (SEA DATA) sub-project (97320-J), Vince Patrick, principal investigator. The work to be done in FY97 and FY98 by the physical modeling group will include:

- Continue model refinement, specifically to include:

  - throughflow forcing of PWS circulation,
  - wind forcing of PWS circulation,
  - tidal forcing of PWS circulation,
  - freshwater forcing of PWS circulation,
  - seasonal wind and thermohaline forcing of PWS circulation,
  - annual cycle simulation of PWS circulation,
  - interannual simulation of PWS circulation;
- Perform model validation, especially focused on April–May—specifically to include:
  - time series comparisons,
  - synoptic map comparisons,
  - vertical profile comparisons,
  - vertical transect comparisons,
- Provide validated April–May circulation fields for input to ecosystem and fisheries models.

Phytoplankton and nutrient field observations will be made by the Phytoplankton and Nutrient sub-project (97320-G), Peter McRoy, principal investigator. The work to be done in FY98 will include:

- Continue time series measurements at AFK Hatchery of nutrients, phytoplankton species composition and chlorophyll concentration, and dissolved oxygen;

Zooplankton field data and analyzed results needed for the modeling effort will be provided by the Zooplankton sub-project (97320-H), Ted Cooney, principal investigator. The work to be done in FY98 will include:

- Analysis of samples collected by OPC/acoustic projects to provide calibration data from the OPC and high-frequency acoustic surveys;
- Analysis and interpretation of all time-series collections;
- Complete and publish studies of the relationships between physical structure, phytoplankton biomass and macrozooplankton biomass/species composition utilizing the OPC and high-frequency acoustics database from the R/V *Alpha Helix* cruise (in cooperation with SEA-Acoustics/SEA-Physical).

Zooplankton isotopic field data will be continued by the "Confirming Food Web Dependencies with Stable Isotope Tracers" (SEA-FOOD) sub-project (97320-I), Tom Kline, principal investigator. The work to be done in FY98 will include:

- Sampling of terminal feeding stage *Neocalanus* in the GOA and PWS to:
  - confirm the existence of the isotopic gradient each year,
  - compare isotopic signatures with nutrient field data,
  - assess the role of nutrient depletion to isotopic field,
  - compare years, *i.e.*, lake/river assessments,
- Determine characteristic isotopic signatures for GOA and PWS each year to:
  - apply the confirmed isotopic signatures in associated pink and herring isotope studies
  - apply the confirmed isotopic signatures for circulation model validation by

  - sampling diapaused copepods in PWS,
  - assessment of source (GOA vs. PWS) in diapausing copepods,
- Compare the prevalence of lake/river copepods to those found in previous years;
- Compare assessment with model forecasts of copepod seeding;

The plankton model development and implementation will be continued by the Trophodynamic Modelling and Remote Sensing sub-project (97320-R), David Eslinger, principal investigator. The work to be done in FY98 by the plankton modeling group will include:

- Implement full three-dimensional plankton model incorporating physical state variabile fields from output of the physical model;
- Collect and analyze satellite imagery of sea surface temperature and ocean color for comparison with the model results;
- Continue model refinement, specifically to:
  - enhance zooplankton vertical movement dynamics,
  - add herring ichthyoplankton component to examine match/mismatch of herring larval time of first feeding with timing of phytoplankton bloom;
- Design and implement a demonstration nowcast system;
- Perform model validations, specifically to include:
  - time series comparisons at hatchery locations,
  - synoptic spatial comparisons of SST and chlorophyll with satellite data and large-scale survey results,
  - vertical profile comparisons with OPC data,
  - interannual comparisons with phytoplankton and zooplankton time and space data.

MILESTONES

A. Physical Field Program

FY98
- Continue analysis of field data, climatological data sets, seasonal signals, and storm data
- Design a cost-effective monitoring scheme for oceanographic and meteorological variables

FY99
- Complete analysis and write final report

B. Physical Modeling Program

FY98
- Iterate with ecosystem and fisheries models focused on April–May
- Continue model validation
- Update annual cycle simulations
- Design future real-time monitoring and nowcast/forecast system
- Participate in "what if?" simulations as part of the SEA synthesis

FY99
- Complete analysis and write final report

C. Phytoplankton Field Program

FY98
- Phytoplankton time series sample analysis and data reduction for model validation
- Test field monitoring program for model input

FY99
- Complete analysis and write final report

D. Zooplankton Analysis and Field Program

FY98
- Zooplankton time series (model validation)
- Zooplankton mapping (OPC/acoustic calibration/validation)
- Test field monitoring program for model input (using OPC/acoustic/nets)

FY99
- Complete analysis and write final report

E. Isotopic Field Program

FY98
- Zooplankton isotopic mapping
- Test field isotopic monitoring program for model input

FY99
- Complete analysis and write final report

F. Plankton Modeling Program

FY98
- Completed phytoplankton/zooplankton/physical model
- Implement nowcast/forecast system
- Integrate plankton model into demonstration model sequence with physical and nekton models

FY99
- Complete analysis and write final report

SUMMARY

Work concluding in FY98 will complete the SEA program as originally described and funded. Nominal funding in FY99 is expected to produce a synthesis describing the influences of bottom-up and top–down forcing on these injured populations. Parts of the completed SEA program are expected to transition forward as new projects. Depending on the continuing modeling needs for management and restoration purposes, a new model-based monitoring program will be proposed for initiation in FY99.

APPENDIX II–B

Pink Salmon Recruitment Dynamics

Pink Salmon Recruitment Model

INTRODUCTION

The pink salmon recruitment model is being developed as a tool to forecast the relative abundance (weak, strong, or average) of wild and enhanced pink salmon, evaluate effects of potential management actions taken to restore pink salmon, and evaluate effects of various enhancement strategies on wild and enhanced salmon production. The pink salmon recruitment model will focus on the early marine period of juvenile salmon from ocean entry to emigration from Prince William Sound (PWS). The model will be composed of three coupled submodels: (1) ocean state model, (2) plankton dynamics model, and (3) nekton model. These models will be developed and coupled during phase II of SEA. The ocean state model will simulate the physical structure and circulation of PWS. The plankton dynamics model will utilize output from the ocean state model to simulate the distribution and abundance of key zooplankton species. The nekton model will utilize output from each of the other submodels to simulate the distribution, feeding, growth, and mortality of several key nekton species that interact with juvenile pink salmon. The nekton model will ultimately estimate losses of wild and enhanced fry along their migratory pathway. Inputs needed to run these models will be obtained from existing agency assessment programs with some directed field measurements. Validation of the submodels will be conducted throughout phase II; however, validation of the entire coupled recruitment model will be initiated in FY99 (phase III). Model estimates of the abundance of wild and enhanced salmon emigrating from PWS will be compared with estimates obtained from a sampling program conducted by ADFG in the southwest passages of the sound.

During phase I, modelling efforts were focused on development of first-order physical and biological models describing predator\prey and energetic processes influencing pink salmon survival. The two components of the SEA nekton (or fish) model have been separately implemented and both have undergone initial simulation and validation studies. In operation, the nekton model describes the simultaneous, instantaneous processes of foraging and dispersion (movement) of interacting fish populations in a format whereby the consequent spatial distribution and overlap of populations can be computed along with the rate of predation of one population upon another. From this, mortality rates and growth rates for each population are computed. The model has two interdependent components. The first is the dispersion model: dispersion depends in part on the rate of foraging, so the foraging model is an essential part of the dispersion model. The second part is the foraging and growth (bioenergetics) component: this second component depends upon the overlap of populations, hence it depends in an essential way upon the dispersion model. The dispersion and the foraging/bioenergetics models have, to date, been implemented using simplifying assumptions regarding the interdependence. For the foraging/bioenergetics model homogeneous spatial distribution is assumed. For the dispersion model gut fullness and satiation are neglected in the foraging model. Of the two components the dispersion model is the more difficult development task because there is significantly more prior work that is applicable for the foraging/bioenergetics model.

Version 4 of the dispersion model was completed and tested during the end of 1995; the dispersion model results presented at the January 1996 EVOS Workshop in Anchorage were the first results from Version 4. (Dispersion model results were also presented at the September 1995 SEA Workshop in Fairbanks, but these were from Version 3) The completion of Version 4 is a major milestone: all of the nekton model development thrusts of 1995 are brought together and are functional in Version 4. These features are :

1. An arbitrary number of interacting fish species can be modelled, with the upper bound dependent solely upon the computational resources available.

2. Version 4 is implemented as a scripting programming language. A scripting language was written whereby the model components can be very rapidly revised and compiled without having to work with the underlying C code. The scripting programming language itself builds the C routines from the user scripts. For a wide class of simulations, recompilation is not necessary. A recompilation is required only if the structure of the model is revised; it is not required if only model parameters are changed.

3. Version 4 implements a new algorithm for the solution of the underlying model equations. This new algorithm eliminates numerical constraints that existed in Version 3 regarding how large the directed movement (flight from predators, pursuit of prey, or avoidance of changing physical features) could be relative to randomly directed dispersion (diffusion). The algorithm of Version 4 is near optimal regarding this constraint and the limitations are essentially those of the computing platform.

4. Version 4, like previous versions, is a finite element solution that uses the exponential fitting method. The model therefore has the favorable property of not having overshoots or undershoots extend beyond the containing element. This is not the case with common alternative methods. Consequently, the model does very well with sharp boundaries between populations, even with low resolution grids.

A core set of simulations have been completed using Version 4: pink salmon fry dispersal following net pen releases, pink fry behavior in nearshore areas in response to avoidance of higher velocity currents during flood and ebb tides, and adult pollock movement in response to a combination of fry and macrozooplankton prey.

During the last quarter of 1995 foraging/bioenergetics models were completed and tested for pink salmon fry and adult pollock. Results from simulations with these models coincided well with published experimental data for growth rates and foraging behavior. A key goal for the foraging/bioenergetics model was to provide a realistic link between the widely differing time scales for dispersive behavior and those for somatic growth. The foraging/bioenergetics model connects these two processes by including within the model the intermediate processes of gut filling, evacuation, and foraging and linking these to growth. Moreover, to adequately describe these intermediate processes for the fish species in SEA it was necessary to further develop the foraging/bioenergetics models and include within them the following new features:

1. The ability to simulate night fasting and a short period of very high consumption at dawn that continues until satiation occurs.

2. The simulation of those fish that feed at a low rate to maintain satiation until gut fullness drops below some value or some environmental triggering event occurs.

However, underlying these new features are well known model elements for encounter rate, foraging rates, handling time, and swimming speed.

Field sampling during phase I focused on identification of the principal species preying on pink salmon and the processes affecting rates of predation. Phase I results indicate that predation by pelagic pollock (age 3+) and seabirds may account for only 15–25% of probable losses of juvenile salmon. These results suggest that additional significant losses may be caused by predators coupled with juvenile salmon in nearshore habitats. However, several factors may have resulted in underestimation of juvenile salmon consumption by pelagic pollock. Pollock biomass may have been underestimated due to vessel avoidance, occurrence of pollock in the surface layer (0–5 m) that was not surveyed, and/or occurrence of pollock below 125 m depth that was not surveyed. In addition, pollock food consumption may have been underestimated if the fish are glut feeding in the surface layer then migrating to depth to rest.

It appears that pink salmon recruitment may be determined by the dominance of either of two processes in any single year (Figure 1). Studies of coded-wire tagged juvenile salmon since 1989 indicate that in years when run failures occur there is no relationship between fry growth and fry-to-adult survival (1991, 1992, 1994). However, in years when the adult return is average or above, a relationship exists between fry growth and fry-to-adult survival. The lack of a relationship between growth and survival may indicate that significant mortality occurred before the fry had a chance to grow or predation was not size selective. Predation by pelagic pollock (age 3+) in early May occurs before the fry have had a chance to grow and it is not size selective. However, pelagic pollock do not appear to take significant numbers of juvenile salmon in offshore habitats. If predation by this group has caused run failures observed in recent years, it is likely that age 3+ pollock are coupling with fry in nearshore habitats which may not have been adequately sampled. Recent analyses of data obtained in 1995 indicate that size-selective predation by age 1–2 pollock may be significant in June. In years when predation by this group is dominant, we would expect to see a relationship between growth and survival. In these years, the relationship between fry size (growth) and the timing of the inshore migration of juvenile pollock (age 1–2) and other fish may determine recruitment. Fry growth and inshore juvenile pollock migration appear to be regulated largely by temperature. These results indicate that pink salmon recruitment modelling efforts should focus on (1) determining if predation by age 3+ pollock in nearshore habitats accounts for estimated losses, (2) developing an understanding of the relationship between fry growth and the timing of the inshore migration of age 1–2 pollock, and (3) determining the conditions that lead to the dominance of either process. In addition, we need to determine the proportion of the age 3+ and age 1–2 pollock populations that couple with juvenile salmon. If this can be done, the pink salmon recruitment model can utilize pollock biomass assessments provided by ADFG or NOAA surveys. This would greatly increase the likelihood that the model would be used as a forecasting tool after EVOS funding ends.

An analysis of density-dependent interactions between wild and enhanced salmon is needed to develop rational management plans for the hatchery program in PWS. Alaska has established a legal and financial structure to promote the development of salmon enhancement programs in the state. However, State statutes require that enhancement programs be developed without adversely affecting natural salmon stocks. The presence of large numbers of enhanced salmon may adversely affect wild salmon during the early marine period in several ways. Predation on wild juveniles may be greater if wild and enhanced fish are mixed and predators are attracted to large aggregations of salmon. The impact of this type of interaction may be amplified if predators select wild salmon from the school. Wild and enhanced salmon are often found in mixed schools, and age 1–2 pollock were found to select smaller juvenile salmon in 1995. The presence of large numbers of enhanced salmon may also lead to reduced growth among wild and enhanced fish leading to reduced survival for both groups. An inverse relationship between whole body energy content and fry density at three sites sampled in 1995 suggests that growth may be density-dependent (Paul and Willette 1996). All juvenile pink salmon released from PWS hatcheries will be otolith thermal marked in FY96, providing an essential tool for these investigations. This component of the pink salmon recruitment model will provide a useful tool to improve management of the Sound's wild and enhanced salmon stocks.

OBJECTIVES

The pink salmon recruitment modelling program will focus on the following objectives in phase II.

FY97:

1. Develop a 3-D version of the nekton model.

2. Develop the first version of the coupled the ocean state, zooplankton and nekton models.

3. Evaluate density-dependent interactions among wild and enhanced salmon.

4. Describe the processes affecting the consumption of juvenile salmon by coupled predators in the nearshore zone.

5. Work cooperatively with ADFG to design a sampling program to estimate the relative abundance of wild and enhanced salmon emigrating from PWS.

FY98:

1. Estimate initial conditions for the salmon fry population upon ocean entry.

2. Continue development of a sampling program to estimate the relative abundance of wild and enhanced salmon emigrating from PWS.

FY99 (Phase III):

1. Monitor relative abundance of wild and enhanced salmon emigrating from PWS and evaluate the performance of the pink salmon recruitment model under various environmental conditions (years).

METHODS

FY97:

Objective 1:

The code, algorithms, and graphical user interface for the nekton model is collectively referred to as the ALaska Experimental Windows Interface for Fisheries Ecosystems (ALEWIFE) model. During FY97 the 2-dimensional and 3-dimensional versions (Version 5) of ALEWIFE will be completed. Initial estimates of fry mortality during outmigration will be computed from combined model simulations for a variety of hypothetical scenarios for spatially and temporally varying physical conditions, macrozooplankton distribution, predator distributions and population structures, fry distribution, and outmigration timing and duration. Both Versions 4 and Versions 5 will be used to extend these methods to the cases resulting from the collection of lake/river scenarios from the ocean model applied to the plankton model. These scenarios will be used as forcing that is, the zooplankton abundance and distribution and the fish distribution will not be coupled.

Objective 2:

During the end of FY97 the first version of the coupled ocean/plankton/nekton model for pink salmon fry will be completed. Simulations and tests with this endpoint version of the model will be conducted during FY98.

Objective 3:

Analyses of density-dependent interactions between wild and enhanced salmon will focus on tracking changes in size and water content of somatic tissues of each group in areas of low and high fry abundance over time. The water content of somatic tissues will be used as a proxy for energy content of fry. Data provided by Parker and Vanstone (1966) indicate that water content (% stomachless body weight) is highly correlated with energy content ($R^2 = .79$). Fry samples (n=100) will be collected with a small-mesh purse seine in mid-May, early June, and mid-June at three sites in areas of high fry abundance (near hatcheries) and three sites in areas of low fry abundance (Port Gravina, Port Fidalgo and Galena Bay). Fry samples utilized for this analysis will be composed of fish obtained from at least three net sets within each site. CTD and zooplankton sampling (20 m vertical tow) will be conducted in association with each fry sample to evaluate environmental conditions at each site. Otolith thermal marks will be used to identify wild- and hatchery-origin fish. Analysis of covariance will be used to test for differences in water content of fry between areas of low and high juvenile salmon abundance and between wild- and hatchery-origin salmon from the same site. Length will be used as a covariate in the analysis.

Size- and condition-dependent predation will be evaluated from analysis of samples of live fry and prey fry collected in FY96. Juvenile salmon previously frozen in seawater will be partially

thawed to allow for handling but not loss of fluids. Standard length, wet weight, dry weight, and whole body energy content will be measured for each individual. After freeze drying, bodies will be placed in a convection oven at 60°C until a constant weight is achieved. Individual wet and dry weight values will be used to calculate moisture content. Dried tissues will be ground in a mill and caloric content will be measured by bomb calorimetry. Fulton's condition factor [CF = g wet wt x 100/(cm standard length)3] will be calculated for each individual. Tests for differences in whole body energy content and size between live fry and prey fry from the same site will be conducted.

Objective 4:

Investigations of predator/prey coupling in the nearshore zone will conducted during three 9-day sampling trips in May and June. Six sites exhibiting a range of fry densities will be sampled in PWS during each trip. Acoustic and net sampling will be conducted every three hours throughout a 12-hour period spanning the night each day. Acoustic surveys will be conducted utilizing side-looking (420 kHz) and downlooking echosounders (70 kHz). Two alongshore transects will be run on each 3 hour cycle to estimate the abundance of predators and juvenile salmon in the nearshore zone. Five acoustic transects will also be run offshore at each site to relate nearshore and offshore predator abundances. Towed underwater video cameras will be used to estimate relative abundance and examine the behavior of predators in nearshore nursery habitats where side-scan acoustics will not be feasible due to reflection from the bottom and sea surface. This technology has been used successfully to estimate fish abundance and size (Irvine et al. 1991, DeMartini and Ellis 1995), identify fish species (DeMartini and Ellis 1995), and evaluate activity and feeding patterns (Collins 1989). Night observations will be made using infrared lighting which cannot be detected by fish and invertebrates (Collins et al. 1991). The diel behavior of pollock will be investigated using sonic tags. Sonic telemetry has been used successfully to investigate the daily activity and movement patterns of juvenile Atlantic cod (Clark and Green 1990). During summer, these fish migrated between a warm surface layer to feed at night and a deep cold layer to rest during the day. It is necessary to determine if pollock exhibit similar daily activity patterns to model their daily food consumption rate and direct sampling. The fish will be captured with jigs, tagged, and held in a net pen for 6 hours to evaluate effects of handling. Thereafter, the fish will be released and tracked continuously using a 8 m vessel. Tags that provide data on the location and depth of the fish will be applied to age 3+ pollock. Smaller sonic tags which do not provide depth information will be applied to age 1–2 pollock. Coupled predators will be sampled using gill nets and jigs to identify acoustic targets and estimate the proportion of the diet comprised of juvenile salmon in the nearshore zone. Both sinking and floating gillnets will be used to obtain a more representative sample of fish in this portion of the nearshore zone. The gear will be checked every 3 hours throughout a 12-hour period spanning night at each site. Water column structure at each study site will be described from CTD casts (0–100 m) taken nearshore and offshore during the first and third sampling period at each site. Seasonal changes in zooplankton biomass and species composition will be described from 20 m vertical ring net samples collected twice each week in the passages adjacent to each of the hatcheries operated by the Prince William Sound Aquaculture Corporation.

Objective 5 :
We will work cooperatively with ADFG to design a sampling program to estimate the relative abundance of wild and enhanced salmon emigrating from PWS. Otolith thermal marking will be used to identify wild and enhanced juvenile salmon. Seine sampling will be conducted by the R\V *Montague* during late June and early July. Approximately six hook sets will be made each day in the southwest passages of the sound. A sample (n=100) of juvenile salmon will be collected from each net set if available to obtain a total sample size of 450 on each day. Otolith processing and data analysis will be conducted by the Otolith Mass Marking Project (/320C).

