Project Title: Port Graham Pink Salmon Subsistence Project

Project Number:	97225
Restoration Category:	General Restoration
Proposer:	Port Graham IRA Council
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	Port Graham IRA Council
	Alaska SeaLife Center
Duration:	2nd year, 5 year project
Cost FY 97	80,400
Cost FY 98	$77,200
Cost FY 99	$79,500
Cost FY 00	$82,000
Geographic Area:	Port Graham, lower Cook Inlet
Injured Resource/Service:	Pink Salmon/Subsistence

ABSTRACT

This project will help supply pink salmon for subsistence use in the Port Graham area during the broodstock development phase of the Port Graham hatchery. Because local runs of coho and sockeye salmon, the more traditional salmon subsistence resource, are at low levels pink salmon are being heavily relied on for subsistence. This project will help ensure that pink salmon remain available for subsistence use until the more traditional species are rejuvenated.

Introduction

This project will help underwrite the hatchery production of pink salmon for subsistence use in Port Graham. Normally pink salmon are not heavily utilized for subsistence. However, with the local sockeye run currently closed to all fishing and the coho subsistence harvest at about 15% of its historic level, pink salmon have played a major role in the subsistence harvest in recent years. Unfortunately, the pink run to Port Graham is also suffering. Escapement into the Port Graham River has barely met the minimum goal for three of the last four years (the 1991 return was somewhat better).

A salmon hatchery is being developed in Port Graham. Its principal mission is to build the pink salmon run back up to levels that will allow commercial exploitation. When this objective is achieved the impact of the subsistence harvest on pinks will be negligible. At this point in time however, the subsistence harvest has a significant impact. The hatchery is in the broodstock development phase. The more eggs that are put in incubation the faster the hatchery will achieve its goals. The low pink returns to the Port Graham River coupled with the subsistence harvest on the hatchery returns is limiting the number of eggs that can be put in the hatchery and extending the time it will take for the hatchery to build the broodstock it needs to become self sufficient.

The EVOS clean-up effort had a negative impact on the Port Graham pink salmon as it did on the local coho and sockeye runs. Boom deployment during the early phases of the clean-up trapped a large number of outmigrating pink salmon fry in the boom curtain on the ebbing tides causing high levels of mortality. It is possible that these losses are contributing to the poor even year returns that have been experienced recently.

This project is a small piece of the overall Port Graham pink salmon enhancement program. It comprises about a third of the overall Port Graham pink salmon enhancement budget. Port Graham pink salmon enhancement program complies with all state policies governing salmon enhancement activities including disease, genetics and harvest management. All required reviews and permits have been obtained for the hatchery program including this project. This project is designed to become self-sustaining beyond the development stage which is currently estimated to occur by the end of the decade.

NEED FOR PROJECT

A. Statement of Problem

The salmon runs to the Port Graham area are at a low levels, partly as a result of the *Exxon Valdez* oil spill. As a consequence it has become more difficult for Port Graham villagers to meets their subsistence needs for salmon. Because of their four to five year life cycles, it will take a long time for the sockeye and coho runs to rebuild. A large number of the pink salmon that are being produced by the hatchery now being developed in Port Graham are being taken in the

local subsistence fishery. Although the subsistence harvest of hatchery fish is helping to make up for the lack of wild fish, it is making it far more difficult for the hatchery to develop the broodstock it needs to become self sufficient. Unless the schedule for developing broodstock can be maintained, the hatchery will lose its positive benefit/cost ratio and may have to be closed.

It is appropriate that the hatchery contribute pinks to the subsistence fishery. However, extraordinary methods will need to be employed for the hatchery to provide for the subsistence fishery as well as maintain its broodstock development schedule. These will include procedures to enhance the survival of juvenile pinks released from the hatchery, and coordinating with ADF&G to maximize the number of wild adult pink salmon returning to Port Graham that can be collected for broodstock.