FY98:
Objective 1:
Initial conditions for the fry population upon ocean entry will be estimated using multivariate statistical techniques applied to several historical data sets. The dependent variable in the model will be pre-emergent fry densities (no. m^{-2}) obtained from surveys conducted by ADFG since 1965. Independent variables in the model will be total escapement of the parent generation and precipitation and air temperature during the embryo incubation period. Total escapement will be estimated from aerial survey data with corrections for observer bias, stream life, and escapement in unsurveyed streams. This data is available from NRDA Fish/Shellfish Study #1 conducted by ADFG in 1990 and 1991. Total abundance of pre-emergent fry will be estimated by the product of fry density (no. m^{-2}) and the area of streambed utilized for spawning by the parent generation. The streambed area utilized by spawners will be estimated from the product of total escapement and mean spawner density (McNeil 1967). Multivariate statistical techniques will also be used to estimate fry outmigration timing. Independent variables in the model will be the escapement timing of the parent generation and precipitation and air temperature during the embryo incubation and outmigration periods. Data from Sashin Creek in southeast Alaska (1965–1985) and six streams in PWS (1990–1991) will be used to construct the model.

Objective 2:
The sampling program described under objective 5 above will be continued in FY98.

Phase III:
A sampling program will be implemented in phase III as a monitoring tool to evaluate the performance of the pink salmon recruitment model under various environmental conditions (years). Model estimates of the abundance of wild and enhanced salmon emigrating from PWS will be compared with estimates obtained from the monitoring program each year. The sampling program will estimate the relative abundance of wild and enhanced salmon utilizing recoveries of otolith thermal marked fish from seine sampling in the southwest passages. If the pink salmon recruitment model accurately forecasts abundances of wild and enhanced salmon, the monitoring program will be discontinued.

MILESTONES

FY97:

Model Development:

Couple models for fry and plankton dispersion and growth to reduce dependence upon intensive zooplankton distribution data; evaluation of methods to initialize model with zooplankton overwintering populations.

Complete second generation fry model that incorporates 2 and 3 spatial dimensions.

Publications:

PREY SELECTION AMONG PELAGIC FISH IN A SUBARCTIC ARCHIPELAGO

Content: Data on environmental conditions and diet composition of age 1–2 walleye pollock, age 3+ pollock and herring during the spring bloom period in western Prince William Sound will be analyzed. Processes that may affect prey selection among these fishes will be evaluated with particular emphasis on piscivory.

RELATIONSHIPS BETWEEN DAILY FORAGING TIME OF JUVENILE PINK SALMON IN NEARSHORE NURSERY HABITATS AND PREDATION RISK

Content: Effects of juvenile salmon abundance and prey abundance on the daily foraging times of juvenile pink salmon in nearshore nursery habitats will be evaluated. Relationships between foraging times and predation risk will be evaluated. Zooplankton biomass and species/size composition between nearshore and offshore habitats will be compared. Data from 1995 sampling program.

EFFECTS OF SIZE- AND CONDITION-DEPENDENT PREDATION ON MORTALITY OF WILD AND ENHANCED PINK SALMON

Content: An analysis of the temporal changes in energetic content and size of wild and enhanced juvenile pink salmon and selective predation. Effects of environmental conditions on observed energetic content of fry will be evaluated. Data from 1996 sampling program.

FY98:

Model Development:

Complete assessment of minimum measurements for 1) initializing and updating the model for macrozooplankton advection, growth, and mortality; 2) contribution of primary production to fry feeding and to strength of next generation.

Extend fish models to include coupling between fish populations of salmon, Pacific herring, and pollock along with coupling of each to macrozooplankton.

Publications:

PROCESSES AFFECTING CONSUMPTION OF JUVENILE SALMON BY AGE 3+ POLLOCK IN NEARSHORE HABITATS

Content: An analysis of the processes affecting coupling of age 3+ pollock in nearshore habitats and an assessment of their total juvenile salmon consumption. Data from video monitoring and acoustic sampling in 1997 and extension of results to earlier year's data.

PROCESSES AFFECTING CONSUMPTION OF JUVENILE SALMON BY AGE 1–2 POLLOCK IN NEARSHORE HABITATS

Content: An analysis of the relationships between juvenile salmon growth and the inshore migration of juvenile pollock modulated by temperature. Data from sonic tagging, time-lapse video monitoring, and acoustic sampling in 1997 program.

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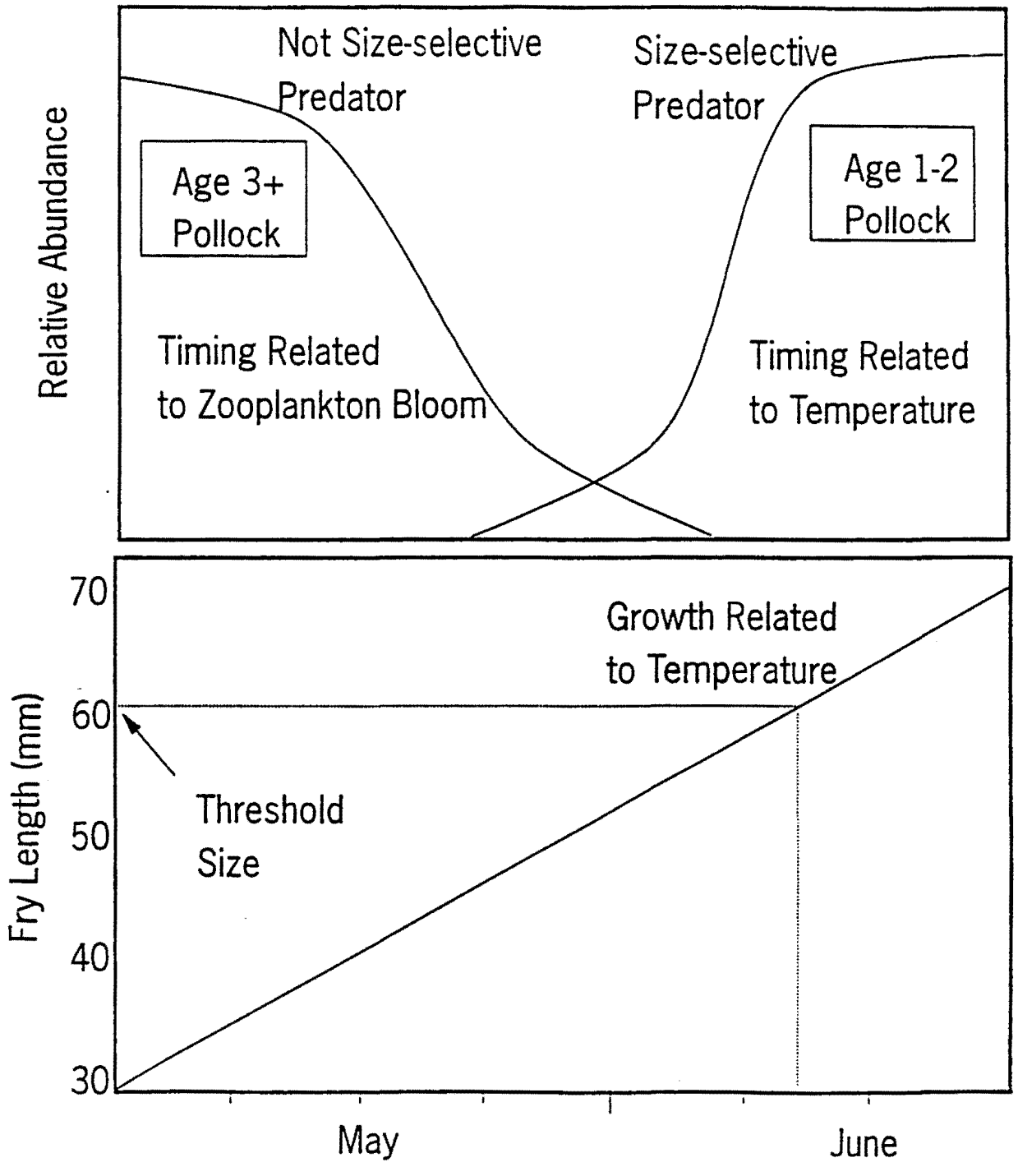

Figure 1. Conceptual model of juvenile pink salmon mortality processes.

APPENDIX II–C

Pacific Herring Recruitment Dynamics

Herring Recruitment Model

Principle Investigators:

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A. J. Paul, UAF
Tom Kline, PWSSC
Gary Thomas, PWSSC
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Vince Patrick, PWSSC
Evelyn Brown, UAF
Chris Mooers, University of Miami
Kevin Stokesbury, UAF

ABSTRACT

The purpose of the Herring Recruitment subgroup of SEA is to create a workable model addressing three objectives (1. Overwintering Survival Model, 2. Summer Habitat Model, 3. Monitoring Strategy), which will result in an understanding of the physical and biological mechanisms affecting the survival of juvenile herring and providing indices of recruitment into the Prince William Sound population. In FY98, the FY96 and FY97 field data will be processed, analyzed and interpreted. Further, a preliminary monitoring strategy will be developed and field tested.

INTRODUCTION

This project examines physical and biological mechanisms influencing the recovery of Pacific herring. Pacific herring is listed as "not recovered" in the "Resources and Services Injured by the Spill" *Exxon Valdez* Oil Spill Restoration Plan.

The Herring Recruitment Model is being developed as the integration of submodels, each of which focuses on a stage in the early life history of Pacific herring (*Clupea pallasi*). We hypothesize that, like other clupeids, year-class strength of Pacific herring in Prince William Sound (PWS) is determined during its early life history. All field, laboratory experiments, and data analysis for all involved components of SEA in FY98 will relate to one or more of these submodels. Two major SEA hypotheses are the focus of these submodels and will be linked within the overall Herring Recruitment Model. The Herring Overwinter Hypothesis states that survival of herring through their first winter is key to survival and ultimate year-class strength of juvenile herring and is dependent upon their condition when they enter winter. We will test this hypothesis by examining distribution and condition of herring in the fall, throughout the winter

and again in the spring. We expect to see a change in condition indices and we expect these changes to be related to geographic location and the physical and biological conditions that characterize these locations. A bioenergetic model, combining SEA field and laboratory observations with energetic information from Atlantic herring studies, will be constructed to predict the likelihood of overwinter survival for recruiting herring. In support of the Herring Overwinter Hypothesis we will examine how the Lake/River Hypothesis applies to transport and distribution of herring at the larval stage. We will employ larval drift simulations, using the Circulation and Transport Models for PWS being formulated by Mooers and Wang as part of the Ocean Dynamics Model, to determine the expected drift of larval herring within PWS and how it affects the distribution of summer juvenile nursery areas. We expect to examine various drift patterns in response to simulated "lake" (i.e. retention), "river" (i.e. rapid movement through the sound), and combinations of varying amounts of "lake" and "river" in accordance with the recent evolution of the lake/river hypothesis. The larval drift synthesis is a tool which will link the Summer Habitat Model, which examines location and characteristics of summer nurseries utilized by juvenile herring, with the Overwintering Survival Model. The Summer Habitat Model will determine the survival and growth rates of juvenile herring and the quality of nursery areas by examining changes in herring distribution, density, length, weight, energy (kJg-1), interspecific biological variables (prey abundance, predation) and physical variables (oceanographic conditions, bathymetry). These data will define the initial conditions of herring as they enter the Overwintering Survival Model.

This is a component of the SEA project, Dr. T. Cooney, Lead Scientist. Within SEA, significant coordination exists between projects linking physical and biological data. Multiple authors on proposed publications reflect this integration. In addition, this project coordinates with the APEX and NVP ecosystem projects via field logistics (vessels, equipment and samples), shared data (catch, aerial survey data, and acoustics results), and joint publications. We anticipate that coordination with these groups will increase during FY98 for the purpose of planning the monitoring of key species (i.e. herring) in the ecosystem that directly or indirectly impact oil-spill injured species (fish, birds, mammals) and resources (commercial and subsistence fisheries).

The research completed under this project combined with data from other SEA projects will identify the physical and biological mechanisms determining herring recruitment. This information will enable us to understand the dynamics of the recovery of this species, aid in future fisheries management of the resource, and provide critical information for other "not recovered" species, as herring are a primary forage fish in PWS.

OBJECTIVES

The research objectives of this project are:

1. Develop an Overwinter Survival Model for juvenile herring.

2. Develop a Summer Habitat Model for juvenile herring.

3. Develop a Monitoring Strategy for juvenile herring.

For the Overwinter Survival Model:

Describe overwinter distribution, size, condition, energy needs, and relative abundance of juvenile herring, physical and biological characteristics of herring nursery areas and overwintering bioenergetics.

Tasks:

1. Collect data on the whole body energy content of age-0 and age-1 herring in the late fall and again for those that survive the winter. This information will be collected for the 1995, 1996, and 1997 year classes.

2. Determine changes in bioenergetics over the winter season using time sequence (monthly) sampling of juvenile herring from two or more index sites in 1996–97 and 1997–98.

3. Examine stomach contents of overwintering recruits and make energetic estimates for consumption during the winters of 1996–97 and 1997–98.

4. In the laboratory determine the energy need of fasting herring.

5. Using field and laboratory measurements of overwinter energy needs and literature values for Atlantic herring, develop a model to predict winter survivorship.

6. Describe spring, pre-bloom biological and habitat conditions as an endpoint of the Overwintering Survival Model and beginning of the second year Summer Habitat Model.

For Summer Habitat Model:

Describe summer and fall distribution, size, condition and relative abundance of juvenile herring (biological data), and physical and biological characteristics of herring nursery areas (habitat data) to evaluate quality of summer growth of herring and as initial conditions for the Overwintering Survival Model.

Tasks:

1. Use Circulation and Transport Models (Ocean Dynamics Model) to simulate drift of larval herring and distribution to summer nursery areas.

2. Determine distribution of juvenile herring during the spring, summer and fall using broad scale surveys which include simultaneous overflights, acoustics and net collections.

3. Determine physical (salinity, temperature, depth, currents, light levels, bathymetry) and biological (zooplankton, competitors) parameters which determine "good" vs. "bad" nursery areas measured by condition of herring (length, weight, age, growth rates, stomach contents, energetic condition and stable isotopes).

4. Develop maps of key habitats (nursery areas) for juvenile herring within PWS.

5. Describe the retention characteristics of herring nursery areas using information from the larval drift simulations, physical oceanographic measurements and biological data (spatial distributions, isotopes, growth rates) indicating immigration or emigration.

6. Develop maps of possible retention areas with different historical spawning sites and transport conditions.

For Monitoring Strategy:

Tasks:

1. Identify key index sites and develop monitoring techniques by relating aerial, acoustic and net sampling data during summer surveys to condition of juvenile herring.

METHODS

In order to address the above objectives and tasks, we have formulated our approach into two component models, each of which has several subcomponents. We hypothesize that the Overwinter Survival Model is the most important in determining successful recruitment of juvenile herring. Critical to that model is the feeding, growth and survival of juvenile herring during the summer addressed in the Summer Habitat Model. These models and subcomponents are described in chronological order of herring life history (Figure 1).

The first subcomponent is embryo survival. This component is not a SEA program, but rather projects funded by EVOS outside of SEA. For the starting point of our Summer Habitat Model, we intend to combine the results of 1) the ADF&G spawn deposition survey, 2) the Haldorson, Quinn and Rooper egg loss model which predicts losses due to physical factors and predation, 3) estimates of baseline egg mortality (Brown and Debevec in prep), and 4) estimates of baseline levels of viable hatch (Hose et al. 1996, Kocan et al. 1996). From this we will know the location of spawning of herring, an estimate of the amount of spawn, and the expected percentage of viable larvae produced.

The output of that subcomponent will be input into our larval drift simulation. We will initially examine the direction of transport without incorporating the population size component. We will run the Ocean Circulation and Transport Model with input at the locations of herring spawning and test observed distribution of particles. Distribution predicted by this subcomponent will be verified by the distribution of age-0 herring during the summer. To validate the larval drift simulation we will rely on the literature for transport and retention of larval Atlantic herring (*Clupea harengus*) in the North Atlantic (Graham and Davis 1971, Graham and Townsend 1985, Sinclair and Iles 1985, Sinclair 1988). We will first use 1989 as test case. By inputting location of spawning and physical conditions which we know occurred in 1989, we can test the model against the offshore distribution of larvae observed in May, June and July 1989 (Norcross and

Frandsen 1996) and the nearshore distribution observed in May 1989 (McGurk 1990). We will also use spawning location information from 1995, 1996 and 1997 and relate the distribution of larvae to the distribution of herring observed from the aerial and acoustic surveys. This simulation will be an iterative process.

The output of the larval drift simulation will be validated and used as input for the Summer Habitat Model. From October 1995 to August 1997 acoustic and aerial surveys were conducted and those data will be processed, analyzed, interpreted and combined in 1998 to determine herring nurseries. The broadscale distribution of age-0 herring was evaluated in October 1995, March and July 1996. These surveys covered most of PWS and adjacent waters to Resurrection Bay. Sampling from the air provided approximately weekly estimates of horizontal distribution of herring across the entire sound during the summer.

These broadscale surveys provided preliminary estimates of oceanographic patterns and distribution of herring. Then, in 1997, we focused on the retention of juvenile herring in nursery areas and the biological and physical mechanisms influencing their growth and survival by initiating time-sequence sampling in four bays where age-0 herring were found (Ziakof, Simpson, Whale and Eaglek). Each bay was surveyed three times in a 24 hour period using sidescan sonar. Net collections of herring were coupled with acoustics estimates of horizontal and vertical distribution and abundance and aerial estimates of horizontal distribution. These net collections are used to ground-truth both acoustic and aerial estimates for species size and composition. Subsamples of herring were retained and later evaluated for size, age, stomach contents, condition (energetics and standard fisheries age-weight-length (AWL)), and stable isotopes (trophic analysis). Simultaneous with net collections for fish were vertical plankton tows to estimate availability of food for planktivorous herring. Oceanographic parameters collected include salinity and temperature at depth (CTD), estimates of current structure (ADCP), light levels and bathymetry at location. The main effort in 1998 will be to process, analyze and interpret these data. Evaluation of these parameters will be used as estimates of the health of the population at each location.

In 1998, multivariate statistics will use biological and physical parameters as independent habitat variables and feeding and condition of herring as dependent variables as a first cut to evaluate the quality of nurseries. From this we will attempt to characterize "good" vs. "bad" nursery habitats. A "good" nursery is defined as one in which herring juveniles are in the best condition as they enter the winter. It will be necessary to determine if herring move among these nursery areas, therefore, we will examine retention within areas based on the 1996 and 1997 spatial distribution data on the large (broadscale) and small (bays) scales. We will examine small scale oceanography (i.e. fronts), and evaluate rates of change of the biological characteristics of herring (i.e. energetics).

Further, in 1998, the field sampling will switch from primarily research to a preliminary monitoring trial. Two surveys, one in October 1997 and the other in March 1998, will be conducted using one vessel supplied with acoustic surveying equipment, a seine for target verification, a plankton net and a CTD for oceanographic measurements. The four bays that were surveyed in 1997 will be surveyed between 1900 and 2400 hours. Herring for AWL, energetics

and diet analyses will be collected in each bay. This will provide a critical data set for the Overwintering Model and Summer Habitat Model, plus it will allow us to calibrate this survey technique and estimate its precision as a cost effective monitoring tool.

The Overwintering Survival Model evaluates distribution and condition of age-0 and age-1 herring as they enter winter, i.e. October, and as they complete winter, i.e. March. Methods on these cruises are the same as those described for the summer cruises, in the same four bays. The objective of this sampling is to determine change in condition of herring over the course of winter in concert with the hypothesis that herring which enter winter in poor condition due to "bad" nursery habitats will not survive winter, while those from "good" habitats will successfully survive winter. In 1998, the 1996–97 data will be analyzed, an additional October–March sample will be collected, and this model will be linked to the Ocean Dynamics Model to determine the effect of the timing of the phytoplankton bloom on successful herring recruitment.

PUBLICATIONS AND REPORTS

As well as the Annual Report in April 1998 this research will produce numerous primary publications.

Primary publications submitted to journals or in the final stage of preparation:

Mooers, C.N.K. and J. Wang. On the development of a three-dimensional circulation model for Prince William Sound, Alaska. Continental Shelf Research. submitted Dec. 1996.

Paul, A.J., J.M. Paul, and E.D. Brown. Fall and spring somatic energy content for Alaskan Pacific herring (*Clupea pallasi*) relative to age, size and sex. Journal of Experimental Biology and Ecology. submitted.

Paul, A.J., J.M. Paul, and E.D. Brown. Ovarian energy content of Pacific herring from Prince William Sound, Alaska. Alaska Fishery Research Bulletin. submitted.

Kline, T.C., Jr. and A.J. Paul. Isotopic signature and somatic energy content of young of the year Pacific herring at two sites in Prince William Sound Alaska: implications for tropic studies. Canadian Journal of Fisheries and Aquatic Sciences. submitted.

Brown and Norcross. Assessment of forage fish distribution and relative abundance using aerial surveys. Fisheries Research. draft.

Foy and Norcross. Spatial and temporal differences in diet of juvenile herring (*Clupea pallasi*) in Prince William Sound, Alaska. Fisheries Research. draft.