B. Rationale/Link to Restoration

The importance of subsistence to the Native villages in the oil spill area has been recognized by the EVOS Trustee Council in its November 1994, *Exxon Valdez Oil Spill Restoration Plan.* This project will help preserve the subsistence lifestyle in Port Graham by providing additional salmon for subsistence needs. Harvest of these hatchery produced salmon will take pressure off the local wild runs; helping them in their recovery effort. Using an enhanced resource to replace harvest of an injured resource is an accepted strategy under the Restoration Plan.

C. Location

The project will be conducted at Port Graham with the bulk of the benefits accruing to the Port Graham village.

COMMUNITY INVOLVEMENT

This proposal is being submitted by the Port Graham IRA Council. The Port Graham hatchery is owned and operated by Port Graham Hatchery, Inc., an arm of the Port Graham IRA Council. It is hoped that the Port Graham IRA Council will manage this project under a contract with ADF&G.

PROJECT DESIGN

A. Objectives

Use the Port Graham hatchery to provide pink salmon for local subsistence use while maintaining the hatchery's pink salmon broodstock development schedule.

B. Methods

Two basic strategies will be employed to meet the objective. The first will be to supplement the ADF&G monitoring of the Port Graham pink salmon return and the second will be to enhance the juvenile to adult survival of the hatchery produced pink salmon through an extended rearing program. A brief discussion of each approach is given below.

The Port Graham River pink salmon run is the source of the hatchery broodstock. A program will be established to work closely with ADF&G in monitoring the pink salmon return to Port Graham each year in order to get as precise an estimate as possible on the wild and hatchery return. This program will supplement the normal management stream and bay surveys of Port Graham that ADF&G conducts. It will include additional stream surveys and closely monitoring the subsistence fishery harvest. This program will also establish regular lines of communications between Port Graham and ADF&G. By coordinating effort and keeping close track of the pink salmon return, it will be possible to maximize the harvest of pink salmon while ensuring that the Port Graham river pink salmon escapement goal is met.

The other aspect of this project involves holding rearing pink salmon fry until they attain an average weight of 1 grams before being released. After emerging from the incubators hatchery pink salmon fry are held and fed in saltwater pens before being released at the hatchery site to go to sea. Studies undertaken at the hatchery over the last three years indicate that pink salmon reared to 8 grams before being released had more than twice the survival of pink salmon fry that were only reared a short time (until the first major zooplankton bloom) before being released. Long term rearing of pink salmon is not cost effective in a normal hatchery operation. However, considering the relatively small number of pinks involved in this strategy and the need to enhance the survival as much as possible to allow for a subsistence take as well as broodstock development, the additional cost or rearing pinks to 8 grams makes fiscal as well as practical sense.

Studies undertaken at other pink salmon hatchery facilities in the state have indicate that rearing salmon to a minimum of one gram also greatly enhances survival at sea. There are two advantages to rearing pinks to only a one gram size. First, the smaller size (as compared to 8 grams) means a larger number of fry can be reared for the same amount of money. Second, the time required to raise fry to one gram is much less than 8 grams thus reducing the risk that the rearing fish may contract a disease or otherwise be injured or killed. Of particular concern is the potential for the rearing fish to contact "warm water vibrio", a highly infectious bacterial infection that pink salmon fry are susceptible to if reared in salt water warmer than 10° C.

During the FY 96 season a group of fry will be reared to the one gram average to see if this can be accomplished before the water temperature reaches 10° C. If this turns out to be the case the entire program may switch to the one gram size rather than risk a vibrio outbreak while rearing the fish to 8 grams.

SUPPLEMENTATION CRITERIA. This is a supplementation project. The following is a brief discussion of how the project fits under each of the supplementation criteria presented in the *Invitation to Submit Restoration Projects for Federal Fiscal Year 1996 and Draft Restoration Program: FY 96 and Beyond*, March 1995, pages 34-35.

Benefits of Supplementation. This project will provide additional pink salmon for harvest in the subsistence fishery in the Port Graham area. By shifting some of the subsistence harvest to hatchery salmon this project will help Port Graham wild salmon stocks recover from their present low levels.