Topics to be covered in future publications:

1. A bioenergetic model for winter energy use by age-0 Pacific herring.

3. Seasonal variation in spatial distribution of juvenile herring in PWS.

4. Winter feeding of age-0 Pacific herring from PWS.

5. Interannual fall and spring abundance of age-0 Pacific herring in PWS.

6. Relative abundance of age-0 Pacific herring and age-0 pollock in PWS.

7. Effects of ocean circulation patterns on distribution and retention of Pacific herring larvae in PWS.

8. Survival of juvenile Pacific herring in relation to spatial and temporal variation in PWS.

9. Growth of juvenile Pacific herring in relation to spatial and temporal variation in PWS

10. Trends in C-13 and C-14 ratios in Pacific herring tissue indicating changes in trophic levels and patterns.

11. Interannual and geographic variations in prey selection of juvenile herring in PWS.

12. Relation of prey selection and stomach fullness of juvenile Pacific herring in PWS to zooplankton production and distribution.

13. Development of a juvenile indexing program for prediction of recruitment and forecasting of Pacific herring populations in Prince William Sound and recommendations for restoration options.

14. Seasonal growth and consumption dynamics of herring in PWS.

15. Spatially-explicit approach for evaluating nursery areas and the spatial distribution of herring.

LITERATURE CITED

Brown, E.D. and E. Debevec. In prep. Effect of the *Exxon Valdez* oil spill on survival of Pacific herring (*Clupea pallasi*) eggs: Comparison of *in situ* observations with laboratory incubations. Under revision after submission to Can. J. Fish. Aquat. Sci.

Graham, J.J. and C.E. Davis. 1971. Estimates of mortality and year class strength of larval herring in western Maine, 1964–67. ICES Rapp. R.-V. 160: 147–152.

Graham, J.J. and D.W. Townsend. 1985. Mortality, growth, and transport of larval Atlantic herring *Clupea harengus* in Maine coastal waters. Trans. Am. Fish. Soc. 114: 490–498.

Hose, J.E., M.D. McGurk, G.D. Marty, D.E. Hinton, E.D. Brown, and T.T. Baker. 1996. Sublethal effects of the *Exxon Valdez* oil spill on herring embryos and larvae: morphologic, cytogenetic and histopathologic assessments, 1989–1991. Can. J. Fish. Aquat. Sci. 53: 2355–2365.

Kocan, R.M., J.E. Hose, E.D. Brown, and T.T. Baker. 1996. Herring embryo (*Clupea pallasi*) sensitivity to Prudhoe Bay petroleum hydrocarbons: laboratory evaluation and *in situ* exposure at oiled and unoiled sites in Prince William Sound. Can. J. Fish. Aquat. Sci. 53: 2366–2375.

McGurk, M.D. 1990. Early life history of Pacific herring: Prince William Sound herring larvae survey. Final report to NOAA-NOS, Contract 50ABNC-7-00141, Anchorage, AK.

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

Sinclair, M. 1988. Marine Populations. Washington Sea Grant Program, Seattle, WA, 252p.

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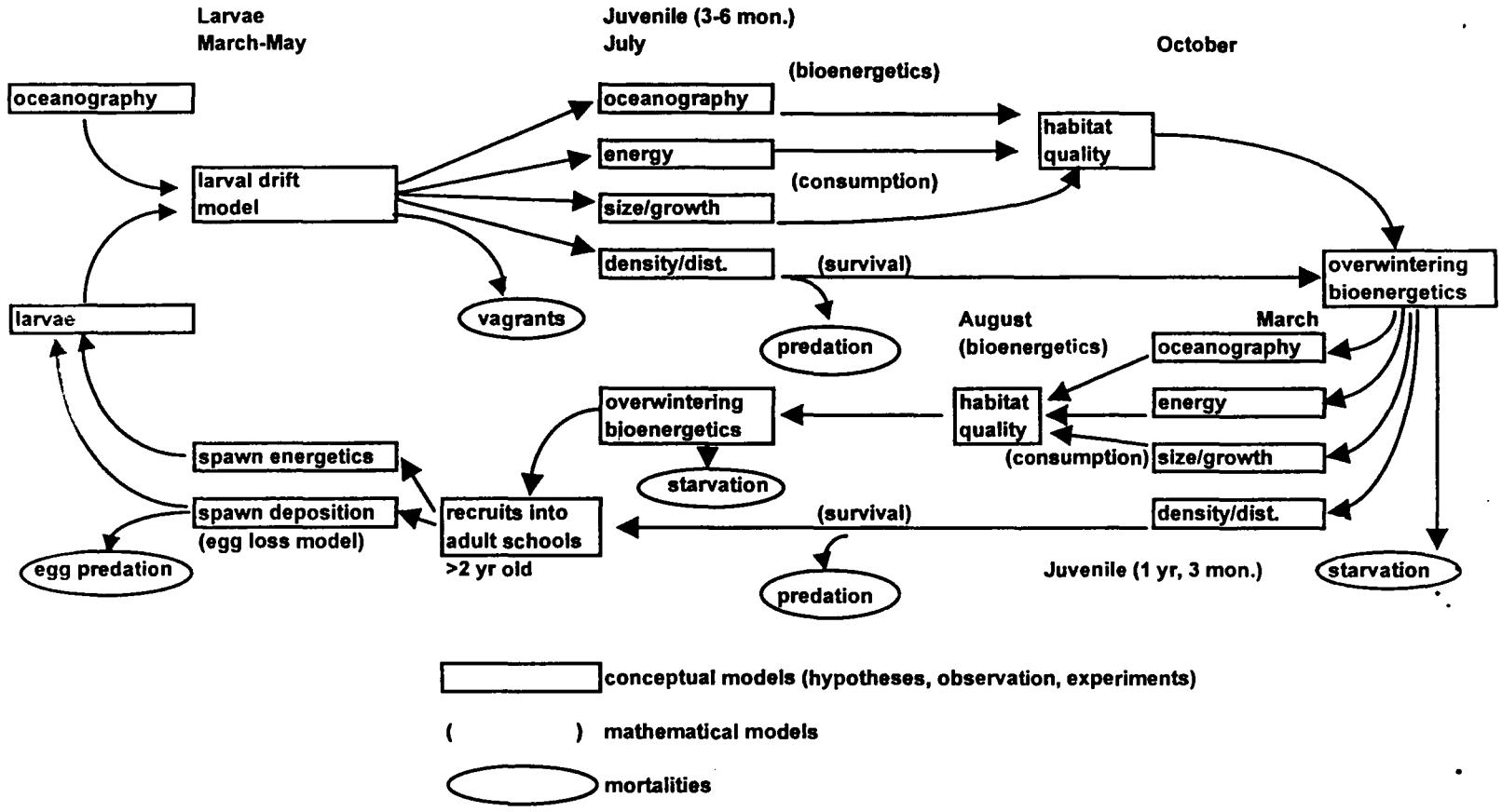


Figure 1. Herring Recruitment Model

approved 8-6-97

98320 / SOUND ECOSYSTEM ASSESSMENT (SEA)
Summary of Funding Authorization by Subproject

	FY 98 Field/Data	FY 99 Closeout	Project Cost Subtotal	Agency Admin. Costs	TOTAL
98320I Isotopes	53.1	70.7	123.8	8.6	132.4
98320J Modeling	203.8	235.5	439.3	21.3	460.6
98320M Oceanography	76.5	47.8	124.3	8.7	133.0
98320N Nekton Acoustics	107.9	52.5	160.4	11.2	171.6
PWSSC Subtotal	441.3	406.5	847.8	49.8	897.6
98320G Phytoplankton	99.7			7.0	106.7
98320H Zooplankton	99.2			6.9	106.1
98320R Trophodynamics	150.0			10.5	160.5
98320T Herring	523.7			23.0	546.7
98320T-Supp Herring TEK	71.0			4.9	*75.9
98320U Energetics	98.9			6.9	105.8
98320Z Synthesis	59.8			4.2	64.0
UAF Subtotal	1,102.3			63.4	1,165.7
98320E Predators	282.1			38.0	320.1
ADFG Subtotal	282.1			38.0	320.1
SUBPROJECTS TOTAL	**1,825.7**	**406.5**		**151.2**	**2,383.4**

* $50.8 of this amount was approved 12/18/97 ($47.5 field/data, $3.3 agency admin.)

NOTE: ADFG project management costs ($49,500) were deducted from SEA's FY 98 request and added to Project 98250/Project Management.

1998 EXXON VALDEZ TRUST COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Personnel	$334.9	$244.1						
Travel	$3.1	$3.1						
Contractual	$142.1	$20.0						
Commodities	$43.0	$14.9						
Equipment	$47.1	$0.0						
Subtotal	$570.2	$282.1						
General Administration	$0.0	$38.0						
Project Total	$570.2	$320.1	$58.9					
Full-time Equivalents (FTE)	4.1	4.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This budget includes $24.6 K in line 100 and $10.0 K in line 300 for logistical support of SEA herring field sampling.

Line 100 'overtime' is actually 'sea duty'. The 'Months Budgeted' does not include 'sea duty'.

Sea Duty
Juv. Herring Sampling $17.2 K
Juv. Salmon Sampling $16.5 K

FY 98

Project Number: 98320-E
Project Title: Salmon Predation
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs: Name	Position Description	GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
M. Willette	Fishery Biologist III	18D	7.0	5.9		41.4
M. Clapsadl	Fishery Biologist II	16A	12.0	4.7		56.4
P. Saddler	Fishery Technician III	11C	11.0	3.5		38.5
M. Powell	Fishery Technician III	11B	3.5	3.5	12.1	24.4
S. Karpovich	Fishery Technician II	9A	4.0	3.2	10.7	23.5
A. Dibaccari	Fishery Technician I	9A	4.0	3.2	10.7	23.5
Vacant	Biometrician I	17A	7.0	5.2		36.4
		Subtotal	48.5	29	34	
Those costs associated with program management should be indicated by placement of an *.					**Personnel Total**	$244.1

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
RT Cordova – Anchorage to attend annual EVOS workshop	200	2	10	95	1.4
RT Cordova – Fairbanks: library research	350	2	10	95	1.7
Those costs associated with program management should be indicated by placement of an *.				**Travel Total**	$3.1

FY 98

Project Number: 98320-E
Project Title: Salmon Predation
Agency: Alaska Department of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1996
Vessel charter for juvenile salmon sampling (purse seine, $1000 per day x 20 days)	20.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$20.0

Commodities Costs:	Proposed
Description	FY 1996
Office Supplies (copier paper, toner, computer diskettes, etc.)	0.5
Laboratory Supplies (sample bottles, formaldehyde, weighing scales, etc.)	1.0
Charter vessel fuel for juv. salmon sampling (3000 gals diesel fuel @ $1.0 per gal.)	3.0
Charter vessel fuel for juv. herring sampling (10000 gals diesel fuel @ $1.0 per gal.)	10.0
Software (SAS License)	0.4
Commodities Total	$14.9

FY 98

Project Number: 98320-E
Project Title: Salmon Predation
Agency: Alaska Department of Fish and Game

FORM 3B
Contractual & Commodities DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUST COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1996
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
6m aluminum skiff	2	ADFG
8m figerglass boat	1	ADFG
120 x 17 fm anchovy seine	1	ADFG
Continuously recording light meter	1	ADFG

FY 98

Project Number: 98320-E
Project Title: Salmon Predation
Agency: Alaska Department of Fish and Game

FORM 3B
Equipment
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$99.7
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$99.7
General Administration		$7.0
Project Total	$0.0	$106.7
Full-time Equivalents (FTE)		2.6
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
	$58.9				

Dollar amounts are shown in thousands of dollars.

Comments:

1998

Prepared: Prepared: 4/15/97
14 Ap 97 wh

Project Number: 98320-G
Project Title: SEA Plankton Dynamics: Phytoplankton and Nutrients
Name: University of Alaska Fairbanks
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Personnel	$80.9	$67.5						
Travel	$6.2	$5.1						
Contractual	$2.7	$0.9						
Commodities	$7.4	$2.1						
Equipment	$0.0	$4.2						
Subtotal	$97.2	$79.8						
Indirect	$24.3	$19.9						
Project Total	$121.5	$99.7	$55.0					
Full-time Equivalents (FTE)	2.8	2.6						
	Dollar amounts are shown in thousands of dollars.							
Other Funds								

Comments:

Indirect costs are 25% Total Direct Cost, the rate negotiated by the EVOS Trustee Council with the University of Alaska.

Tuition costs are included with graduate student salaries.
Simpson is a resident and Ward's tuition is at the non-resident rate.

FY 98

Project Number: 98320-G
Project Title: SEA Plankton Dynamics: Phytoplankton and Nutrients
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs: Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
C. McRoy	Professor – P.I.		1.0	11.6		11.6
J. Cameron	Technician – Sample Analysis		3.0	5.6		16.7
P. Simpson	Graduate Student – Ph.D.		11.0	1.6		17.6
A. Ward	Graduate Student – M.S.		12.0	1.6		18.7
E. Suring	Undergraduate Student Assistant III		4.5	0.6		2.9
	Subtotal		31.5	21.0	0.0	
					Personnel Total	$67.5

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
Fairbanks–Anchorage – Attend EVOS meetings	133	3	16	125	2.4
Fairbanks–San Diego – Attend AGU/ASLO meeting present results	1,200	1	7	100	1.9
Fairbanks–Cordova – Attend SEA meeting	375	1	3	125	0.8
				Travel Total	$5.1

FY 98

Project Number: 98320-G
Project Title: SEA Plankton Dynamics: Phytoplankton and Nutrients
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed FY 1998
Description	
Communications – Fax and phone tolls directly and solely related to this project	0.3
Printing and Duplicating – directly and solely related to this project	0.6
Contractual Total	$0.9

Commodities Costs:	Proposed FY 1998
Description	
Chemicals for sample analysis	2.1
Commodities Total	$2.1

FY 98

Project Number: 98320-G
Project Title: SEA Plankton Dynamics: Phytoplankton and Nutrients
Name: University of Alaska Fairbanks

FORM 4B
Contractual & Commodities DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 1998
Description			
Digital Image Processing Computer to facilitate sample analysis	1	4,200	4.2
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$4.2

Existing Equipment Usage:	Number of Units
Description	

FY 98

Project Number: 98320-G
Project Title: SEA Plankton Dynamics: Phytoplankton and Nutrients
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$99.2
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$99.2
General Administration		$6.9
Project Total	$0.0	$106.1
Full-time Equivalents (FTE)		1.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
	$53.5				

Dollar amounts are shown in thousands of dollars.

Comments:

1998

Prepared: Prepared: 4/15/97
14Ap 97/wh

Project Number: 98320-H
Project Title: The Role of Zooplankton in the Prince William Sound Ecosystem
Name: University of Alaska Fairbanks
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Personnel	$90.5	$69.6						
Travel	$5.1	$5.4						
Contractual	$5.2	$2.9						
Commodities	$1.2	$1.5						
Equipment	$0.0	$0.0						
Subtotal	$102.0	$79.4						
Indirect	$25.5	$19.8						
Project Total	$127.5	$99.2	$50.0					
Full-time Equivalents (FTE)	2.0	1.0						
	Dollar amounts are shown in thousands of dollars.							
Other Funds								

Indirect costs are 25% Total Direct Cost, the rate negotiated by the EVOS Trustee Council with the University of Alaska.
1 Semester Tuition ($1,455) is included with M. Donovan wages.
Personnel costs for the principal investigator and associated personnel reflect the time required to complete the objectives stated in this proposal. This includes minimal sample processing in the laboratory, continuing data analyses, application of the data for model formulation and validation, report preparation and submission, and manuscript submission and revision. Mr. Donovan has been working on the problem of the feeding ecology of squids in the region and expects to graduate during fall semester, 1998. Completion of his program will bring squid results to the SEA data base.
Travel is requested for one national meeting (American Geophysical Union/American Society of Limnology and Oceanography Joint Ocean Sciences Meeting; February, San Diego) at which the principal investigator will present a synthesis paper on the role of zooplankton in the Prince William Sound ecosystem. As part of his accelerating data application and synthesis duties, the principal investigator expects to collaborate with colleagues at the Prince William Sound Science Center and Alaska Department of Fish and Game, Cordova on at least three occasions. In addition, at least one workshop of the entire program will be called in Anchorage to assist with developing synthesis work. Travel is requested for the annual EVOS workshop as directed in the call for proposals.
A small supply of sample bottles and preservative (formalin) will be required to support the continuing calibration and surveying of zooplankton populations by optical plankton and acoustic techniques. A statistical program being used for data analysis will be upgraded.
No equipment is requested in this proposal.

FY 98

Project Number: 98320-H
Project Title: The Role of Zooplankton in the Prince William Sound Ecosystem
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
R. Cooney	Professor – P.I.		3.5	11.1		38.7
K. Coyle	Research Associate		2.0	5.7		11.1
C. Stark	Technician		3.0	4.6		13.9
M. Donovan	Graduate Student		4.0	1.5		5.9
	Subtotal		12.5	22.9	0.0	
					Personnel Total	$69.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
EVOS Workshop	300	1	7	100	1.0
National Meeting – AGU/ASLO; San Diego, February	900	1	6	100	1.5
Fairbanks to Cordova	400	3	10	70	1.9
SEA Workshop Anchorage	300	1	7	100	1.0
				Travel Total	$5.4

FY 98

Project Number: 98320-H
Project Title: The Role of Zooplankton in the Prince William Sound Ecosystem
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed FY 1998
Description	
Communications – conference calls for synthesis purposes and other communications with SEA investigators	1.5
SFOS Academic Services – budget preparation and formatting, graphic preparations, internal UAF review of FY99 H-component close out proposal, submission of electronic forms, 35 hours @ $40/hour	1.4
Contractual Total	$2.9

Commodities Costs:	Proposed FY 1998
Description	
Bottles and preservative	1.0
Software upgrade: Statistix, Analytical Software Inc.	0.5
Commodities Total	$1.5

FY 98

Project Number: 98320-H
Project Title: The Role of Zooplankton in the Prince William Sound Ecosystem
Name: University of Alaska Fairbanks

FORM 4B
Contractual & Commodities DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	

Existing Equipment Usage: Description	Number of Units	

FY 98

Project Number: 98320-H
Project Title: The Role of Zooplankton in the Prince William Sound Ecosystem
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 4/15/97

Revision 20-91

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$123.8
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$123.8
General Administration		$8.7
Project Total	$0.0	$132.5
Full-time Equivalents (FTE)		1.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002
$0.0			

Dollar amounts are shown in thousands of dollars.

Comments:

This Budget includes two major components:
FY 1998 "Remaining": $53.1K -project cost plus $3.7K GA = $56.8K
FY 1999 "Closeout": $70.7K -project cost plus $ 4.9K GA = $75.6K

Total: $132.4K

1998

Project Number: 98320-I
Project Title: SEA:FOOD, Confirming Fish Food Web Dependencies in the PWS Ecosystem Using Natural Stable Isotope Tracers
Name: Prince William Sound Science Center
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: Prepared: 6/18/97
14Ap 97/wh rev 18 Jun97 wjh

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Budget Category:	Authorized FY 1997	Proposed FY 1998	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Personnel	$74.2	$91.1						
Travel	$10.4	$7.8						
Contractual	$11.0	$2.8						
Commodities	$2.1	$1.5						
Equipment	$0.0	$0.0						
Subtotal	$97.7	$103.2						
Indirect	$19.5	$20.6						
Project Total	$117.2	$123.8						
Full-time Equivalents (FTE)		1.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This budget is for NOAA CY98: February 1, 1998 – January 31, 1999.
Due to close out the deliverable final report on this project will not be completed until approx. September 30, 1999.
The close-out of this project will extend beyond a 12 mo. contract year.

FY 98

Project Number: 98320-I
Project Title: SEA:FOOD, Confirming Fish Food Web Dependencies in the Prince William Sound Ecosystem Using Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

Prepared: 6/18/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

February 1, 1998 - January 31, 1999

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1998
	T. Kline	Principal Investigator	7.6	7.6		57.8
	J. Williams	Fish Biologist	7.6	4.4		33.3
		Subtotal	15.2	12.0	0.0	
					Personnel Total	$91.1

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1998
	Cordova – Anchorage EVOS annual meeting	200	2	10	141	1.8
	Cordova – Fairbanks SEA Workshop	400	3	15	141	3.3
	Car rental			15	50	0.7
	Cordova – San Diego Ocean Sciences Meeting	800	1	7	122	1.7
	Car Rental			5	50	0.3
					Travel Total	$7.8

FY 98

Project Number: 98320-I
Project Title: SEA:FOOD, Confirming Fish Food Web Dependencies in the Prince William Sound Ecosystem Using Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 6/18/97

Contractual Costs:	Proposed
Description	FY 1998
Photocopying	0.4
Shipping	0.3
Posters for annual workshops 4 @ $200	0.8
Communications	0.3
Page charges 2 @ $500	1.0
Approx titles of Pubs; (see DPD for more details):	
Spatial patterns of Gulf of AK carbon in PWS pelagic food webs determined by 13C/12C. - Trans. Amer. Fish. Soc	
'Fall isotopic and somatic energy signatures of young of the year Pacific herring at two sites in PWS - Can. J. Fish. Aquat. Sci.	
Trophic relations and carbon sources of the pelagic community of PWS/natural stable isotope - Can. J. Fish. Aquat. Sci.	
Evidence for the flow of zooplankton into PWS from the northern GOA - for Limol. Oceanogr.	
Contractual Total	$2.8

Commodities Costs:	Proposed
Description	FY 1998
Office and computer supplies	0.7
Dye Sub materials 2 @ $300 each	0.6
Miscellaneous	0.2
Commodities Total	$1.5

FY 98

Project Number: 98320-I
Project Title: SEA:FOOD, Confirming Fish Food Web Dependencies in the Prince William Sound Ecosystem Using Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4B
Contractual & Commodities DETAIL

Prepared: 6/18/97

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 1998
Description			
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number of Units
Description	

FY 98

Project Number: 98320-I
Project Title: SEA:FOOD, Confirming Fish Food Web Dependencies in the Prince William Sound Ecosystem Using Natural Stable Isotope Tracers
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Prepared: 6/18/97

Revisio[illegible]20-97

1998 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$439.3
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$439.3
General Administration		$21.3
Project Total	$0.0	$460.6
Full-time Equivalents (FTE)		1.9
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002
$0.0			

Dollar amounts are shown in thousands of dollars.

Comments:

This Budget includes two major components:
FY 1998 "Remaining": $203.8K -
FY 1999 "Closeout": $235.5K
Sum: $439.3K - project cost plus $21.3K GA

Total: $460.6K

1998

Project Number: 98320-J
Project Title: Information Systems and Model Development
Name: Prince William Sound Science Center
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: Prepared: 6/17/97
14Ap 97/wh rev 17 Jun97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Budget Category:	Authorized FY 1997	Proposed FY 1998	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Personnel	$205.4	$142.6						
Travel	$25.5	$21.5						
Contractual	$204.6	$188.0						
Commodities	$5.3	$5.5						
Equipment	$2.0	$8.5						
Subtotal	$442.8	$366.1						
Indirect	$88.6	$73.2						
Project Total	$531.4	$439.3						
Full-time Equivalents (FTE)		1.9						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This budget is for NOAA CY98: February 1, 1998 – January 31, 1999.
Due to close out the deliverable final report on this project will not be completed until approx. September 30, 1999.
The close-out of this project will extend beyond a 12 mo. contract year.

FY 98

Project Number: 98320-J
Project Title: Information Systems and Model Development
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

Prepared: 6/17/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1998
	V. Patrick	Principal Investigator	2.4	7.8		18.7
	J. Allen	Tech. Project Manager/Data Manager	4.0	5.4		21.6
	S. Bodnar	Systems Specialist	4.0	5.5		22.0
	D. Mason	Fish Ecologist				
	R. Nochetto	Numerical Analyst				
	V. Patrick 99 Close-out	Principal Investigator	4.0	8.2		32.8
	J. Allen	Tech. Project Manager/Data Manager	4.0	5.7		22.8
	S. Bodnar	Systems Specialist	2.4	5.7		13.7
	D. Mason	Fish Ecologist	1.0	4.9		4.9
	R. Nochetto	Numerical Analyst	0.8	7.6		6.1
		Subtotal	22.6	50.8	0.0	
					Personnel Total	$142.6

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1998
	CDV-FBKS (data management)	456	1	2	140	0.7
	CDV-Baltimore ((UMD) fish model collaboration)	1100	1			1.1
	CDV-conference (AGU/ASLO)	800	1	4	97	1.2
	Baltimore-CDV (database development) (no per diem)	1100	1	10	103	2.1
	Car rental			26	30	0.8
	CDV-FBKS (final model coordination)	456	1	5	140	1.2
	CDV-Baltimore ((UMD) fish model: wrap-up collab.) (no per diem)	1100	1			1.1
	Baltimore-CDV (2, database: database wrap-up; EVOS review)	1100	2	30	103	5.3
	CDV-Miami ((RSMAS) Circulation model: wrap-up) (no per diem)	1300	1			1.3
	CDV-ANC (3 PIs, EVOS January review)	224	3	15	170	3.2
	Madison-CDV (2, Fish model: wrap-up; EVOS review)	700	2	20	103	3.5
					Travel Total	$21.5

FY 98

Project Number: 98320-J
Project Title: Information Systems and Model Development
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 6/17/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Contractual Costs:			Proposed
Description	99 Remain	99Close-out	FY 1998
Telephone, facsimile	3.0	1.5	4.5
Copying	0.8	0.8	1.6
Shipping, mail	1.1	1.1	2.2
Software maintenance, support, licenses: AVS, IDL, AutoPLAN, Publisher, utility items	1.0	6.0	7.0
Computer systems maintenance		2.9	2.9
Wide & Local Area Networks: telecommunications charges, Internet access, LAD circuits, maintenance	10.0	6.4	16.4
Software: database licenses, clients and servers		5.0	5.0
Publication costs: see DPD for titles and journals		1.0	1.0
Subcontract to Adv. Visualization Lab: database design and development	22.9	26.6	49.5
Subcontract to Rosenstiel School of Marine and Atmospheric Science: ocean circulation model development	61.2	36.7	97.9
		Contractual Total	$188.0

Commodities Costs:			Proposed
Description	99 Remain	99Close-out	FY 1998
Mass storage media (CD-ROMs, tapes)		1.1	1.1
Bond paper	0.2	0.2	0.4
Toner	0.1	0.1	0.2
Sparc printer drum	0.1		0.1
Dye sublimation papers	0.4	0.4	0.8
Dye sublimation transparency media	0.2	0.2	0.4
Dye sublimation ribbon	0.6	0.6	1.2
Media: display, archive, photographic	0.4	0.4	0.8
Cables, connectors		1.0	0.5
		Commodities Total	$5.5

FY 98

Project Number: 98320-J
Project Title: Information Systems and Model Development
Name: Prince William Sound Science Center

FORM 4B
Contractual & Commodities DETAIL

Prepared: 6/17/97

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Server: Memory increase	1	0.7	0.7
Close-out	1	4.2	4.2
Data server: Hard drive mass store increase	2	0.8	1.6
Data server: CD-ROM mass store increase	1	2.0	2.0
Model server: Mass store increase			
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$8.5

Existing Equipment Usage: Description	Number of Units

FY 98

Project Number: 98320-J
Project Title: Information Systems and Model Development
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Prepared: 6/17/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$124.3
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$124.3
General Administration		$8.7
Project Total	$0.0	$133.0
Full-time Equivalents (FTE)		1.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
	$0.0				

Dollar amounts are shown in thousands of dollars.

Comments:

This Budget includes two major components:
FY 1998 "Remaining": $76.5K -project cost plus $5.4K GA = $81.9K
FY 1999 "Closeout": $47.8K -project cost plus $3.3K GA = $51.1K

Total: $133.0K

1998

Prepared: Prepared: 4/15/97
14Ap 97/wh

Project Number: 98320-M
Project Title: Observational Physical Oceanography
Name: Prince William Sound Science Center
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Budget Category:	Authorized FY 1997	Proposed FY 1998	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Personnel	$218.9	$88.5						
Travel	$11.1	$4.6						
Contractual	$41.0	$6.8						
Commodities	$7.5	$3.7						
Equipment	$0.0	$0.0						
Subtotal	$278.5	$103.6						
Indirect (20%)	$55.7	$20.7						
Project Total	$334.2	$124.3						
Full-time Equivalents (FTE)		1.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This budget is for NOAA CY98: February 1, 1998 – January 31, 1999.
Due to close out the deliverable final report on this project will not be completed until approx. September 30, 1999.
This portion of the project will extend beyond the 12 mo. contract year.

Salary figures include a 3% raise.

FY 98

Project Number: 98320-M
Project Title: Observational Physical Oceanography
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
S. Vaughan	Physical Oceanographer (PI)		4.5	7.0		31.5
K. Osgood	Physical Oceanographer		4.5	4.9		22.1
S. Gay	Physical Oceanographer		4.5	5.2		23.3
L. Tuttle	Biological Oceanographer		2.5	4.7		11.6
	Subtotal		16.0	21.8	0.0	
					Personnel Total	$88.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
CDV-MIA, Circulation Modelling w/ RSMAS (1r/t @ $945., no pd)	945	1	0	0	1.0
SEA PI Mtg. – Anchorage – in FY98 (1r/t @$160, 2 days @ $140)	160	1	2	140	0.4
AGU* Ocean Sciences Mtg. – San Diego – Feb. 9–13 (1r/t @ $600, 5 days @ $140)	600	1	5	140	1.3
EVOS Workshop (10th Anniversary) – Anchorage – March 1999 (3 r/t @ $160, 4 days ea. @ $140)	160	3	4	140	1.1
SEA Workshop – Anchorage – March 1999 (after EVOS) (3 for 2 days ea. @ $140)	0	0	6	140	0.8
*AGU – American Geophysical Union				**Travel Total**	$4.6

FY 98

Project Number: 98320-M
Project Title: Observational Physical Oceanography
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Contractual Costs:	Proposed
Description	FY 1998
Phone, fax, copying	1.4
Publication Costs (Titles and Journals are listed in the DPD)	1.0
Mail, freight, shipping	1.3
Network Communications	1.5
Slide processing and poster printing	0.6
Computer and Analytical Software Licensing	1.0
Contractual Total	$6.8

Commodities Costs:	Proposed
Description	FY 1998
Office supplies	1.3
Computer supplies	1.5
Film and camera supplies	0.5
Dye-Sub Paper for GIS Printing	0.4
Commodities Total	$3.7

FY 98

Project Number: 98320-M
Project Title: Observational Physical Oceanography
Name: Prince William Sound Science Center

FORM 4B
Contractual &
Commodities
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 1998
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number
Description	of Units

FY 98

Project Number: 98320-M
Project Title: Observational Physical Oceanography
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Prepared: 4/15/97

Revised 6-20-97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$160.4
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$160.4
General Administration		$11.2
Project Total	$0.0	$171.6
Full-time Equivalents (FTE)		1.1
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002
$0.0			

Dollar amounts are shown in thousands of dollars.

Comments:

This Budget includes two major components:
FY 1998 "Remaining": $107.9K -project cost
FY 1999 "Closeout": $52.5K -project cost
Sum of costs: $160.4K plus GA costs ($11.2K)

Total: $171.6K

1998

Prepared: Prepared: 6/17/97
1f5\n ~~14Ap~~ 97/wh

Project Number: 98320-N
Project Title: Nekton and Plankton Acoustics
Name: Prince William Sound Science Center
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Budget Category:	Authorized FY 1997	Proposed FY 1998	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Personnel	$252.0	$120.9						
Travel	$15.0	$6.0						
Contractual	$6.0	$3.4						
Commodities	$11.0	$3.4						
Equipment	$3.0	$0.0						
Subtotal	$287.0	$133.7						
Indirect	$58.0	$26.7						
Project Total	$345.0	$160.4						
Full-time Equivalents (FTE)		1.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This budget is for NOAA CY98: February 1, 1998 – January 31, 1999.
Due to close out the deliverable final report on this project will not be completed until approx. September 30, 1999.
The close-out of this project will extend beyond a 12 mo. contract year.

Salary figures include a 3% raise.

FY 98

Project Number: 98320-N
Project Title: Nekton and Plankton Acoustics
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

Prepared: 6/17/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1998
	G. Thomas	Principal Investigator	1.5	13.6		20.4
	J. Kirsch	Electrical Engineer	9.0	6.5		58.5
	G. Thomas	Principal Investigator (Close Out)	3.0	14.0		42.0
		Subtotal	13.5	34.1	0.0	
					Personnel Total	$120.9

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1998
	CDV–ANC (GT,JK) EVOS annual mtg.(PD=4r/t x 4/d incl. trvl.)	224	2	8	170	1.8
	CDV-San Diego (GT/JK, acoustics paper, Ocean Sciences Conf.)	550	2	10	126	2.4
	Car rental			20	31	0.6
	1 RT Cdv–Anc 99SEA Mtg.	165	1	5	170	1.0
	Car Rental			5	31	0.2
					Travel Total	$6.0

FY 98

Project Number: 98320-N
Project Title: Nekton and Plankton Acoustics
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 6/17/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

Contractual Costs:	Proposed
Description	FY 1998
Telephone, mail, facsimile	0.7
film processing and slide & poster preparation	0.6
Copying, printing, publication	0.4
Mail, freight, shipping	0.4
Network communications	1.0
Close out phone, fax, copyiing	0.3
Publication costs	
Mail, freight, shipping	
Network communications	
Contractual Total	$3.4

Commodities Costs:	Proposed
Description	FY 1998
analytical, communications and statistical software (Annual IDL, AVS lisc. and maintenance, communication tools)	2.5
office supplies	0.3
video tapes, disks, film	0.3
Close out office & computer supplies	0.3
Commodities Total	$3.4

FY 98

Project Number: 98320-N
Project Title: Nekton and Plankton Acoustics
Name: Prince William Sound Science Center

FORM 4B
Contractual & Commodities DETAIL

Prepared: 6/17/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
February 1, 1998 - January 31, 1999

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 1998
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	
Description	of Units	

FY 98

Project Number: 98320-N
Project Title: Nekton and Plankton Acoustics
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Prepared: 6/17/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$150.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$150.0
General Administration		$10.5
Project Total	$0.0	$160.5
Full-time Equivalents (FTE)		2.6
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002
$59.3			

Dollar amounts are shown in thousands of dollars.

Comments:

1998

Prepared: 4/15/97
14Ap 97/wh

Project Number: 98320-R
Project Title: Trophodynamic Modeling and Remote Sensing
Name: University of Alaska Fairbanks
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel	$106.0	$81.5
Travel	$5.1	$12.2
Contractual	$22.8	$23.0
Commodities	$2.3	$3.3
Equipment	$0.0	$0.0
Subtotal	$136.2	$120.0
Indirect	$34.0	$30.0
Project Total	$170.2	$150.0
Full-time Equivalents (FTE)	3.6	2.6
Other Funds		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
$55.4					

Dollar amounts are shown in thousands of dollars.

Comments:

Indirect costs are 25% Total Direct Cost, the rate negotiated by the EVOS Trustee Council with the University of Alaska.

Graduate Student salaries include $5544 of tuition each.

FY 98

Project Number: 98320-R
Project Title: Trophodynamic Modeling and Remote Sensing
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
D. Eslinger	Assistant Professor – PI		4.5	7.0		31.4
C. Chu	Programmer Analyst – System Admin		0.8	5.4		4.0
D. Allen	Technician – Buoy/Instrumentation		2.0	4.2		8.5
S. Thornton	Graduate Student		12.0	1.6		19.4
N. Pintchouk	Graduate Student		12.0	1.5		18.2
	Subtotal		31.3	19.7	0.0	
					Personnel Total	$81.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
Fairbanks–Cordova – Deploy and retrieve buoy	475	2	14	120	2.6
Truck Rental – Equipment movement and sample transport	100		10		1.0
Taxi and Parking Fees					0.1
Fairbanks–Anchorage – SEA synthesis meetings	300	3	15	120	2.7
Car Rental during Meeting	250				0.2
Fairbanks to National Meeting/Present research data before peers	855	3	15	120	4.4
Meeting Registration Fees: San Diego - Ocean Sci.	300	3			0.9
Car Rental during Meeting	300				0.3
				Travel Total	$12.2

FY 98

Project Number: 98320-R
Project Title: Trophodynamic Modeling and Remote Sensing
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
Communications – charges for tolls related to SEA 98320-R	1.0
Publishing/Page Charges for 3 papers on project results - Titles and journals are listed in DPD	1.0
Buoy Servicing	1.0
ARGOS Service	3.5
Satellite Charges	3.0
Ship Time Charges	5.0
Terrascan License	4.0
Shipping charges for samples and equipment between Fairbanks and Cordova	3.5
Manuscript Preparation Services	1.0
Contractual Total	$23.0

Commodities Costs:	Proposed
Description	FY 1998
Project Supplies – miscellaneous items necessary to the completion of project 98320-R	0.4
Color Printing Supplies	2.0
DAT Tapes for archiving project data	0.9
Commodities Total	$3.3

FY 98

Project Number: 98320-R
Project Title: Trophodynamic Modeling and Remote Sensing
Name: University of Alaska Fairbanks

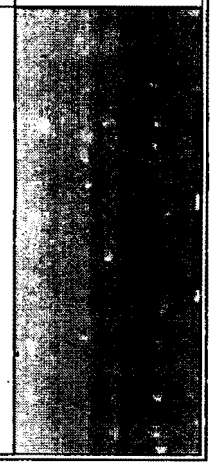
FORM 4B
Contractual & Commodities DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
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 98

Project Number: 98320-R
Project Title: Trophodynamic Modeling and Remote Sensing
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 4/15/97

Revision 10-97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$523.7
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$523.7
General Administration		$23.0
Project Total	$0.0	$546.7
Full-time Equivalents (FTE)		9.6

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
	$369.5				

Dollar amounts are shown in thousands of dollars.

Comments:

1998

Project Number: 98320-T
Project Title: Juvenile Herring Distribution and Habitats
Name: University of Alaska Fairbanks
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared: 17 Jun 14Ap 97/wh

Prepared: 6/17/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Personnel	$335.4	$354.4						
Travel	$26.4	$19.1						
Contractual	$314.6	$35.0						
Commodities	$15.0	$10.5						
Equipment	$4.5	$0.0						
Subtotal	$695.9	$419.0						
Indirect	$174.0	$104.8						
Project Total	$869.9	$523.7	$350.0					
Full-time Equivalents (FTE)		9.6						
	Dollar amounts are shown in thousands of dollars.							
Other Funds								

Comments:

Indirect costs are 25% Total Direct Cost, the rate negotiated by the EVOS Trustee Council with the University of Alaska.

Travel - Funds are requested to include the participation of 4 people from Fairbanks to Anchorage for the annual EVOS meeting. Funds are also requested for the attendance of 4 people to attend the annual Herring Review. The number of people needed to participate at these meetings is necessary to allow proper explanation of each individual's part in the Herring Model. Two research cruises are scheduled for this year and funds are requested for 2 people to go on each cruise, leaving from Fairbanks to Cordova. All of these airfare and per diem charges are based on past expenses incurred by this project for the same activities. Additional trips are planned to Cordova from Fairbanks to facilitate in the analysis and coordination of the hydroacoustics and oceanography data. It is planned that Dr. Stokesbury will go to Cordova 3 times to meet with PWSSC personnel to prepare data and analyze the information that has been collected over the past few years. Additional funds are requested to present papers and/or posters at national meetings. These results will be presented at the annual American Fisheries Society meeting, location unknown at this time.
Tuition - Four semesters of tuition are requested. This includes Fall 98, Spring 99 and Summer 99 for R. Foy. One additional semester is requested for F.J. Muter, a doctoral student working under Dr. Norcross for statistical analysis and consultation.

FY 98

Project Number: 98320-T
Project Title: Juvenile Herring Distribution and Habitats
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

Prepared: 6/17/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1998
	B. Norcross	Associate Professor – P. I.	3.0	7.7		23.2
	K. Stokesbury	Research Associate – Co-P. I.	10.0	6.0		60.2
	E. Brown	Research Associate – Project Leader	10.0	5.2		52.0
	M. Frandsen	Technician – Lab Coordinator	12.0	4.1		49.6
	M. Vallarino	Technician – Database	4.0	4.8		19.0
	C. Stark	Technician – Zoop/Stomach Analysis	4.0	4.6		18.5
	M. McEwen	Technician – Field and Lab	12.0	2.9	5.4	40.2
	P. Lovely	Technician – Field Work	12.0	2.9		34.8
	F. Muter	Graduate Student – Statistical Analysis	6.0	1.6		9.5
	R. Foy	Graduate Student – Habitat Analysis	12.0	1.7		20.6
	Vacant	Laborer	6.0	2.4		14.2
	Vacant	Student Assistant – Office	12.0	0.5		6.3
	Vacant	Student Assistant – Laboratory	12.0	0.5		6.3
		Subtotal	115.0	44.9	5.4	
					Personnel Total	$354.4

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1998
	Fairbanks - Anchorage EVOS Meeting	200	4	16	111	2.6
	Fairbanks - Anchorage Herring Review	200	4	16	111	2.6
	Fairbanks - Cordova Sampling Trips	300	6	36	111	5.8
	Fairbanks - Cordova Data Analysis	300	3	18	111	2.9
	Fairbanks - AFS Meeting and Registr -Present project data and results	700	4	20	120	5.2
					Travel Total	$19.1

FY 98

Project Number: 98320-T
Project Title: Juvenile Herring Distribution and Habitats
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 6/17/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
Communications charges – phone and fax charges related solely to SEA 98320-T	2.5
Copying and duplication charges related solely to SEA 98320-T	1.0
Page charges for publication of research results	1.0
Reprint charges for published results	1.0
Presentation Preparations – slides, overheads, and posters for EVOS/Herring/AFS meetings	1.5
Shipping supplies, gear and samples to and from Fairbanks, Cordova, and Seward	1.2
Vessel Charter – Seine boat 18 days @ $1350/day	24.3
Photo Analysis	1.0
Statistical Software	1.5
Contractual Total	$35.0

Commodities Costs:	Proposed
Description	FY 1998
Computer Supplies – diskettes, toner cartridges, etc.	1.5
Office Supplies – paper, miscellaneous office supplies as necessary	1.5
Lab Supplies – vials, gloves, preservatives for stomach content samples, etc.	3.5
Field Supplies – bottles, waterproof paper, baggies, etc.	4.0
Commodities Total	$10.5

FY 98

Project Number: 98320-T
Project Title: Juvenile Herring Distribution and Habitats
Name: University of Alaska Fairbanks

FORM 4B
Contractual & Commodities DETAIL

Prepared: 6/17/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 1998
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	
Description	of Units	

FY 98

Project Number: 98320-T
Project Title: Juvenile Herring Distribution and Habitats
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 6/17/97

Revision 2 /98
Approved T /18/1997
(adds to budget approved 8/6/97)

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

January 1, 1998 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$47.5
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$47.5
General Administration		$3.3
Project Total	$0.0	$50.8
Full-time Equivalents (FTE)		0.0

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
	$21.4				

Dollar amounts are shown in thousands of dollars.