Generic Risk. The Port Graham pink salmon hatchery program was reviewed by the ADF&G, CFMD Genetics Section who determined that the program (which includes this project) meets all criteria of the state Genetics Policy for Salmon Enhancement. The program (including this project) has been awarded a state Fish Transport Permit.

Mixed-stock Fishery. The potential for the Port Graham pink salmon hatchery program (including this project) creating or exacerbating a mixed stock fishery program is minimal. The harvest of Port Graham pink salmon are spatially and/or temporally separated from other Kachemak Bay pink salmon stocks as well as other salmon species. There is very little overlap. The same is true with the other salmon species that spawn in the Port Graham area.

Monitoring and Evaluation. A portion of the pink salmon reared to 8 grams will be coded wire tagged. The local fisheries and the hatchery egg take will be monitored for marked fish.

Economic Criteria. This project, especially long term rearing pink salmon fry to increase adult survival, will negatively impact the hatchery benefit/cost ratio. However, not doing this project would either cause a reduction in the overall subsistence harvest in Port Graham as well as put additional pressure on the wild stocks, and/or extend the hatchery broodstock development phase to the point where operating the hatchery stops making economic sense.

Procedural Criteria. All evaluations (Regional Salmon Planning Team, Coastal Project Certification) of the Port Graham hatchery program (including this project) have been conducted and all necessary permits (hatchery permit, fish transport permit, COE, DNR, CZM) have been obtained. This project has not been evaluated under the NEPA process.

C. Cooperating Agencies, Contracts and Other Agency Assistance

The Port Graham IRA Council will operate this project under a contract with ADF&G. The funds for stream survey air charters will be retained by ADF&G to supplement the normal management surveys of Port Graham.

SCHEDULE

A. Measurable Project Tasks for FY 97

April 10 to October 30	250,000 pink salmon fry from the Port Graham hatchery placed in net pens and reared to an average weight of 8 grams.
April 10 to June 30	In lieu of rearing fish to eight grams, 2 million fry will be reared to an average weight of one gram.
July 7 to August 31	Monitor pink salmon escapement into Port Graham.
August 10 to August 25	Capture hatchery broodstock.
August 28 to September 10	Egg take.
April 1997	Annual report on FY 97 work.

B. Project Milestones and Endpoints

The project objective will be successfully met if broodstock development phase is completed on schedule at the end of FY 00.

C. Completion Date

This project will end when the broodstock development phase at the Port Graham hatchery is complete. This is expected to occur by the end of FY 00.

PUBLICATIONS AND REPORTS

Annual reports	Describes project activities for the year, analyzes successes and problems, makes recommendations for improvements due April 1 following fiscal year being reported on.
Final report	Synopsis of each tear's activities with analysis of project as a whole. Due April 1 following final year of project.

PROFESSIONAL CONFERENCES

No travel to professional conferences is planned under this project.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

If funded, this project will be integrated into the overall pink salmon enhancement program in Port Graham.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

The project design will differ from the approved FY 96 DPD if it is decided during the FY 96 season to raise the fry to an average size of one gram rather than the eight gram size originally proposed. These changes are being investigated as a result of work done at other pink salmon hatcheries in the state that found rearing fry to the one gram size greatly increased ocean survival. If the one gram size can be achieved at Port Graham before the sea water temperature exceeds 10° C, this method will be adopted because this will eliminated the risk of the rearing fish contracting "warm water vibrio" disease.

PRINCIPAL INVESTIGATOR

Ephim Anahonak, Jr., Hatchery Manager
Port Graham Hatchery
P. O. Box 5543
Port Graham, AK 99603
phone (907) 284-2233
fax (907) 284-2238

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997						
Personnel	$2.5	$0.0						
Travel		$0.0						
Contractual	$80.4	$75.1						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$82.9	$75.1	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
General Administration	$6.0	$5.3						
Project Total	$88.9	$80.4	$77.2	$79.6	$81.9	$0.0	$0.0	
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:
Funding for this project would be contracted through the Kenai Peninsula Borough Economic Development District I via a Standard Agreement written by the ADF&G. They would in turn subcontract with the Port Graham Village Council.