Other Resources								

Comments:

Approved 8-6-97 25.1

Approved 12-18-97 50.8

$75.9

1998

Prepared: 1 of 5

12Jan 98/wh/ revised 5 Feb/11Feb 98/wjh

Project Number: 98320-T Supplement (Remaining)
Project Title: Documenting Herring and Other Forage Fish Natural History through Traditional Ecological Knowledge
Name: University of Alaska Fairbanks
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMAR

2/12/98

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

January 1, 1998 - September 30, 1998

Budget Category:	Proposed FFY 1998
Personnel	$ 27.3
Travel	$ 8.0
Contractual	$ 1.9
Commodities	$ 0.8
Equipment	$ -
Subtotal	$ 38.0
General Administration (25%)	$ 9.5
Project Total	$ 47.5
Full-time Equivalents (FTE)	

LONG RANGE FUNDING REQUIREMENTS

Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
$50.8	$0.0	$0.0	$0.0	0

Other Resources							

Comments:

Indirect Cost Rate: 25% Total Direct Cost as negotiated with the University of Alaska

Personnel: Project Leader: 4.5 months for report writing/conference attendance, in the field conducting interviews or in the office planning interviews, processing data, getting data into databases. Virtually all field time is community involvement. Technician time for data entry, processing & mapping. Data entry technician; work under project leader entering data. PI time covered under existing EVOS or UAF projects.

Travel; Funds are requested for travel to attend EVOS workshops, meet with SEA researchers and project staff in Fairbanks, and complete travel necessary to complete interviews in Chenega Bay, Homer and Valdez.

Contractual and Commodities: Funds are requested for dta entry, analysis, and write up this fall.

1998

Project Number: 98320T Supplement (Remaining budget)
Project Title: Documentation of Forage Fish Natural History
Agency: AK Dept. of Fish & Game

FORM 3A
AGENCY
PROJECT
DETAIL

Prepared: December 17, 1997 by Jody Seitz - revised - Frandsen

2/12/98

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

January 1, 1998 - September 30, 1998

Personnel Costs:			GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
PM	Name						
	Wages						
	Seitz			4.5	3.80		$ 17.1
	GIS TECH			0.5	3.25		$ 1.6
	DATA ENTRY TECH			3.80	2.25		$ 8.6
		Subtotal		8.8		0	
Those costs associated with program management should be indicated by placement of an *.						**Personnel Total**	$ 27.3

Travel Costs:			Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
PM	Description						
	CDV-ANC	EVOS and scientific meetings	200.00	4	6	125	$1.6
	CDV-VDZ		287.00	2	6	100	$1.2
	CDV-CHB	to complete interviews	700.00	2	6	100	$2.0
	CDV-SWD	(drive from Anchorage)	0.00		8	100	$0.8
	CDV-TAT		320.00	1	2	100	$0.5
	ANC-HOM		150.00	1	2	100	$0.3
	FBX-JUN		400.00	1	5	100	$0.9
	CAR RENTAL IN Anchorage, Juneau, Seward		35.00		19		$0.7
Those costs associated with program management should be indicated by placement of an *.						**Travel Total**	$ 8.0

1998

Project Number: 98320T Supplemental (Remaining budget)
Project Title: Documentation of Forage Fish Natural History
Agency: AK Dept. of Fish & Game

FORM 3B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

January 1, 1998 - September 30, 1998

Contractual Costs:		Proposed FY 1998
Description		
participant costs $20/hr x 20 participants, 3 hours each		$ 1.2
Communications		$ 0.3
Copying		$ 0.3
Publication Charges		$ 0.1
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$ 1.9

Commodities Costs:		Proposed FY 1998
Description		
software		$ 0.6
mylar, pens, maps		$ 0.2
	Commodities Total	$ 0.8

1998

Project Number: 98320T Supplemental (Remaining budget)
Project Title: Documentation of Forage Fish Natural History
Agency: AK Dept. of Fish & Game

FORM 3B
Contractual & Commodities DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

January 1, 1998 - September 30, 1998

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY98
			-
			-
			-
			-
			-
			-
			-
			-
			-
			-
			-
Those purchases associated with replacement equipment should be indicated by placement of a "R"		**New Equipment Total**	-

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency
Fax/Printer	1	
Copier	1	
office furniture	3	
work station - university of Alaska	1	
work station software	1	
computer purchased in FY97 for Cordova	1	

1998

Project Number: 98320T Supplemental (Remaining budget)
Project Title: Documentation of Forage Fish Natural History
Agency: AK Dept. of Fish & Game

FORM 3B
Equipment
DETAIL

Interim Budget
Approved 8-6-97
Add to funding approved
12-18-97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - December 31, 1997

Budget Category:		Proposed FY 1998
Personnel		$10.7
Travel		$4.0
Contractual		$3.7
Commodities		$0.4
Equipment		$0.0
Subtotal		$18.8
General Administration		$4.7
ADF&G Overhead		$1.6
Project Total		$25.1
Full-time Equivalents (FTE)		0.3
	Dollar amounts are shown in thousands of dollars.	
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Comments:

Indirect Cost Rate: 25% Total Direct Costs as negotiated with the University of Alaska

Personnel: Project Leader: 1.5 months for report writing/conference attendance, in the field conducting interviews or in the office planning interviews, processing data, getting data into databases. Virtually all field time is community involvement. Technician time for data entry, processing & mapping. Data entry technician; work under project leader entering interview data. PI time covered under existing EVOS or UAF projects.

Travel: Funds are requested for travel to attend EVOS workshops, meet with SEA researchers and project staff in Fairbanks, and complete travel necessary to complete interviews in Chenega Bay, Homer, and Valdez.

Contractual and Commodities: Funds are requested for data entry, analysis, and write-up this fall.

TOTAL FY98 Funding:

Approved 8-6-97	$ 25.1
Approved 12-18-97	50.8
	$ 75.9

FY 98

Project Number: 98320-T Supplement -- Interim budget
Project Title: Documenting Herring and Other Forage Fish Natural History Through Local and Traditional Ecological Knowledge
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

Prepared: 8/27/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - December 31, 1997

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1998
	J. Seitz	Project Leader	1.5	3.8		5.7
	Vacant	GIS GMT Technician	1.0	3.3		3.3
	Vacant	Data Entry Technician	0.8	2.3		1.7
		Subtotal	3.3	9.4	0	
					Personnel Total	$10.7

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1998
	Cordova-Anchorage–EVOS and Scientific meetings	200	2	6	100	1.0
	Cordova-Fairbanks–Meet with project staff, mapping, data sharing	400	2	9	100	1.7
	Cordova-Chenega Bay–Complete interviews	700	1	6	100	1.3
					Travel Total	$4.0

FY 98

Project Number: 98320-T Supplement -- Interim budget
Project Title: Documenting Herring and Other Forage Fish Natural History Through Local and Traditional Ecological Knowledge
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 8/27/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - December 31, 1997

Contractual Costs:	Proposed
Description	FY 1998
Participant costs $20/hr X 10 participants, 6 hours each	1.2
Communications	0.2
Copying	0.2
Publication charges	0.1
Statistical consultant (80 hours @ $25/hour)	2.0
Contractual Total	$3.7

Commodities Costs:	Proposed
Description	FY 1998
Project supplies	0.4
Commodities Total	$0.4

FY 98

Project Number: 98320-T Supplement -- Interim budget
Project Title: Documenting Herring and Other Forage Fish Natural History Through Local and Traditional Ecological Knowledge
Name: University of Alaska Fairbanks

FORM 4B
Contractual & Commodities
DETAIL

Prepared: 8/27/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - December 31, 1997

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 1998
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number
Description	of Units
Fax/Printer	1
Copier	1
Office Furniture	3
Work Station - University of Alaska	1
Work Station Software	1
Computer purchased in FY97 for Cordova	1

FY 98

Project Number: 98320-T Supplement -- Interim budget
Project Title: Documenting Herring and Other Forage Fish Natural History Through Local and Traditional Ecological Knowledge
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 8/27/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$98.9
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$98.9
General Administration		$6.9
Project Total	$0.0	$105.8
Full-time Equivalents (FTE)		1.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002
$52.1			

Dollar amounts are shown in thousands of dollars.

Comments:

1998

Prepared: 14Ap 97/wh

Prepared: 4/15/97

Project Number: SEA 98320-U
Project Title: Fish Energetics
Name: University of Alaska Fairbanks
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Personnel	$106.9	$75.0						
Travel	$5.0	$2.1						
Contractual	$1.6	$1.2						
Commodities	$2.0	$0.8						
Equipment	$0.0	$0.0						
Subtotal	$115.5	$79.1						
Indirect	$28.8	$19.8						
Project Total	$144.3	$98.9	$48.7					
Full-time Equivalents (FTE)		1.3						
	Dollar amounts are shown in thousands of dollars.							
Other Funds								

Comments:

Indirect costs are 25% Total Direct Cost, the rate negotiated by the EVOS Trustee Council with the University of Alaska.

FY 98

Project Number: SEA 98320-U
Project Title: Fish Energetics
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
A. Paul	Associate Professor – P. I.		3.4	7.8		26.4
J. McDonald	Technician		12.0	4.1		48.6
		Subtotal	15.4	11.9	0.0	
					Personnel Total	$75.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
Seward–Anchorage Round Trip – Attend EVOS and Scientific Meetings	87.0	3	10	187	2.1
				Travel Total	$2.1

FY 98

Project Number: SEA 98320-U
Project Title: Fish Energetics
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
Communications	0.4
Copying	0.1
Sample Shipments, Cordova–Seward, 10 x $65/shipment	0.7
Contractual Total	$1.2

Commodities Costs:	Proposed
Description	FY 1998
Calorimeter Supplies	0.2
Label Tape and Markers	0.2
Printer Cartridges	0.1
Sample Bags	0.3
Commodities Total	$0.8

FY 98

Project Number: SEA 98320-U
Project Title: Fish Energetics
Name: University of Alaska Fairbanks

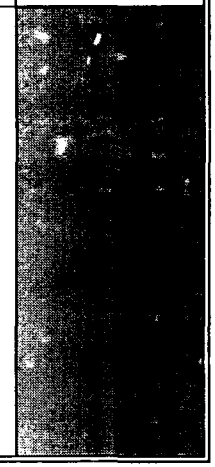
FORM 4B
Contractual & Commodities DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
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 98

Project Number: SEA 98320-U
Project Title: Fish Energetics
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$59.8
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$59.8
General Administration		$4.2
Project Total	$0.0	$64.0
Full-time Equivalents (FTE)		0.2
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
	$53.5				

Dollar amounts are shown in thousands of dollars.

Comments:

1998

Prepared: 14Ap 97/wh

Prepared: 4/15/97

Project Number: 98320-Z
Project Title: Sound Ecosystem Assessment (SEA): Synthesis and Integration
Name: University of Alaska Fairbanks
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel	$22.4	$28.7
Travel	$17.0	$15.0
Contractual	$5.9	$4.1
Commodities	$0.5	$0.0
Equipment	$0.0	$0.0
Subtotal	$45.8	$47.8
Indirect	$11.5	$12.0
Project Total	$57.3	$59.8
Full-time Equivalents (FTE)	2.0	0.2
Other Funds		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
$50.0					

Dollar amounts are shown in thousands of dollars.

Indirect costs are 25% Total Direct Cost, the rate negotiated by the EVOS Trustee Council with the University of Alaska.

The principal investigator requests 2.6 months of time to coordinate, assemble, write, and submit the single, integrated FY99 DPD for SEA close-out, and the single, integrated FY97 Annual Report. This time will also support the planning of synthesis workshops/meetings and processing requests for meeting and conference calls. The lead scientist, working with the SEA executive committee, is responsible for selecting a meeting site and for setting the meeting/workshop agenda.

Travel is requested to allow each SEA principal investigator to participate in one or more synthesis and integration workshops established at the full program, or sub-model group levels. These meetings could be held in Cordova, Anchorage, or Fairbanks depending on the needs of the whole or partial group.

Support is requested for conference calls (usually several hours in length) and Academic Services Support to assist with the formatting, internal review, and submission (hard and electronic copies) of the FY99 SEA close-out DPD, and the single, integrated FY97 Annual Report. These services are not available to IMS faculty outside the Academic Services Recharge Center. No services, supplies, equipment, salaries or goods used by the Center are included in the University of Alaska Fairbanks Indirect Cost Allocation Pool.
No funds are requested for supplies and equipment

FY 98

Project Number: 98320-Z
Project Title: Sound Ecosystem Assessment (SEA): Synthesis and Integration
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

Prepared: 4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1998
	R. Cooney	Professor – P. I.	2.6	11.1		28.7
		Subtotal	2.6	11.1	0.0	
					Personnel Total	$28.7

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1998
	Travel expenses and per diem for investigators to attend workshop in Anchorage	500	15	75	100	15.0
					Travel Total	$15.0

FY 98

Project Number: 98320-Z
Project Title: Sound Ecosystem Assessment (SEA): Synthesis and Integration
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/15/97

1998 EXXON VALDEZ TRUST COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed FY 1998
Description	
Communications – Support of conference calls between project leaders and investigators	2.5
Report formatting and copying; Academic Services; 40 hr @ $40/hr	1.6
Contractual Total	$4.1

Commodities Costs:	Proposed FY 1998
Description	
Commodities Total	$0.0

FY 98

Project Number: 98320-Z
Project Title: Sound Ecosystem Assessment (SEA): Synthesis and Integration
Name: University of Alaska Fairbanks

FORM 4B
Contractual & Commodities DETAIL

Prepared: 4/15/97

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	

Existing Equipment Usage: Description	Number of Units

FY 98

Project Number: 98320-Z
Project Title: Sound Ecosystem Assessment (SEA): Synthesis and Integration
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 4/15/97

98325-BAA

Approved TC 8-6-97

Assessment of Injury to Intertidal and Nearshore Subtidal Communities: Preparation of Manuscripts

Project Number:	98325-BAA
Restoration Category:	Research
Proposer:	T. Dean/Coastal Resources Associates, Inc.
Lead Trustee Agency:	NOAA
Cooperating Agencies:	None
Alaska SeaLife Center:	No
New or Continued:	New
Duration:	1st yr. 3 yr. project
Cost FY 98:	$99.9
Cost FY 99:	
Cost FY 2000:	$0.0
Cost FY 01:	$0.0
Cost FY 02:	$0.0
Geographic Area:	No field work proposed
Injured Resource/Service:	Intertidal communities

ABSTRACT
This project will prepare manuscripts for publication in scientific journals based on previous Trustee Council funded evaluations of injury to, and restoration of, coastal habitats (intertidal and subtidal communities).

INTRODUCTION

The *Exxon Valdez* Oil Spill Trustee Council (hereafter referred to as the EVOS Trustees) has funded a number of projects that examined the injury to, and recovery of intertidal and nearshore subtidal systems. These include Coastal Habitat Study 1A: Comprehensive Assessment of Coastal Habitat; Restoration Project 94086: Herring Bay experimental monitoring studies; and several projects dealing with nearshore subtidal communities (Air/Water Project ST2A, and Restoration Projects 93047 and 95106). The final reports for these projects have been submitted to the Trustees (Highsmith et al. 1994, 1995; Jewett et al. 1995; and Jewett and Dean 1996) and several aspects of this work have either been published or are submitted for publication in the peer reviewed scientific literature (see Literature Cited). However, there are still several important scientific aspects of this work that have not been published. This proposal seeks funding to prepare those manuscripts.

NEED FOR THE PROJECT

A. Statement of Problem

Publication of past Trustee sponsored studies of coastal habitats is important because these studies serve as a critical foundation for future injury assessment and restoration efforts. These studies are the most thorough and comprehensive investigations of a major oil spill that have been conducted to date, and should serve as cornerstone for future oil spill studies. Some of the Trustee sponsored work has recently been criticized (e.g. Paine et al. 1996) and a timely publication of coastal habitat studies is needed in order to correct some current misconceptions.

B. Rationale/Link to Restoration

The lessons learned from studies of coastal habitats following the *Exxon Valdez* oil spill, both about the ecology of the nearshore environment and about the process of assessing impacts from a major oil spill, are valuable ones that need to be applied to future restoration efforts.

C. Location

There are no field studies to be conducted. Past studies, on which publications will be based, were conducted in Prince William Sound, Kenai/Cook Inlet, and Kodiak/Alaska Peninsula.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The projects are based on data gathered throughout the damage assessment and restoration phases of the Exxon Valdez Oil Spill studies funded by the Trustees. Past work has been presented at various public meetings sponsored by the council. It is anticipated that manuscripts produced will be the basis of future presentations at Trustee sponsored restoration workshops.

One of the manuscripts that is to be produced as part of this project, "Comparison of Study Designs for Assessment of Shoreline Impacts of the *Exxon Valdez* Oil Spill" will critique study designs utilized by the Trustee sponsored work, studies sponsored by NOAA, and studies by Exxon. An obvious shortcoming of all of these works is the failure to address subsistence issues, and the failure to utilize traditional ecological knowledge in the study design. A discussion of

how these shortcomings might be addressed in future studies will be developed in consultation with the Oil Spill Restoration Office, and will be included as part of the manuscript.

PROJECT DESIGN

A. Objectives

The objective of the proposed study is to produce a minimum of ten manuscripts for publication in the peer reviewed scientific literature. Six will be prepared and submitted in FY98. Of these, two are in preparation, and funding for these is being requested for page charges only. A proposal for the additional manuscripts listed will follow in April 1998, for funding in FY99.

B. Methods

The manuscripts will be prepared by a team of scientists who have been directly involved in the coastal habitat studies funded by the Trustees. The work will be coordinated by Coastal Resources Associates, Inc. (CRA), and they will be responsible for the financial and scientific management of the project. Dr. Thomas Dean, President of CRA will serve as project leader. Key individuals in the coastal habitat injury assessment program will serve as lead authors of manuscripts to be prepared. These will include Drs. Ray Highsmith and Mike Stekoll of the University of Alaska, and Dr. Lyman McDonald of West. Dr. Dean will also serve as a lead author, and will be assisted by Dr. Larry Deysher of CRA who has had extensive involvement in the CHIA program.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This proposal is being submitted under BAA by Coastal Resources Associates, Inc. However, it is anticipated that a portion of the funding will be directed to the University of Alaska, with contract administration for that portion of the contract conducted by Alaska Department of Fish and Game.

SCHEDULE

A. Measurable Project Tasks for FY 98 (October 1, 1997 - September 30, 1998)

A total of six manuscripts will be prepared for publication during FY98. A description of these is given under "Publications and Reports" below.

B. Project Milestones and Endpoints

All manuscripts slated for preparation in FY98 will be in draft form and available for internal review by January 31, 1998. At that time, a progress report will be submitted to the Trustees that includes the draft manuscripts. All manuscripts will be submitted by April 15, 1998. A request for funding of four additional manuscripts will be prepared at that time. The schedule for publication will depend on the length of the review period, and on the extent of revisions (if any) required. It is anticipated that all manuscripts will be ready for final acceptance by August 1998.

C. Completion Date

It is anticipated that all ten manuscripts proposed will be submitted and accepted by September 1999. Some carry over of funds may be required to cover page charges incurred in FY00.

PUBLICATIONS AND REPORTS

It is anticipated that a minimum of ten manuscripts will be produced. Six of these are slated for submission in FY98, including two that are in preparation. (Funding is being requested only for page charges for the two manuscripts in preparation). A listing of anticipated authors, titles, journals selected for submission, and a brief description of the content of each manuscript follows.

Manuscripts to be prepared in FY 1998

1. Comparison of Study Designs for Assessment of Shoreline Impacts of the *Exxon Valdez* Oil Spill

Proposed Authors: Lyman L. McDonald, Wallace P. Erickson, M. Dale Strickland, and Charles Peterson. (Order to be determined by relative contribution and amount written.)

Possible Journals: Marine Pollution Bulletin or Oecologica

This manuscript will contrast the design of the Coastal Habitat Injury Assessment (Highsmith et al. 1996, Jewett et al. 1995, McDonald et al. 1995, Stekoll et al 1996) to study designs used in assessment of shoreline impacts of the spill by Exxon supported scientists (Page et al. 1995) and NOAA scientists (Mearns 1996, Houghton et al. 1996). The objectives of these studies will be contrasted and the designs will be evaluated in terms of how well project objectives were met, the relative ability of each design to quantify impacts of the Exxon spill, and the relative strengths and weaknesses of each design. The role of the following will be assessed in each of the studies:

1) random selection of study sites,
2) subjectively selected study sites,
3) interspersion of study sites,
4) definition and selection of reference sites,
5) levels of statistical inference,
6) power to detect important ecological effects (and specifically trade offs one must make with respect to power and ability to make broader statistical inferences),
6) the role of experiments (as contrasted to surveys) in injury assessment,
7) statistical analyses, and
8) definitions for recovery.

2. *Fucus* and the *Exxon Valdez* Oil Spill: Injury and Recovery

Proposed Authors: Michael S. Stekoll, Lawrence E. Deysher, and Mandy R. Lindeberg.

Possible Journals: Marine Ecology Progress Series or Marine Environmental Research

Analysis of injury to *Fucus* will be presented for all areas (Prince William Sound, Kenai/Lower Cook Inlet, and Kodiak/Alaskan Peninsula) and habitats (Sheltered Rocky, Exposed Rocky,

Coarse Textured, and Estuarine) for the period 1991-1994. The focus will be on *Fucus gardneri* populations (abundance, biomass. reproductive state, injury to plants, extent of fouling, percent cover), and will contrast the patterns observed at the three areas representing different levels of oiling and cleanup, and different physical regimes. The discussion will draw on previously published studies of experimental evaluations on the recovery and recolonization of *Fucus* in Herring Bay (Stekoll and Deysher 1996, Van Tamlen and Stekoll 1995, 1996; and Van Tamlen et al. 1997) to help explain differences in patterns observed in different areas and habitats.

3. Injury to, and Recovery of Rocky Intertidal Communities in Prince William Sound Following the *Exxon Valdez* Oil Spill

Proposed Authors: Raymond C. Highsmith, Thomas A. Dean, and Susan M. Saupe

Possible Journals: Marine Ecology Progress Series or Marine Environmental Research

This manuscript will assess injury to dominant taxa of intertidal plants and animals in Prince William Sound in sheltered rocky, exposed rocky, and coarse textured habitats. The paper will utilize data from a broad geographic examination of injury based on studies carried out throughout the Sound (Coastal Habitat Injury Assessment Studies), and from a longer time series of observations in Herring Bay (Herring Bay Population Dynamics Studies) to evaluate injury and recovery of dominant taxa (*Fucus*, ephemeral algae, barnacles, limpets, mussels and littorines). We will examine how the Herring Bay and CHIA data correlate with one another and attempt to use the Herring Bay data to infer mechanisms of impact and processes of recovery for communities throughout the Sound. For example, the paper will related algal species composition and abundance following the spill and potential relationships to subsequent invertebrate distributions, and vice versa.

4. Factors Limiting Recovery of Limpet Populations following the *Exxon Valdez* Oil Spill

Proposed Authors: Raymond C. Highsmith, Thomas A. Dean, and Anthony J. Hooten. (Order to be determined by relative contribution and amount written.)

Possible Journals: Marine Ecology Progress Series or Marine Environmental Research

This paper will focus on limpets. The evidence for injury (based mostly on CHIA data), and recovery (based mostly on the Herring Bay population dynamics data) will be reviewed. The bulk of the paper will examine experimental data from fencing and caging experiments on the effects of oiled substrates as well as other factors (e.g. algal density and limpet density) on the recovery process. A preliminary examination of the data suggest that limpets (especially *T. persona* in the upper intertidal) were severely injured, that most populations perhaps recovered by 1993 or 1994, and that oiled substrates apparently did not inhibit recovery. Experimental data indicate that limpets graze on algae and provide a mechanism that might explain why cover by filamentous algae increased following the spill. Experimental data also suggest some interesting biology regarding density dependence in limpets, and the potential effects of predators on survival of limpets. Population dynamics data indicate that there was a large increase in the abundance of limpets at both oiled and control sites in Herring Bay between 1990 and 1994. We can speculate that this might have been natural temporal variation, or a result of a release from predation

pressure throughout Herring Bay because of an oil relate reduction in oystercatchers, harlequin ducks and other potential predators.

5. Effects of the *Exxon Valdez* Oil Spill and Non-Anthropogenic Factors on the Distribution and Abundance of Nearshore Benthic Fishes in Prince William Sound, Alaska.

Proposed Authors: T.A. Dean, L. Haldorson, D. Laur, and S. Jewett. (Order to be determined by relative contribution and amount written.)

Possible Journals: Fisheries Bulletin, Environmental Biology of Fishes

This paper will examine the factors affecting the distribution and abundance of nearshore benthic fishes including a variety of habitat characteristics (vegetation type, slope, substrate type, exposure) as well as oiling of adjacent shorelines. We will examine community response (MDS and PCA analysis) as well as responses of dominant taxa (using non-linear models and/or PCA analysis). A previous publication (Laur and Haldorson 1996) examined only the differences between fish abundance at oiled and control sites, by species and habitat. This manuscript will present a more community based approach, that also examines the influence of factors other than oil on distribution and abundance. Data are from the 1990 subtidal surveys, with a few other data from eelgrass habitat surveys in subsequent years . A draft of this manuscript is in preparation.

6. Impacts of the *Exxon Valdez* Oil Spill on Benthic Communities in Eelgrass Habitats.

Proposed Authors: S.J. Jewett, T.A. Dean, A. Blanchard, and R.O. Smith

Possible Journals: Marine Environmental Research, Marine Ecology Progress Series

Examination of impacts to subtidal benthic infauna and small epifauna based on subtidal studies. This is a manuscript that comes directly from sections of the report of Jewett and Dean (1996) on eelgrass communities that deal with dredge sample data. A draft of this manuscript has been produced.

Manuscripts to be prepared in FY99

7. Algal Community Function Following the *Exxon Valdez* Oil Spill

Proposed Authors: Michael S. Stekoll, Lawrence E. Deysher, and M.R. Lindeberg

Possible Journals: Marine Ecology Progress Series or Marine Environmental Research

An examination of community level responses following the EVOS, based on algal data from Coastal Habitat Injury Assessment studies conducted in Prince William Sound, Kenai/Cook Inlet, and Kodiak/Alaskan Peninsula. Community similarity (MDS), diversity, functional group analysis (e.g. leafy blades, filamentous algae), higher order taxa analysis (red vs. green algae), and life history groupings (annuals vs. perennials, widely dispersed vs. not so widely dispersed, etc.) will be presented.

8. Responses of Intertidal Communities to the *Exxon Valdez* Oil Spill: Regional Comparisons of the Extent of Injury.

Proposed Authors: Raymond C. Highsmith, Thomas A. Dean, Michael S. Stekoll, Lawrence E. Deysher and Susan M. Saupe

Possible Journals: Marine Ecology Progress Series or Marine Environmental Research

A summary of impacts to both algal and invertebrate communities in Prince William Sound, Kenai/Cook Inlet, and Kodiak/Alaska Peninsula will be presented. The focus will be on the differences in response of dominant taxa in different areas, and potential causes for different responses in the different regions including extent of exposure to oil, cleanup methods, and differences in physical environments. The manuscript will also discuss implications toward impacts of different cleanup methods if appropriate.

9. A Summary of Impacts of the *Exxon Valdez* Oil Spill on Nearshore Subtidal Communities.

Proposed Authors: T.A. Dean and S.J. Jewett

Possible Journals: Ecological Applications, Annual Reviews of Ecology and Systematics

A summary of available information on the injury and recovery of subtidal communities including (but not necessarily limited to) studies of impacts and recovery of subtidal communities (Armstrong et al. 1995; Dean et al. 1996a, 1996b; Jewett and Dean 1997; Jewett et al 1995, 1996; Laur and Haldorson 1996) hydrocarbon data (Bence and Burns 1995; Carlson and Kvenvolden 1996; O'Clair et al., 1996; Page et al. 1995; Short and Babcock 1996; Short et al. 1996a, 1996b; Wolfe et al. 1994); bacteria data (Braddock and Richter 1994; Braddock et al. 1995, 1996); toxicity data (Armstrong et al. 1995; Wolfe et al. 1996), biomarker data in subtidal fishes (Armstrong et al. 1995; Collier et al. 1996). Salmon and Herring data will be not be reviewed. This manuscript is in preparation.

10. A Summary of Impacts of the *Exxon Valdez* Oil Spill on Intertidal Communities.

Proposed Authors: Raymond C. Highsmith, Thomas A. Dean, Michael S. Stekoll, Lawrence E. Deysher

Possible Journals: Ecological Applications, Annual Reviews of Ecology and Systematics

A summary of available information on the injury and recovery of intertidal communities including (but not necessarily limited to) studies of impacts on intertidal algae and invertebrates (De Vogelaere and Foster 1994; Ebert and Lees 1996; Fleeger et al. 1996, Gilfilan et al. 1996a, 1996b; Highsmith et al. 1994, 1995, 1996; Hooten and Highsmith 1996, Houghton et al. 1993, 1994, 1995, 1996a, 1996b; Lees et al. 1996; Mearns et al. 1996, Stekoll et al 1996a, 1996b; Van Tamlen and Stekoll 1994, 1995, 1996: van Tamlen et al 1997; Trowbridge et al. 1996) hydrocarbon data (Bence and Burns 1995; Carlson and Kvenvolden 1996; O'Clair et al., 1996; Page et al. 1995; Short and Babcock 1996; Short et al. 1996a, 1996b; Wolfe et al. 1994); bacteria

data (Braddock and Richter 1994; Braddock et al. 1995, 1996); and toxicity data (Armstrong et al. 1995; Wolfe et al. 1996).

PROFESSIONAL CONFERENCES

No funding is being requested for attendance at professional conferences in FY98.

NORMAL AGENCY MANAGEMENT

This project has been developed through collaboration of private sector and University of Alaska scientists. None of the proposers have management responsibility. However, it is anticipated that publications produced will be widely utilized in future management decisions.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The scientists involved in the preparation of manuscripts have worked collaboratively in previous Trustee funded investigations of injury and recovery in coastal habitats. Authors will serve as internal reviewers of each of the manuscripts while these manuscripts are in preparation.

Several of the authors are also participants in other large ecosystem studies funded by the Trustees. Thomas Dean and Stephen Jewett are principal investigators for the Nearshore Invertebrate Predator Project and Lyman McDonald serves as consulting statistician for both the Nearshore Vertebrate Predator and APEX projects. The APEX and especially the Nearshore Vertebrate Predator Project have large components that deal with coastal habitats, and new findings produced by these studies will be considered when preparing manuscripts. It is also anticipated that information presented in the manuscripts, along with the information gained in ongoing research and monitoring efforts, will be integrated and utilized in developing future monitoring plans for coastal habitats.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This is a new project.

PROPOSED PRINCIPAL INVESTIGATORS

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Approved T ,6-97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$93.4
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$93.4
General Administration		$6.5
Project Total	$0.0	$99.9
Full-time Equivalents (FTE)		0.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	

Dollar amounts are shown in thousands of dollars.

Comments:

Separate detailed budgets are provided for:

Coastal Resources Associates, Inc. (BAA)	$31.1
West, Inc. (BAA)	$21.7
University of Alaska, SE (ADFG RSA)	$17.3
University of Alaska Fairbanks (ADFG RSA)	$23.3

Coasal Resources Associates, Inc. will have management responsibilities for the project.
The GA is shared by NOAA ($3.7) and ADFG ($2.8).

1998

Prepared: 1 of 1

Project Number: 98325-BAA
Project Title: Intertidal/Subtidal Manuscript Preparation
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

9/9/97

Revised 6-16-

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$14,662
Travel		$0
Contractual		$1,400
Commodities		$1,740
Equipment		$0
Subtotal		$17,802
Indirect		$13,318
Project Total		$31,120
Full-time Equivalents (FTE)		2.20
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
	$32,000				

Dollar amounts are shown in thousands of dollars.

Comments: 1. Contractual changes are as follows:

S. Saupe - Consultant		Hours	Rate/Hr	Total
Personnel	Co-Author	40	$ 35	$ 1,400

2. CRA, Inc. Indirect Rates calculated as follows: Overhead = 59.5% of salaries and fringe.
General Administrative = 12.085% of total direct costs,.
Fee = 5% of total direct and indirect

3. Rates are based on DCAA audits conducted within the past year.

1998

Prepared:

Project Number: 98325-BAA
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: Coastal Resources Associates, Inc.

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1998
	Dean, Thomas A.	Project Coordinator-Lead Author	1.00	7,604	0.0	7,604
	Deysher, Lawrence E.	Co-author	0.70	7,604	0.0	5,323
	Jung, Dennis	Graphical/Production Assistant	0.50	3,469	0.0	1,735
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	2.2	18,677	0.0	
					Personnel Total	$14,662

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1998
						0.0
	None					0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$0

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: Coastal Resources Associates, Inc.

FORM 4B
Personnel
& Travel
DETAIL

6/11/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:		Proposed FY 1998
Description		
S. Saupe - Consultant		1,400
	Contractual Total	$1,400

Commodities Costs:		Proposed FY 1998
Description		
Page Charges	4 journal articles	1,740
	Commodities Total	$1,740

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: Coastal Resources Associates, Inc.

FORM 4B
Contractual & Commodities DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 1998
Description			
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage:	Number of Units	
Description		

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: Coastal Resources Associates, Inc.

FORM 4B
Equipment
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$10,831
Travel		$0
Contractual		$0
Commodities		$0
Equipment		$0
Subtotal		$10,831
Indirect		$10,881
Project Total		$21,712
Full-time Equivalents (FTE)		1.90
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002
$22,000			

Dollar amounts are shown in thousands of dollars.

Comments:

1. West Indirect Rates are 118% of salaries and fringe. Indirect Rates indicated here include a cost sharing of $1,900

2. Rates are based on DCAA audits conducted within the past year.

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: West, Inc..

FORM 4A
Non-Trustee
SUMMARY

6/11/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
McDonald, Lyman	Project Coordinator-Lead Author		0.80	7,230	0.0	5,784
Erikson, Wallace	Co-author		0.80	4,049	0.0	3,239
Strickland, Dale	Co-Author		0.25	7,230	0.0	1,808
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.9	18,509	0.0	
					Personnel Total	$10,831

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 1998
						0.0
None						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$0

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: West, Inc.

FORM 4B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
None	0
Contractual Total	$0

Commodities Costs:	Proposed
Description	FY 1998
None	0
Commodities Total	$0

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: West, Inc.

FORM 4B
Contractual & Commodities DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			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	

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: West, Inc.

FORM 4B
Equipment
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$18,113.0
Travel		$0.0
Contractual		$0.0
Commodities		$500.0
Equipment		$0.0
Subtotal	$0.0	$18,613.0
Indirect		$4,653.0
Project Total	$0.0	$23,266.0
Full-time Equivalents (FTE)		2.00
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
	$25,000.0				

Dollar amounts are shown in thousands of dollars.

Comments:

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: University of Alaska, Fairbanks

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1998
	Highsmith, Ray	Lead Author	1.5	10,291	0.0	15,437
	Chu, Chirk	Data Base Manager	0.5	5,352		2,676
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	2.0	15,643	0.0	
					Personnel Total	$18,113

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1998
						0.0
	None					0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$0.0

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: University of Alaska, Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

6/11/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:		Proposed FY 1998
Description		
None		
	Contractual Total	$0.0

Commodities Costs:		Proposed FY 1998
Description		
Page Charges	Manuscript	500
	Commodities Total	$500

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: University of Alaska, Fairbanks

FORM 4B
Contractual & Commodities DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 1998
Description			
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number of Units	
Description		

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: University of Alaska, Fairbanks

FORM 4B
Equipment
DETAIL

6/11/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$13,055.0
Travel		$0.0
Contractual		$0.0
Commodities		$1,000.0
Equipment		$0.0
Subtotal	$0.0	$14,055.0
Indirect		$3,289.0
Project Total	$0.0	$17,344.0
Full-time Equivalents (FTE)		1.50
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
	$25,000.0				

Dollar amounts are shown in thousands of dollars.

Comments:

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the *Exxon Valdez* Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: University of Alaska, Southeast

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1998
	Stekoll, Mike	Lead Author	1.5	8,703	0.0	13,055
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	1.50	8,703	0.0	
					Personnel Total	$13,055

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1998
	None					0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$0.0

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: University of Alaska, Southeast

FORM 4B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed FY 1998
Description	
None	
Contractual Total	$0.0

Commodities Costs:	Proposed FY 1998
Description	
Office and computer supplies	500
Page charges - manuscript	500
Commodities Total	$1,000

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: University of Alaska, Southeast

FORM 4B
Contractual & Commodities DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	

1998

Prepared:

Project Number:
Project Title: Assessment of Injury to Intertidal and Nearshore Subtidal Communities Following the Exxon Valdez Oil Spill: Preparation of Manuscripts for Publication "Submitted under BAA"
Name: University of Alaska, Southeast

FORM 4B
Equipment
DETAIL

Approved TC 8-6-97

Pigeon Guillemot Restoration Research at the Alaska SeaLife Center

Project Number:	98327
Restoration Category:	Research
Proposer:	D. Roby/Oregon State Univ.
Lead Trustee Agency:	DOI
Cooperating Agencies:	None
Alaska SeaLife Center:	Yes
New or Continued:	New
Duration:	1st yr. 3 yr. project
Cost FY 98:	$123.3
Cost FY 99:	$159.5
Cost FY 2000:	$168.8
Cost FY 01:	$95.1
Cost FY 02:	$0.0
Geographic Area:	Resurrection Bay
Injured Resource/Service:	Pigeon guillemot

ABSTRACT

This project will test the feasibility of direct restoration techniques for pigeon guillemots (e.g., installation of artificial nest sites, use of social attractants, captive propagation and release). While raising young guillemots in captivity it will also be possible to conduct controlled experiments crucial to two other restoration objectives: (1) development of nondestructive biomarkers of petroleum hydrocarbon contamination, and (2) understanding how dietary factors (prey species composition, prey size, lipid content, feeding frequency) constrain growth, development, and condition at fledging in guillemots.

INTRODUCTION

The Pigeon Guillemot (*Cepphus columba*) population in Prince William Sound has failed to recover from declines that occurred both before and after the *Exxon Valdez* Oil Spill (EVOS). Post-spill studies of Pigeon Guillemot reproductive success have identified three primary factors preventing recovery:

1) In Prince William Sound (Naked and Jackpot islands) and Kachemak Bay, predation on eggs and chicks was a major source of nesting failure (Hayes 1996, Prichard 1997).

2) There has been a decline in the proportion of sand lance in the diet at some guillemot colonies in Prince William Sound (e.g., Naked island), and the proportion of high-quality schooling forage fish in the diet seems to be a key factor in guillemot reproduction. The Alaska Predator Ecosystem Experiment (APEX) Project components F (Factors Limiting Pigeon Guillemot Recovery) G (Seabird Energetics), and M (Seabird/Forage Fish Studies in Lower Cook Inlet) are investigating the relationship between a lack of recovery and the availability and quality of forage fish. A decline in availability of high-lipid forage fishes (sand lance, herring, capelin) in the last two decades may be responsible for lower growth rates, fledging weights, post-fledging survival, and adult recruitment rates.

3) The Nearshore Vertebrate Predator (NVP) Project (River Otter and Pigeon Guillemot component) is testing the hypothesis that exposure to residual oil from the spill continues to limit recovery of Pigeon Guillemots. Pigeon Guillemots feed on a diversity of nearshore demersal fishes and some schooling forage fishes, prey that were likely injured by EVOS. The approach of this study is to measure certain biomarkers in blood and compare biomarker levels in nestlings from oiled and nonoiled areas. These blood biomarkers still need to be calibrated to known doses of weathered Prudhoe Bay Crude Oil (PBCO).