1997

Prepared:

Project Number: 97225
Project Title: Port Graham Pink Salmon Subsistence Project
Agency: AK Dept. of Fish & Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY
4/11/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
						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	FFY 1997
					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

1997

Prepared:

Project Number: 97225
Project Title: Port Graham Pink Salmon Subsistence Project
Agency: AK Dept. of Fish & Game

FORM 3B
Personnel
& Travel
DETAIL

4/11/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed
Description	FFY 1997
Contract with the Kenai Peninsula Borough Economic Development District	75.1
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$75.1

Commodities Costs:	Proposed
Description	FFY 1997
Commodities Total	$0.0

1997

Prepared:

Project Number: 97225
Project Title: Port Graham Pink Salmon Subsistence Project
Agency: AK Dept. of Fish & Game

FORM 3B
Contractual & Commodities DETAIL

4/11/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
			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

1997

Project Number: 97225
Project Title: Port Graham Pink Salmon Subsistence Project
Agency: AK Dept. of Fish & Game

FORM 3B
Equipment
DETAIL

Prepared: 4/11/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997						
Personnel	$30.4	$31.4						
Travel	$0.0	$0.0						
Contractual	$18.0	$19.6						
Commodities	$5.0	$11.1						
Equipment	$15.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$68.4	$62.1	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Indirect	$12.0	$13.0						
Project Total	$80.4	$75.1	$69.5	$71.7	$73.9	$0.0	$0.0	
Full-time Equivalents (FTE)		12.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: Funding for this project would be contracted through the Kenai Peninsula Borough Economic Development District via a Standard Agreement written by the ADF&G. They would in turn subcontract with the Port Graham Village Council.

1997

Project Number: 97225
Project Title: Port Graham Pink Salmon Subsistence Project
Name: Port Graham Village Council

FORM 4A
Non-Trustee
SUMMARY

Prepared: 4/11/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:				Months	Monthly		Proposed
	Name	Position Description		Budgeted	Costs	Overtime	FFY 1997
		Fish Culturist		6.0	2620		15.7
		Fish Culturist		6.0	2620		15.7
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		12.0	5240.0	0.0	
						Personnel Total	$31.4

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FFY 1997
						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

1997

Prepared:

Project Number: 97225
Project Title: Port Graham Pink Salmon Subsistence Project
Name: Port Graham Village Council

FORM 4B
Personnel
& Travel
DETAIL

4/11/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed
Description	FFY 1997
Freight	2.1
Utilities	2.2
Maintenance & Repair	0.8
Telephone	0.4
Seine boats for broodstock collection four days @ $550/day	4.4
Building Rent - 2months	2.2
Air charter for stream surveys - to ADF&G	2.5
Technical consultants	5.0
Contractual Total	$19.6

Commodities Costs:	Proposed
Description	FFY 1997
Fish Food	7.5
Skiff fuel/oil	0.5
Plumbing supplies	0.5
Building supplies	0.5
40 x 40 rearing pen nets (2)	2.1
Commodities Total	$11.1

1997

Prepared:

Project Number: 97225
Project Title: Port Graham Pink Salmon Subsistence Project
Name: Port Graham Village Council

FORM 4B
Contractual & Commodities DETAIL

4/11/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
			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	

1997

Project Number: 97225
Project Title: Port Graham Pink Salmon Subsistence Project
Name: Port Graham Village Council

FORM 4B
Equipment
DETAIL

Prepared:

4/11/96

Status and Recovery of Intertidal Communities

Project Number:	97227
Restoration Category:	Monitoring
Proposer:	Drs. Michael S. Stekoll and Raymond C. Highsmith
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	University of Alaska, NOAA Hazmat
Alaska SeaLife Center:	
Duration:	October 1996 - April 2000
Cost FY97:	$258,300
Cost FY98:	$300,000
Cost FY99:	$250,000
Cost FY00:	$200,000
Geographic Area:	Prince William Sound, Cook Inlet-Kenai Peninsula, and Kodiak-Alaska Peninsula
Injured Resource/Service:	Intertidal Communities

ABSTRACT

Two major studies involving intertidal organisms impacted by the *Exxon Valdez* oil spill have been carried out by the University of Alaska (Coastal Habitat Study No. IA, CHIA) and by the Federal government agency NOAA. This proposed study will investigate the current recovery status of intertidal communities impacted by the *Exxon Valdez* oil spill through integration and comparison analyses of these existing databases for Prince William Sound and through supplemental monitoring of selected oiled habitats in Prince William Sound, Kenai-Cook Inlet and Kodiak-Alaska Peninsula regions.

INTRODUCTION

The Coastal Habitat Injury Assessment (CHIA) study was initiated to assess injury to biological resources in intertidal habitats impacted by the *Exxon Valdez* oil spill. Intertidal communities were subjected to the most severe impacts of the spill and subsequent clean-up operations. The study encompassed the three major geographic areas impacted by the spill: Prince William Sound, Cook Inlet-Kenai Peninsula, and Kodiak-Alaska Peninsula. Oiled sites were selected randomly and matched with non-oiled, reference sites. All site pairs were classified into sheltered rocky, exposed rocky, coarse textured, or estuarine habitats. Sampling was conducted from 1989-1991 via randomly placed quadrats in each of the upper three meters of the intertidal zone. The CHIA study was designed to assess the overall injury caused by the oil/cleanup efforts within the entire spill area.

Results from the above study showed severe injury to the intertidal communities during the first two years after the spill (Highsmith et al. 1994, 1996, Stekoll et al. 1996). Documented injury included decreased populations of the dominant seaweed, *Fucus gardneri*, along with injury to at least 35 other species of seaweeds and invertebrates. Injury occurred at all habitats and at all tidal levels throughout the area of the spill. Little recovery was indicated by the end of the 1991 field season, the last full-scale sampling period. Subsequent limited sampling on selected sheltered rocky sites indicated that recovery of *Fucus* and other organisms was proceeding slowly, with the lower intertidal recovering quickest. As of 1994 recovery was still not complete. The upper intertidal areas have been slow to recover due to limited recruitment and environmental factors (Highsmith et al. 1995).

Another study entitled "Evaluation of the Condition of Prince William Sound Shorelines following the *Exxon Valdez* Oil Spill and Subsequent Shoreline Treatment" (NOAA 1989-1993) was designed to investigate the ecological implications of shoreline treatments on intertidal and shallow subtidal marine life of Prince William Sound, Alaska, following the spill. Sampling was conducted from 1989-1993, with initial studies (Maki and Houghton 1989; Dames & Moore 1989; Lees and Houghton 1990, Lees et al. 1993) providing data on the short-term effects of oiling and beach treatments. The more recent sampling efforts were conducted to assess the effects of high-pressure hot-water washing in intertidal and subtidal habitats in the fourth year following the spill, as well as investigate the rates of recovery over several years between oiled areas and oiled and treated areas (Houghton et al. 1995a, 1995b). Sampling was conducted via quadrats placed at varying levels (upper, middle, and lower) within the intertidal and sampled for both epifauna and infauna.

The results of the NOAA studies were in general agreement with the CHIA studies although there were differences in habitat types and regions studied. For example the NOAA study has no sites in the Cook Inlet-Kenai or Kodiak-Alaska Peninsula regions and no sites in exposed rocky or estuarine shorelines. For sheltered rocky sites in Prince William Sound *Fucus* was found to have decreased as a result of the spill and treatment and most epifauna and infauna were also decimated. But the NOAA studies also reported effects that were not seen in the CHIA studies, such as decreased red algal cover in the lower zones at treated beaches which persisted through 1993. There are several other instances where the two projects differ in observations, conclusions and methodology. It is therefore difficult to make a direct comparison of the results of the two

studies.