The proposed research will be conducted at the SeaLife Center in Seward and will address all three of the above limiting factors. Experimental studies using captive subjects will be integrated with raising Pigeon Guillemot nestlings in captivity in order to establish both captive and free-ranging guillemot breeding colonies at the SeaLife Center. Predator-free nest sites will be built at the SeaLife Center and, in association with the use of decoys and audio playbacks of guillemot calls, will be used to attract and recruit prospecting guillemots to breed. Guillemot populations are frequently nest-site limited (Storer 1952) and Pigeon Guillemots readily breed in anthropogenic structures, such as docks and breakwalls, at many locations throughout the species' range. Like most seabirds, guillemots are philopatric to their natal location, and the cohorts that are raised in captivity at the SeaLife Center and released can be expected to return and attempt to breed at the SeaLife Center. Although guillemots only rarely breed before three years of age, prospecting 2-year-olds that are raised in the first year of this three-year study can be expected to visit the SeaLife Center in the last year of this study. For the first two years of the study,

immigration from nearby natural colonies will provide recruits to the colony of free-ranging guillemots that we seek to establish at the SeaLife Center.

Providing artificial nest sites has the potential to restore guillemot populations through enhancing both adult recruitment and breeding productivity. The success in recruiting prospecting adult guillemots to use artificial nest sites and the proportions of captive-reared and immigrant birds that utilize artificial nest sites will allow us to test the feasibility of this direct restoration technique for enhancing recovery of guillemot populations in the EVOS area.

The proposed work is intended to result in the establishment of a breeding colony of free-ranging Pigeon Guillemots at the SeaLife Center. By banding immigrants to the colony and young that are raised and released at the SeaLife Center, we can establish a breeding colony comprised of known-age individuals whose breeding history is known. Accessibility of nest sites can be a major obstacle for studies of factors influencing nesting success and demographics of guillemots, and artificial nests sites can provide investigators with unique opportunities. A dockside Black-legged Kittiwake (*Rissa tridactyla*) colony in Great Britain has been studied for the past 30 years and provided most of what is known about that species in the northeastern Atlantic (i.e., Coulson 1988, Coulson and Thomas 1985). Establishment of a Pigeon Guillemot colony at the SeaLife Center has the potential of providing a similar resource, in addition to being integrated with the Center's public education program.

Besides providing recruits for the breeding colony of free-ranging guillemots to be established at the SeaLife Center, raising chicks in captivity will also provide the opportunity to conduct controlled experiments that are relevant to two major issues in Pigeon Guillemot restoration: (1) the importance of prey type, size, quality, and frequency of delivery on growth rates and condition of fledglings and (2) the utility of biomarkers in blood and excreta as indicators of exposure to oil. Research on these two topics can best be conducted using captive subjects whose environment and diet can be carefully controlled to avoid confounding variables so common in natural populations. In the first year of this study, chicks will be raised on different diet regimes to determine the effects of the proportion of schooling forage fishes (sand lance, capelin, herring) vs. nearshore demersal fishes (gunnels, pricklebacks, sculpins) on growth rates. In the subsequent two years of the study, controlled feeding experiments will be conducted that are designed to reveal the tradeoffs inherent in meal size, meal frequency, and meal quality (energy density) as they influence nestling growth performance. The results from this study will complement continuing studies on the role of diet in productivity of guillemots that are part of the APEX Project.

In the second and third years of the study, some chicks that are raised in captivity will be fed small, sublethal doses of weathered Prudhoe Bay crude oil (PBCO). Subsequent to dosing, samples of blood and excreta will be collected at prescribed intervals for measurement of

biomarkers of health status. These results will allow us to define the dose-response relationship between ingested PBCO and each biomarker of exposure. Such results are essential for evaluating the efficacy of particular biomarkers and the utility of these biomarkers for assessing the exposure of free-ranging guillemots to oil.

Of particular value for interpretation of the results of captive feeding trials and crude oil dose-response experiments will be the subsequent release of these subjects and measurements of their return rates in subsequent years. Although it can not be assumed that all young guillemots that are fledged from the SeaLife Center and survive to breeding age will return to the SeaLife Center to breed, the return rates of nestlings raised on various diets, plus return rates of oil-dosed and control nestlings, will provide valuable information on the long term effects on guillemot fitness of prey composition and oil exposure.

NEED FOR THE PROJECT

A. Statement of Problem

In the last two decades the Pigeon Guillemot population in Prince William Sound has declined from 15,000 to 5,000 individuals (Laing and Klosiewski 1993). While this decline apparently began prior to the EVOS, an estimated 10-15% of the population in the spill area died as a direct result of the spill. Post-spill censuses have not detected an increase in numbers, suggesting no appreciable recovery has occurred in the aftermath of the spill. Reasons for the lack of recovery are unclear, but may be related to changes in prey resources, continuing exposure of guillemots or their prey to oil, or nesting failure due to predation.

Predation on Pigeon Guillemot eggs and chicks was apparently minimal before EVOS, but post-spill studies have frequently recorded high levels of predation from river otters and mink (Hayes 1995). High predation rates could be reducing production of local birds, increasing breeding dispersal (lack of fidelity to a previously used nest site or location) of established breeders, and decreasing the immigration of guillemots from other colonies. While Pigeon Guillemots typically have high fidelity to their breeding site, disturbance and lack of breeding success can increase the rate and distance of breeding dispersal. Populations suffering high levels of disturbance, such as persistent nesting failure due to terrestrial predators, will decline due to a lack of production of new recruits, dispersal of breeding birds, and decreased immigration.

Two ongoing EVOS projects have identified potential reasons for a lack of recovery. The APEX Project has identified a major shift in the nearshore ecosystem that has apparently resulted in fewer schooling fish, particularly sand lance (*Ammodytes hexapterus*) fed to chicks (Oakley and Kuletz 1994). Pre-spill studies found sand lance, a nearshore schooling fish with a high lipid content, to be the dominant prey returned to chicks. Post-spill studies have found gadids and nearshore demersal fish to constitute the majority of the diet. The NVP project has attempted to determine if blood biomarkers can be used to monitor level of exposure to oil and if blood from individuals in wild populations currently indicates exposure to oil is occurring. Both of these projects have examined wild populations that are exposed to numerous sources of variability that confound the examination of factors affecting chick growth or blood biomarkers.

This study is relevant to EVOS Restoration Work because it is designed to develop direct restoration techniques for Pigeon Guillemots, a species injured by the spill that is failing to recover. Techniques developed during this research will be relevant to restoration of other alcid species. Also, dose-response experiments with guillemot nestlings fed small, sublethal amounts of weathered Prudhoe Bay crude oil will provide crucial validation and calibration results for interpretation of on-going studies of biomarkers as indicators of crude oil exposure. Experimental studies with captive-reared guillemots will also provide a better understanding of

how shifts in the diet of guillemots and other seabirds breeding in EVOS area affects growth, development, fledging condition, and, ultimately, fitness. By monitoring the growth and development of nestlings raised on controlled rations, the relative nutritional quality of various prey can be assessed. Also, fitness tradeoffs between prey size/quality and provisioning rate can be assessed through monitoring of subsequent survival in the wild of captive-reared chicks. Understanding the constraints imposed on guillemots by diet composition, oil exposure, and nest site quality will be crucial for designing management initiatives to enhance productivity in this and other seabird species that are failing to recover from EVOS.

B. Rationale/Link to Restoration

Artificial nest sites have the potential to increase the size of both guillemot breeding colonies and populations. A Black Guillemot colony in arctic Alaska increased from 10 to 225 pairs in 17 years through provision of artificial nest sites (Divoky et al. 1974 and in prep.). In Washington State 27% of the 33 Pigeon Guillemot colonies are in piers or other anthropogenic structures (Speich and Wahl 1989). Establishment of a Pigeon Guillemot colony at the SeaLife Center will demonstrate the utility of direct restoration in assisting the recovery of Pigeon Guillemot populations in the northern Gulf of Alaska. If artificial nest sites are successful in attracting breeding adults and if successful reproduction ensues, artificial nest sites can be used in Prince William Sound to enhance productivity, recruitment, and immigration, all of which will facilitate recovery. Clusters of artificial nest sites similar to those at the SeaLife Center can be installed near natural colonies that suffer from chronically high nest predation rates. Nests could be placed on pilings or "dolphins" constructed specifically for colony development.

Aside from providing a prototype for artificial colonies in other parts of the EVOS area, a breeding colony of free-ranging guillemots at the SeaLife Center will allow investigators to conduct research on Pigeon Guillemots that would not be possible at natural colonies. Loss of eggs or chicks to predation has been a major source of nest failure in post-spill studies of Pigeon Guillemots in Prince William Sound (Hayes 1995). In addition, marked adults and returning young will allow an examination of demographics that has not been possible in Prince William Sound studies. A lack of recovery could be due to demographic parameters (e.g., adult survival, subadult survival, immigration/emigration rates) not evident in studies of nesting success or colony censuses. Guillemot demographics are much more easily studied at a colony of artificial nest sites where the banding of chicks and adult entails far fewer problems than at natural colonies. Should the proposed work result in the deployment and use of artificial nest sites in Prince William Sound, investigators will be able to obtain demographic information for that area that could explain the lack of recovery of local populations.

While the proposed colony of Pigeon Guillemots to be established at the SeaLife Center will have the benefit of captive-reared chicks returning to their natal location and assisting in establishment of the colony, immigration is obviously the source of birds founding new colonies. Immigrants can also be the primary source of recruits to established and expanding colonies (Petersen 1981). Unlike many seabirds, guillemots are semi-colonial and able to breed as single pairs as well as colonially. Prospecting guillemots can be expected to search for nesting opportunities more extensively than more colonial seabirds, which require numbers of conspecifics for successful breeding. Nest sites at the SeaLife Center are likely to attract nonbreeding prospectors from the approximately 100 pairs of Pigeon Guillemots breeding between Aialik Cape and Cape Resurrection (Nishimoto and Rice 1987), as well as more distant colonies. An expanding colony of Black Guillemots in arctic Alaska drew most of its recruits from colonies more than 400 km distant (Divoky, in prep.)

A Pigeon Guillemot colony could also have the potential of attracting other seabird species to nest in the area of the SeaLife Center. Some of these other species may also be recruited by nest site provisioning. A Black Guillemot breeding colony that utilized artificial nest sites in arctic Alaska has also attracted Horned Puffins (*Fratercula corniculata*), some of which used the artificial nest sites by the late 1980's (Divoky 1982 and unpubl.).

The research component of the study will allow evaluation and validation of the use of nondestructive biomarkers (in blood and excreta) to assess the health status of individual guillemots and potential exposure to petroleum hydrocarbons. There is evidence that certain acute phase proteins (i.e., haptoglobin) in blood and porphyrins in excreta and induced by ingestion of sublethal doses of weathered crude oil (Prichard et al., in press). The results of a dose-response experiment with wild guillemot nestlings in their natural nest sites, however, were ambiguous because of variability in baseline values for biomarkers among sites (Prichard 1997). Also, guillemot nestlings were fed small doses (0.05-0.2 ml) of highly weathered PBCO; these doses were not sufficient to cause a significant decline in growth rates of nestlings. Finally, blood samples for measuring biomarker levels were not collected until five days post-dosing, when any induction of an acute phase response may have passed. While the use of blood and fecal biomarkers for monitoring oil exposure and general population health of guillemots is promising, more research under controlled, captive conditions is required to validate the techniques and provide a sound basis for interpretation of results from wild guillemots.

There is a definite need for information on the relationship between diet and reproductive success for Pigeon Guillemots, a seabird species that is failing to recover from EVOS at an acceptable rate (1994 *Exxon Valdez* Oil Spill Restoration Plan). Guillemots are the most neritic members of the marine bird family Alcidae (i.e., murres, puffins, and auks), and like the other members of the family, capture prey during pursuit-dives. Pigeon Guillemots prey on a wide variety of fishes,

including schooling forage fish (e.g., sand lance, herring, pollock) and subtidal/nearshore demersal fish (e.g., blennies, sculpins; Drent 1965, Kuletz 1983). There is strong evidence of a major shift in diet composition of guillemot pairs breeding at Naked Island. Sand lance were the predominant prey fed to young in the late 1970's (Kuletz 1983), but currently sand lance is a minor component of the diet (D. L. Hayes, unpubl. data). In contrast, guillemots breeding in Kachemak Bay continue to provision their young predominately with sand lance, and sand lance is particularly prevalent in the diet at sites that support high densities of breeding pairs (Prichard 1997). Also, young of breeding pairs that provision their nestlings with most sand lance have higher growth rates (Prichard 1997). Jackpot Island in southwestern Prince William Sound supports the highest nesting densities of guillemots anywhere in the Sound and growth rates of nestlings are correspondingly high. The high availability of juvenile herring to guillemots nesting at Jackpot Island may be responsible for both the high nesting density and high growth rates. Thus availability of high quality schooling forage fishes (herring, sand lance) may be crucial for maintaining high nesting densities of highly productive guillemots.

C. Location

Pigeon Guillemot nestlings will be raised in captivity at the SeaLife Center in Seward. Guillemot nestlings will be hatched from eggs obtained from source colonies on Kodiak Island or at other appropriate Gulf of Alaska colonies. Most of the captive-reared fledglings will be banded and released at the SeaLife Center to assist in efforts to establish local breeding colonies of free-ranging guillemots at the SeaLife Center. Artificial nest sites will be constructed outside of the SeaLife Center on the Center's grounds and on an adjacent dock and breakwall to enhance the prospects for colony establishment. Colonies in Resurrection Bay that may serve as sources of immigrants or may recruit captive-reared guillemots will be censused and checked for banded adults annually during the three years of the project. The information obtained from this project will benefit Pigeon Guillemot populations in the Gulf of Alaska, especially Prince William Sound. An understanding of the affect of prey type on chick growth will help explain the role of ecosystem shifts in continuing declines of Pigeon Guillemot populations. Assessing the utility of blood biomarkers for detecting and quantifying exposure to crude oil will benefit efforts to monitor the health of Pigeon Guillemot populations throughout the spill zone.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

All research will be conducted at the SeaLife Center, which will allow the community in and around Seward to observe progress in the establishment of a guillemot colony in artificial nest sites. The wild breeding colony outside of the SeaLife Center has the potential for involving science classes from local schools. The location of the colony will allow easy viewing by the

public and allow science teachers to use the colony for teaching about seabird breeding biology and restoration. Science classes could conduct observations on the occurrence and activities of prospecting and breeding guillemots. Some of these (timing of arrival in the spring and sightings of color banded adults) could provide important information for the period when the investigators are not in Seward. Local science teachers can receive annual summaries of information about the colony (e.g., timing of clutch initiation, breeding success) that can provide the basis for lessons on regional climate change and annual variability in the marine environment. The Seaquest Program of the Chugach School System would be a logical avenue for presenting this material to students.

PROJECT DESIGN

A. Objectives

This research project has three primary objectives listed below. During the first year of the project (CY 98), the emphasis will be on achieving Objective 1, with pilot studies to address Objectives 2 and 3.

1. Determine the feasibility of using direct techniques for restoration of Pigeon Guillemots, including:

   a) providing artificial nest sites

   b) use of social attraction, such as decoys and playbacks of vocalizations

   c) release of captive-reared young

2. Determine the response of particular guillemot biomarkers of crude oil exposure (acute phase proteins, plasma sodium, fecal porphyrins) to variables of exposure, and the survival of exposed nestlings post-fledging. Exposure variables that will be examined include:

   a) dose of ingested oil

   b) degree of weathering of ingested oil

   c) time since ingestion of dose

   d) frequency of exposure

3. Determine the effect of diet variables on growth performance, development, fledging condition, and post-fledging survival of Pigeon Guillemots, including:

a) relative proportions of schooling forage fishes vs. nearshore demersal fishes

b) lipid content of the diet

c) size of prey items

d) frequency of prey delivery

B. Methods

The proposed work will test the following three basic hypotheses, which relate to each of the three primary objectives listed above:

Hypothesis 1. Artificial nest sites, decoys, and playbacks of vocalizations can be used to establish new Pigeon Guillemot breeding colonies and enhance breeding success over that experienced in natural nest sites.

Hypothesis 2. Biomarkers from the plasma and excreta of Pigeon Guillemots can be used as indicators of exposure to weathered crude oil, and the subsequent survival of young guillemots post-fledging.

Hypothesis 3. Growth performance, fledgling condition, and post-fledging survival of Pigeon Guillemots are sensitive to differences in prey type, prey size, feeding frequency, and lipid content of prey.

Methodology employed during the first year of the study (CY 98) will consist of the following:

Objective 1: Testing Feasibility of Direct Restoration Techniques

a. Installation of Artificial Nest Sites and Use of Social Attraction

Pigeon Guillemot nest sites will be constructed and installed at three locations on and adjacent to the SeaLife Center: (1) under the Institute of Marine Science dock, (2) on top of the remnants of a breakwall in front of the SeaLife Center, and (3) on the seaward wall of the SeaLife Center. Five nest sites and three to five decoys will be placed at each location. Additional nest sites will be provided when the number of breeding birds and prospecting adults exceeds 15 pairs. Design of the artificial nest sites will be based on the sites developed by Divoky for Pigeon Guillemots in Puget Sound, with modifications based on studies of nest site characteristics that are associated with nesting success in Kachemak Bay (Prichard 1997). Sites will have two entrances with a central nesting cavity. Baffles in the entryways to the nest cavity will prevent avian predators from viewing nest contents. Based on the locations of Pigeon Guillemot nest sites associated with docks and piers, it appears that placing the sites beneath an overhang will increase their attractiveness to guillemots prospecting for nest sites. Sites under an overhang apparently have the advantage of decreased avian predation. Sites will be large enough to accommodate monitoring devices (such as a closed circuit camera, platform scale, or activity monitor) that may be used in future research.

Guillemot decoys will be made from waterfowl decoy kits. A tape recorder or CD player with external speakers will be used to play adult Pigeon Guillemot calls from March to late August. Because prospectors may make recruitment decisions based on local breeding productivity (Boulinier et al. 1996), from late June to late August the calls of chicks in nest sites will also be played during the early morning and evening, when colony attendance can be expected to be highest. Similar combinations of decoys and audio playbacks have been used successfully for other seabird species (Kress and Nettleship 1989, Kress 1983).

Guillemots may begin prospecting for nest sites as early as March and nest sites and decoys will be deployed in early March 1998. Personnel from this project will not be present at the SeaLife Center during most of March and April and staff from the SeaLife Center will be asked to make incidental observations of any guillemots associating with the nest sites or decoys during our absence. All of the nest sites and decoy placements will be visible from the SeaLife Center. We will begin systematic observations of the nest sites and decoy sets in early May. Daily observations will be conducted at the times expected to have maximum colony attendance (0200-0900 and 1600-2000 Alaska Daylight Time, high tides). Initially observations will be made every 15 minutes on the number of Pigeon Guillemots visible from the roof of the SeaLife Center and their distance from artificial nest sites. Once guillemots begin associating with decoys and nest sites, we will conduct detailed observations on the behavior of prospecting birds. The location and activities of prospectors will be recorded during 15-minute periods. Behavioral observations will be similar to those conducted by Preston (1968) on Black Guillemot social behavior. In the initial stages of the study, when the sighting of any guillemots associating with

the nest sites will be important, we will attempt to use a closed-circuit television camera to monitor activity while project personnel are in the SeaLife Center.

b. Monitoring of Pigeon Guillemot Breeding Biology and Demographics

Should breeding occur in the artificial nest sites in 1998, we will obtain information on the breeding biology of birds using the nest sites. To reduce the chances of nest site abandonment, no adults will be captured during 1998. In later years we will attempt to noose breeding adults for banding. In 1998 the following breeding parameters will be monitored:

- date of clutch initiation
- egg weight and volume
- egg color and pattern
- date of hatching
- weight at hatching
- hatching success
- growth rate (measured every two days)
- fledging weight
- fledging age
- fledging success

The observations on breeding chronology and success can be compared with ongoing field studies of Pigeon Guillemot nesting in Prince William Sound and Kachemak Bay. Additionally the information on egg size and color can be used in future years to assess the potential of using egg characteristics to measure female survival and recruitment.

During the nestling period we will conduct observations on the prey types delivered to chicks. These observations will determine the taxonomic composition of nestling diets at each nest and collectively. These observations will be compared with diet data from Prince William Sound and Kachemak Bay (Hayes 1995, Prichard 1997).

c. Captive-rearing of Chicks

Guillemot eggs will be collected in May, during the laying period or early in incubation. Eggs will be collected from nests on Kodiak Island or other locations in the Gulf of Alaska. Collection will occur as soon as possible after clutch completion. Guillemots frequently relay when a clutch is lost within a few days of clutch completion (Divoky, unpubl.), and taking eggs early in incubation would reduce the impact on productivity of the host colony. Additionally, the sensitivity of embryos to lapses in incubation increases during development, and transporting eggs in the early stages of development should increase hatching success. Eggs will be transported to the SeaLife Center and incubated in Hovabater incubators until hatching. We

prefer to collect and transport eggs rather than chicks partly so that all the conditions influencing post-natal growth can be controlled in the lab. In addition, chicks translocated late in the nestling period display philopatry to the location of hatching, instead of fledging (Serventy 1967, Fisher 1971).