A major portion of this proposal involves a detailed comparative study of these two projects in order to ascertain the current status of the intertidal communities in Prince William Sound and to determine what future research, if any, is needed to bring closure to this aspect of the oil spill. As a first step we will develop comprehensive databases for easy access to the CHIA and NOAA data sets. The data will then be evaluated for compatibility and comparability. An integrated analysis will compare, contrast, and combine when appropriate the results of the two studies. Advantages and disadvantages of both studies will be identified to understand the effects of the oil spill on the intertidal and subtidal communities. A list of data gaps within each study will also be presented. This portion of the study would be carried out and completed in FY 97.

Other related studies such as the Herring Bay Experiments (Highsmith et al. 1995) will be identified and considered for feasibility of integrating information into the database. Several studies, some that have been completed, including the Exxon intertidal studies conducted by Page et al. (1993), and ongoing *Exxon Valdez* Oil Spill Trustee Council funded studies of sea otter, river otter, pigeon guillemot, and Harlequin duck populations in the Nearshore Vertebrate Project (NVP Number 96025) and seabird-forage fish interactions in the Alaska Predator Ecosystem Experiment (APEX Number 96163) will be reviewed and evaluated for feasibility of integration into these results.

The NOAA and CHIA studies have played an integral role in the injury assessment, restoration, and monitoring of the intertidal communities impacted by the *Exxon Valdez* oil spill. Most of these efforts were focused in Prince William Sound near the source of the spill. Yet oiling also occurred hundreds of miles away on the unique coastlines of the Cook Inlet-Kenai and Kodiak-Alaska Peninsulas. The CHIA project was the only study to investigate injury to all oiled habitats including these more remote areas. At the conclusion of the CHIA 1991 field season, many of the intertidal organisms still showed significant injury to their populations in CIK and KAP (Highsmith et al. 1995, 1996, Stekoll et al. 1996). For most of these populations the current recovery status is unknown. To complement efforts being made with integrating the recovery of intertidal communities in PWS, we propose to revisit the CHIA sites in CIK and KAP to determine their recovery status. Sampling will occur during the second year (FY98) in CIK and KAP. Limited sampling will be proposed for Prince William Sound for the following year (FY99) as a result of recommendations from the data analyses and comparisons conducted in FY 97. A final report will then be submitted in FY00.

NEED FOR THE PROJECT

A. Statement of Problem

Intensive sampling and research by the CHIA project showed that the spill and subsequent cleanup had serious and persistent effects on intertidal communities through 1991. Most regions and habitats (other than sheltered rocky sites in PWS) have not been monitored since the summer of 1991. Thus, the recovery status of the intertidal community is unknown. The results of the CHIA study generally showed lower percent cover and biomass of several algal species on oiled

sites compared to reference sites. There was a corresponding increase in the amount of bare rock at the oiled sites. In addition, the dominant intertidal alga, *Fucus gardneri,* was not as reproductive and had higher levels of epiphyte infestation on oiled sites. Other effects were found such as the enhancement of some algal species in the mid to lower intertidal. By 1994, many of the algal taxa, including *Fucus*, still showed significant injury and little recovery at sheltered rocky sites in PWS and CIK. Analyses of intertidal invertebrate abundance and biomass revealed differences between oiled and reference sites for several major taxa. These were grazers (*Tectura persona, Littorina sitkana,* and *L. scutulata*), barnacles (*Chthamalus dalli, Semibalanus balanoides* and *Balanus glandula*), mussels, amphipods, and oligochaetes. Oiling effects and recovery varied between each region, habitat, and tidal elevation zone but many of the taxa showed incomplete recovery by the last sampling date in 1991.

The results from the NOAA studies also indicate that the oiling/treatment had severe impacts on intertidal communities in Prince William Sound. In 1990 at middle and upper stations, *Fucus* and limpets, both community dominants, commonly exhibited significantly lower abundances on Category 3 (oiled/treated) beaches. Other species showing significantly lower abundances at these beaches included periwinkles, drills, and barnacles. Filamentous green algae seem to have been more abundant at Category 2 (oiled/not treated) and 3 stations than at the controls; several taxa of red algae showed the opposite pattern at the single Category 3 lower station sampled. By 1992 the majority of high-pressure hot-water washed beaches appeared, superficially at least, to have recovered. This appearance was due to the proliferation of *Fucus* at middle rocky stations on oiled (Category 2 and 3) beaches. The increased cover was likely the result of reduced numbers of grazers. In 1994 there was a reduction in *Fucus* cover at all three elevations sampled on oiled rocky habitats. In contrast, cover at unoiled reference sites increased somewhat. Littorine densities at oiled upper and middle rocky stations converged with those at unoiled stations, a sign of increasing stability. Limpet densities increased at oiled middle stations, probably in response to the abundance of weakened *Fucus* thalli.

The NOAA study also found that the impacts of washing on a group of perennial red algae were severe immediately following the washing. During the next four years, cover of *Fucus* expanded to over 65 percent before declining to about 50 percent in 1994. The red algae have not exceeded 20 percent cover since 1989, and recovery to pretreatment abundance at this one site will likely take several more years. This observation is similar to that seen in the CIK-Kenai region by the CHIA study. Although in the CHIA study the affected alga was the brown annual *Alaria* and not perennial reds.

At coarse textured oiled/treated sites in the CHIA study an increase in oligochaetes was observed. Other infauna (eg polychaetes) showed decreases at oiled sties. In the NOAA mixed-soft beaches the infauna showed relatively high abundances of nematodes and oligochaetes at Category 2 and 3 sites through 1994.

From detailed mechanistic studies performed in Herring Bay from 1990 to 1993 (Highsmith et al. 1994) it was found that lower percent cover of *Fucus* at oiled sites was a result of the removal of large, reproductive plants by the spill and associated clean-up activities. *Fucus* cover was lower at the same oiled sites and tidal levels where the density of these large plants was reduced. There were also increases in the cover of weedy, ephemeral algal species such as *Cladophora, Scytosiphon, Enteromorpha* and *Pilayella.* Surviving *Fucus* plants may have been stressed by the

oil or clean-up efforts, leaving them more vulnerable to epiphytism by ephemeral algae. The upper intertidal on oiled shorelines in Herring Bay continued to show significantly lower densities of major grazers, especially in sheltered rocky habitats.

All of the above intertidal studies concluded that recovery of the intertidal communities in Prince William Sound was proceeding slowly, but was still incomplete by 1994. Data for the other two regions are available only through 1991, when several species were still showing injury. Because it is relatively expensive to sample these habitats in a comprehensive manner, there is a need to make re-sampling these regions as efficient as possible. To this end we are proposing that sites in Prince William Sound not be re-sampled until we determine what information needs to be collected through the data comparison study. However, the other two regions should be revisited for at least one more sampling to determine the status of their recovery from the effects of the oil spill.

B. Rationale/Link to Restoration

This project addresses the explicit need stated in the "Invitation to Submit Restoration Projects for Fiscal Year 1997" to monitor the injured intertidal resources. Intertidal communities were subjected to the most severe impacts of the spill and subsequent cleanup operations. The intertidal is a very productive and diverse ecosystem, providing food for higher organisms. Algae constitute a major portion of the ecosystem structure, providing protective habitat and forage for many fish and invertebrate species that are, in turn, resources for birds, fish and otters. The results of the CHIA study implicated oiling effects in all three regions and four habitats studied. In general, recovery of some damaged species had occurred by 1991 in all regions and habitats. Without integration of data from other studies and returning to selected sites, a comprehensive understanding of the effects of the spill on injured intertidal resources and the status of their recovery will be unknown.