The source colonies for eggs have yet to be determined. Olga Bay on Kodiak Island has an estimated population of 100 pairs of Pigeon Guillemots breeding in an abandoned cannery building. We will attempt to obtain 50 eggs in each year of the project and hope to release 40 captive-reared chicks into the wild annually. Assuming a level of philopatry similar to that observed for Black Guillemots (Divoky, in prep.), 35% of fledging chicks should return to the SeaLife Center with each cohort providing >10 potential recruits. If all surviving captive reared guillemots recruit at the natal location, a colony of > 20 pairs should be present by 2004, even if the sites do not attract immigrants before that time.

d. Release of Captive-reared Chicks

Guillemots fledge at night as early as 30 days after hatching, with most fledging after 35 days (Hayes 1995). Fledglings are able to fly at the time of nest departure and are independent of parental care post-fledging. When captive-reared chicks reach 32 days of age, they will be moved in their containers to the roof of the SeaLife Center. The covers will be removed from the buckets after sunset and chicks provided the opportunity to fledge. To insure that no predation by gulls occurs, project personnel will attend the chicks whenever they are on the roof. Fledglings will be taken to the roof nightly until all have fledged. Fledglings will be banded with a stainless steel U.S. Fish and Wildlife band and a unique combination of color polyvinyl chloride bands to allow individual identification at a distance. The latter will be sealed with an adhesive to reduce band loss.

e. Assessment of Size and Productivity of Pigeon Guillemot Colonies in Resurrection Bay

An census of guillemot colonies in Resurrection Bay and adjacent areas will facilitate understanding of the conditions contributing to the establishment of a colony at the SeaLife Center. Immigration constituted the majority of recruits at a colony of Black Guillemots in arctic Alaska that was enhanced using artificial nest sites, and birds fledging from local natural colonies that have yet to breed can be expected to prospect the sites at the SeaLife Center. To assess the size of these potential source populations and their annual productivity we will attempt to census as many local colonies as possible and, when possible, determine breeding productivity. We have not budgeted for transportation to these sites but will attempt to visit them on tour boats, National Park Service vessels, or on foot (Caine's Head). Personnel from the Kenai Fjords National Park have indicated they may provide space on their vessels for this purpose.

If it appears that Pigeon Guillemot nest sites can be accessed at these colonies, we will attempt to band nestlings. Resightings of these guillemots at the SeaLife Center will provide information on dispersal distance for this species. Intercolony visits are common for prebreeding alcids (Harris 1983, Kress and Nettleship 1989), and in 1999 and 2000 we will search these colonies for banded individuals that were raised in captivity at the SeaLife Center.

f. Work with SeaLife Center Personnel on Development of a Population of Guillemots Breeding in Captivity

The staff of the SeaLife Center is developing a captive-breeding population of Pigeon Guillemots and there are several potential areas of cooperation between their work and our proposed activities. If the number of chicks raised to fledging age in 1998 is sufficiently large, a small number could be donated to the Center's captive breeding population. Once the captive population is established it can be a source of eggs or chicks for our proposed research on captive chicks. Chicks raised from eggs produced by the captive population have the potential of being released into the wild and displaying philopatry to the SeaLife Center, thus providing potential recruits to the wild breeding population.

The captive colony also has the potential for providing information on guillemots that will assist with interpretation of the findings of our proposed work and knowledge of guillemots in general. We would work with the SeaLife Center's staff to make them aware of the potential importance of these observations. Many of these observations can be made during normal maintenance of the breeding population. Examples of the types of observations include:

1) Growth rate of chicks post-fledging

Guillemot chicks fledge at approximately 90% of adult weight and wing length. No studies have been conducted on post-fledging growth and no one has examined changes in guillemot weight and wing length from fledging to age of first reproduction.

2) Molt progression from fledgling to breeding.

Guillemots retaining remnants of basic (winter) plumage into the breeding season are assumed to be first-year birds by most authors (Petersen 1981, Asbirk 1979). Sightings of these birds are frequently used to assess the number of first-year birds visiting breeding colonies. However, some first-year birds can have complete alternate (breeding) plumage and second-year birds can also retain basic plumage into the breeding season (Divoky, in prep.). If personnel at the SeaLife Center document the molt progression of all captive guillemots from fledging to attainment of full adult alternate plumage, they can determine the utility of aging guillemots from plumage characteristics.

3) Period of flightlessness during wing molt

All large alcids typically undergo a molt of all flight feathers at the end of the breeding period (Ewins 1988). While seabirds are especially vulnerable to oil pollution during this period (they cannot fly and are more likely to come in contact with a spill), the number of days individuals are flightless is unknown. Such information would be important in assessing the potential impact of a spill in late summer or early fall. Personnel of the SeaLife Center will probably be able to observe the flightless period for several individuals each year and obtain information about the length of the flightless period.

Objective 2. Validation and Calibration of Nondestructive Biomarkers for Monitoring the Health and Exposure to Oil of Guillemots

a. Measurement of Baseline Values for Certain Blood Biomarkers of Petroleum Hydrocarbon Exposure

In the first year of this study (CY 98), research on blood biomarkers will be limited to collecting blood samples from chicks raised in captivity at 20, 25, and 30 days post-hatch and measuring haptoglobin and other acute phase protein levels in plasma samples in order to determine baseline values and variability. Blood samples (ca. 1 cc) will be obtained nondestructively via brachial vein puncture and blood will be centrifuged immediately and plasma frozen for later analysis. Assays for blood biomarkers will be conducted in the laboratory of Dr. Larry Duffy at the University of Alaska Fairbanks. Blood biomarker levels will be compared among the four diet groups (see below) to assess the role of diet in determining biomarker levels in blood.

b. Measurement of Baseline Values for Biomarkers in Excreta

In addition to collection of blood samples, samples of excreta will be collected at 20, 25, and 30 days post-hatch in order to measure fecal porphyrin levels and determine baseline values and variability. As with blood biomarkers, fecal porphyrin levels will be compared among the four diet groups. Measurements of fecal porphyrins in excreta will be conducted in the laboratory of Dr. Larry Duffy at the University of Alaska Fairbanks.

Objective 3. Captive Feeding Trials to Assess the Relationship between Diet and Postnatal Development in Guillemots

a. Comparison of Guillemot Growth Performance on Diets of Nearshore Demersal Fish vs. High-lipid Schooling Forage Fish

In CY 98, guillemot chicks will be raised on one of four diets: (1) 100 g of crescent gunnels per day, (2) 100 g of herring per day, (3) 150 g of crescent gunnels per day, 150 g of herring per day. Both of these prey species are major components of guillemot chick diets at

certain sites and the two species are representative of the two primary prey types in guillemot diets: nearshore demersal fishes and schooling forage fishes. These daily rations are designed so as to provide a variety of caloric and biomass consumption rates that are within the normal range experienced by guillemot nestling. The rations are also designed so that isocaloric diets of gunnels and herring (150 g of gunnels and 100 g of herring) can be compared. Each chick will be kept in a separate cage so that food consumption can be monitored individually. The daily rations will be provided in six daily feedings at about 0700, 1000, 1300, 1600, 1900, and 2200 Alaska Daylight Time. Each day at approximately the same time the body mass, wing length, and outer primary length of each chick will be measured until each chick is 35 days post-hatch, when captive-reared chicks are capable of fledging and will be released into the wild. Return rates of subadults in the third year of this study will allow us to assess the role of prefledging nutrition and fledging condition on subsequent post-fledging survival.

CY 1999 and 2000

In 1999 and 2000 all of the direct restoration activities listed above for 1998 will be conducted, with the addition of monitoring the survival and site and mate fidelity of any banded birds breeding in the wild colony the preceding year. Additionally, after 1998 we will attempt to locate birds from the SeaLife Center at regional colonies during our surveys.

Also in 1999 and 2000, we will conduct dose-response experiments with captive-reared guillemot chicks to validate the use of certain biomarkers for assessing the health status and oil exposure of wild guillemot chicks. These experiments will emphasize acute phase proteins, such as haptoglobin and hemaplexin, which are known to be induced in birds in response to disease, trauma, or other stress. A range finding experiment will be conducted to determine the no-effect dose for guillemot chicks consuming weathered PBCO. We will also determine the time course of biomarker response to ingestion of PBCO, including the time post-ingestion when biomarker induction is no longer detectable. Finally, we will investigate the role of weathering in reducing the toxicity of PBCO by comparing results of dose-response experiments using PBCO that has been weathered for different periods. Small sample sizes of dosed and undosed (control) chicks will be sacrificed for measurement of CP-450 levels in liver tissues and to examine nasal gland tissues for hypertrophy.

Captive feeding trials in 1999 and 2000 will continue to investigate the relative quality of various prey types commonly fed to guillemot chicks by their parents. Additional experiments will be designed to explore the tradeoffs for guillemot nestlings of meal size, meal frequency, and meal quality. This will be accomplished by raising guillemot chicks on isocaloric rations (same number of calories ingested per day) of large or high energy density prey fed infrequently vs.

small or low energy density prey fed frequently. The growth rates and fledging condition of chicks raised on these various diets will be compared, and subsequent survival post-fledging will be assessed from return rates of captive-reared adults to the natal site. Small samples of chicks raised on the different diet regimes will be sacrificed to measure body composition using proximate analysis techniques. The results of these captive feeding trials will enable us to interpret guillemot diet data that are collected as part of long-term monitoring activities and assess the availability and quality of forage fishes for breeding guillemots.

Approval of the field protocols for work with live birds described in this DPD will be obtained from the Institutional Animal Care and Use Committee at Oregon State University. Any take of eggs or incidental/unintentional take of nestling or adult guillemots will be covered by relevant Federal and State Scientific Collecting permits. All fledgling, captive-reared guillemots released to the wild will be banded with USFWS stainless steel leg bands and polyvinyl chloride colored leg bands under a Master Station banding permit held by the Oregon Cooperative Wildlife Research Unit.

C. Contracts and Other Agency Assistance

Laboratory analyses of the biochemical composition and energy content of forage fishes fed to captive guillemots and the proximate composition of chick carcasses will be conducted in the laboratory of the PI at Oregon State University.

Maintenance of guillemot breeding stock in captivity during the non-breeding season (September - April) will be accomplished by the staff of the SeaLife Center.

Analyses of biomarkers in blood plasma and fecal samples will be conducted in the lab of Dr. Lawrence K. Duffy at the University of Alaska Fairbanks, where the expertise is available to perform this task.

SCHEDULE

A. Measurable Project Tasks for CY 98 (May 1, 1998 - April 30, 1999)

March 1 - May 15: Install artificial nest sites, decoys, and playback sound equipment at SeaLife Center.

May 15 - August 31: Collect field data on guillemot use of artificial nest sites, raise guillemot nestlings in captivity, conduct captive rearing experiments, and release

captive-reared fledglings.

Sept. 1 - Dec. 31:	Enter, analyze, and interpret field data and data collected from captive-reared chicks. Conduct laboratory analyses of plasma samples, diet samples, and chick carcass samples.
January 1 - 14:	Prepare for Annual Restoration Workshop
January 15 - 24:	Attend Annual Restoration Workshop and present FY 98 results to peer reviewers.
Jan. 24 - April 14:	Prepare 1998 annual report of findings.
April 15:	Submit annual report (FY 98 findings) Submit FY 99 DPD to Trustee Council
March 16 - April 30:	Arrange logistics and prepare for FY 99 field season and captive-rearing experiments.

B. Project Milestones and Endpoints

CY 98

May 15, 1998	Installation of artificial nest sites, decoys, and audio equipment at SeaLife Center
August 31, 1998	Completion of first field season, release of first cohort of captive-reared nestlings, collection of baseline blood and fecal biomarker samples, completion of captive-feeding trials comparing nestling growth performance on schooling forage fish vs. nearshore demersal fish.
April 30, 1999:	Completion of first annual report of findings

CY 99

August 31, 1999	Completion of first year of a two-year experimental study of the role of diet on nestling growth performance and dose-response experiments with ingested crude oil

CY 00

August 31, 2000	Completion of field work and Objective 1

CY 01

June 30, 2001:	Completion of M.S. thesis
September 30, 2001	Completion of Objectives 2 and 3 and submission of manuscripts addressing these objectives

C. Completion Date

The anticipated completion of this project will be early in FY 02, at the end of calendar year 2001. This will allow adequate time to complete data analysis, thesis preparation by the Masters student, and manuscript preparation and submission following the last field season in 2000 and completion of laboratory analysis early in 2001.

PUBLICATIONS AND PROJECT REPORTS

The following publications are projected for this research project (this is a rough projection and by no means complete):

An annual report for the first year of this project will be submitted by 15 April 1999. The final report for this project will be submitted 15 December 2001. At least three manuscripts will be generated from this research, and all will be published in the peer-reviewed scientific literature. Each of these three manuscripts will address one of the three major objectives/hypotheses of this study: (1) guillemot colony establishment as a direct restoration technique, (2) biomarkers as a means of assessing exposure of guillemots to crude oil, and (3) diet as a factor in nestling growth and post-fledging survival. A portion of the final report will be excerpted from the thesis of the M.S. student on this project. This student will be strongly encouraged and directly assisted by the PI to submit for publication in the peer-reviewed scientific literature the results from this research.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The research described in this proposal takes advantage of the new research facilities and potential represented by the Alaska SeaLife Center and dove-tails nicely with continuing research as part of the APEX and NVP projects that assesses factors limiting recovery of Pigeon Guillemot populations damaged by EVOS. It is also relevant to efforts toward developing seabird models as upper trophic level sentinels of oil pollution in nearshore ecosystems. The proposed research approach utilizes growth performance, fledgling body condition, and blood and fecal biomarkers to assess the health status of guillemot nestling exposed to oil and raised on different diet rations. These data are essential for developing techniques for long term monitoring of the health and status of guillemot populations in the EVOS area.

Studies of foraging, reproduction, and population recovery following the EVOS are on-going for pigeon guillemots. This proposal complements and enhances other studies on pigeon guillemots, without duplication of effort. The PI on the present proposal has been and will continue to work closely with David Irons and Greg Golet (PIs on APEX Component 98163 F "Factors Affecting Recovery of PWS Pigeon Guillemot Populations"), Dave McGuire (Co-PI on NVP studies of biomarkers of oil exposure in guillemot nestlings), and John Piatt (PI on APEX Components 98163 M "Lower Cook Inlet Forage Fish Studies and 98163 N Black-legged Kittiwake Feeding Experiment") in developing protocols for collecting data.

PRINCIPAL INVESTIGATOR

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The PI has extensive experience with studies of the reproductive biology of high latitude seabirds and the relationship between diet composition and productivity. He is currently the PI of the Seabird Energetics component (Component G) of the APEX Project and Co-PI of the Diet Quality and Chick Growth component (Component N) of the APEX Project. He has been involved in research on the factors constraining recovery of Pigeon Guillemots in the EVOS area for the last three years.

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Revised TC 6-27-97
Approved TC 8-6-97

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$109.7
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$109.7
General Administration		$7.7
Project Total	$0.0	$117.4
Full-time Equivalents (FTE)		0.0

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Dollar amounts are shown in thousands of dollars.					
Other Resources					
Project Total	$159.5	$168.8	$95.1		

Comments:
Prepared by Lisa Thomas USGS-BRD See forms 4A&B for detail.

Note: Estimates for years '99-'01 are based on calculations done by the EVOS Restoration Office and have been inserted above.

Total project funding:

$117.4
+ 5.9 bench fees ASLC
$123.3

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SEP 25 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

1998

Project Number: 98327
Project Title: Pigeon Guillemot Restoration Research at the Seward Sealife Center
Lead Agency: USGS-BRD

FORM 3A
TRUSTEE
AGENCY
SUMMARY

9/22/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1998
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
					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

1998

Project Number: 98327
Project Title: Pigeon Guillemot Restoration Research at the Seward Sealife Center
Lead Agency: USGS-BRD

FORM 3B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
Linkage with forms 4A&B	109.7
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$109.7

Commodities Costs:	Proposed
Description	FY 1998
Commodities Total	$0.0

1998

Prepared:

Project Number: 98327
Project Title: Pigeon Guillemot Restoration Research at the Seward Sealife Center
Lead Agency: USGS-BRD

FORM 3B
Contractual & Commodities DETAIL

9/22/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
			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

1998

Project Number: 98327
Project Title: Pigeon Guillemot Restoration Research at the Seward Sealife Center
Lead Agency: USGS-BRD

FORM 3B
Equipment
DETAIL

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$28.9
Travel		$6.6
Contractual		$41.2
Commodities		$9.4
Equipment		$0.0
Subtotal	$0.0	$86.1
Indirect		$23.6
Project Total	$0.0	$109.7
Full-time Equivalents (FTE)		15.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
	$149.1	$157.8	$88.9		

Dollar amounts are shown in thousands of dollars.

Comments:

Indirect rate for OSU is 42.5% of Modified Total Direct Cost (MTDC=Direct cost- assistanship and equipment) on-campus research rate and 26% of MTDC off-campus research rate.

~~Not included in this budget is bench space for the Seward Sealife Center estimated by John Hendricks at $870/mo for use of office space (4 months) and lab space (3 months). Total= $25.3K~~ See final page of budget.

Prepared by Lisa Thomas USGS-BRD 6/26/97

1998

Prepared: 5 of 8

Project Number: 98327
Project Title: Pigeon Guillemot Restoration Research at the Seward Sealife Center.
Name: Oregon State University
Agency: USGS-BRD Contractor

FORM 4A
Non-Trustee
SUMMARY

9/22/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
	Graduate Student (Ph.D.) stipend		9.0	1.5		13.5
	Graduate Student salary- field season		3.0	1.6		4.8
	Research Assistant-field season		3.0	1.5		4.5
	Student Assistantship					6.1
	Subtotal		15.0	4.6	0.0	
					Personnel Total	$28.9

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
Corvallis/Seward/Corvallis	0.6	4			2.4
Anchorage/Olga Bay/Anchorage	0.5	4			2.0
Anchorage per diem			6	0.1	0.6
Restoration Workshop Corvallis/Anchorage/Corvallis	0.5	2			1.0
per diem while at Restoration Workshop			6	0.1	0.6
					0.0
				Travel Total	$6.6

1998

Project Number: 98327
Project Title: Pigeon Guillemot Restoration Research at the Seward Sealife Center.
Name: Oregon State University
Agency: USGS-BRD Contract

FORM 4B
Personnel
& Travel
DET

epared:
/22/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
Personal Services Contract to George Divoky	25.0
Housing in Seward for 3 persons (4 mo @75$/day)	9.0
Lab/Office space estimated at 25K	
duplication/computer fees	0.5
lab analyses of blood and excreta samples for biomarkers (L. Duffy, UAF)	3.5
samples shipping	0.5
publication- reports and visual aids	0.2
vehicle rental Anchorage to Seward	0.7
field equipment maintenance	0.8
phone services- long distance charges	1.0
Contractual Total	$41.2

Commodities Costs:	Proposed
Description	FY 1998
chick rearing cages	0.5
nest boxes/sites	1.0
decoys, playbacks, other social attractants	1.0
binoculars, spotting scopes, tripods for observing guillemots at Sealife Center	0.0
egg collecting equipment	0.3
incubators	0.3
blood sample collection supplies	1.0
food for personnel at Seward (3 persons, 16 wk@$200/wk)	3.2
Ohaus top-loading balance, battery-powered	0.6
food for chicks	0.8
bands and banding supplies	0.2
miscellaneous supplies for captive rearing	0.5
Commodities Total	$9.4

1998

Project Number: 98327
Project Title: Pigeon Guillemot Restoration Research at the Seward Sealife Center.
Name: Oregon State University
Agency: USGS-BRD Contractor

FORM 4B
Contractual & Commodities DETAIL

Prepared: 9/22/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
			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
analytical balance	1
drying ovens	3
Soxlet apparatus	2
muffler furnace	1
freezers	2
zodiac and motor (from APEX project we hope)	1

1998

Prepared:

Project Number: 98327
Project Title: Pigeon Guillemot Restoration Research at the Seward Sealife Center.
Name: Oregon State University
Agency: USGS-BRD Contractor

FORM 4B
Equipment
DETAIL

'/22/97

1998 EXXON VALDEZ TRU[illegible]COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$0.0
Travel		$0.0
Contractual		$5.5
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$5.5
General Administration		$0.4
Project Total	$0.0	$5.9
Full-time Equivalents (FTE)		0.0

LONG RANGE FUNDING REQUIREMENTS					
	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	

Dollar amounts are shown in thousands of dollars.

Other Resources

Comments:

Contractual funds are for bench fees at the Alaska SeaLife Center.

1998

Prepared: 1 of 1

Project Number: 98327
Project Title: Bench Fees: Pigeon Guillemot Research at ASLC
Agency: ADFG

FORM 3A
TRUSTEE
AGENCY
SUMMARY

9/9/97