C. Location

Comparisons of CHIA and NOAA data sets will made at the University of Alaska Fairbanks and at the Juneau Center, School of Fisheries and Ocean Sciences where programming and database management exists for the CHIA project. Additional work will be done by WEST Inc. in Alaska and Wyoming. Arrangements will be made to transfer NOAA data located in Seattle to the Juneau database. Monitoring in the field will take place on CHIA and/or other sites throughout CIK, KAP, and PWS, if necessary. Laboratory work, data analyses, and report writing will be shared among the Fairbanks and Juneau campuses.

COMMUNITY INVOLVEMENT

This project will utilize personnel that were involved in the original CHIA study due to the many years of experience they have acquired for the collection, taxonomic identification, and analysis of algae and invertebrate samples and data. However, during the field sampling in the three major geographic regions, we may occupy shorelines that are of interest to other groups. It should be possible to share space on our sampling platform with people interested in areas specific to their interests. Annual reports will be provided in April of FY98 and FY99 and will be available to the

general community through the OSPIC office. In addition, a final report will be provided by June of FY00.

PROJECT DESIGN

A. Objectives

The overall objective of this study is to determine the extent of continued injury from the *Exxon Valdez* oil spill and cleanup and the status of recovery of injured intertidal communities in the PWS, CIK, and KAP regions.

1. Database Comparisons

    a. Develop compatible databases for easy access to the CHIA and the NOAA data sets.

    b. Evaluate the compatibility, comparability and inferences of data and results collected under Coastal Habitat Injury Assessment (CHIA) study No. 1 and the NOAA Shoreline study.

    c. Based on results from meeting objective 2, compare, contrast and combine when appropriate the results of the two studies in an integrated analysis.

    d. Identify advantages and disadvantages of both studies in understanding the effects of the oil spill on intertidal and subtidal communities. Present a list of data gaps within each study.

    e. Identify other related studies and the feasibility of integrating information and results from these studies.

2. Supplemental Sampling

    a. Monitor the recovery of intertidal algae impacted by the *Exxon Valdez* oil spill throughout the area of the spill.

    b. Monitor the recovery of intertidal invertebrates impacted by the *Exxon Valdez* oil spill.

    c. Use those statistical analyses derived from the comparison studies to define recovery of the intertidal community.

B. Methods

1. Database Comparisons

a. Development of Databases

A PC based database using the database management software PARADOX 4.5 for DOS (Borland 1993) has been developed at the Juneau Center, School of Fisheries and Ocean Sciences (UAF) containing all of the algal data collected as part of the CHIA study. Summary invertebrate data at the site level including sample size, means, and standard errors are also housed at the University in Juneau. We propose to develop a similar database in Juneau containing the NOAA intertidal and subtidal data. We will assist Dr. Alan Mearns of Hazmat, NOAA in Seattle in developing his database in a format compatible with the Juneau database. We will also summarize and transfer the quadrat level invertebrate data to the Juneau database. The invertebrate data will be housed within the CHIA database. The NOAA data will be housed as a parallel database to CHIA on the same system. Rigorous quality control procedures will be performed on the CHIA invertebrate and NOAA data prior to full incorporation. Programs will be written with PARADOX and/or C++ Development Suite (Borland 1996) to create an umbrella application, thus unifying the databases and enabling the easy retrieval of data for analyses, interpretations, presentations and publications. Documentation of the resulting application, databases and applicable programs will be prepared and housed with the system in Juneau.

b. Evaluation of the Compatibility, Comparability and Inferences of Data and Results

Both the CHIA study and NOAA studies will be reviewed in detail by the principal investigators and support staff. Technical reports that exist for each study will be reviewed (e. g., NOAA Technical Memorandum NOS ORCA 67,73,82, Coastal Habitat Study No. 1A, Final Report) for methods and results. Species and parameters common to both studies will be identified. For example, *Fucus gardneri* density was estimated during both studies. Methods, time periods, habitats, and tide heights will also be evaluated for compatibility. In the CHIA study, density of most organisms was estimated by collections of biota within a rectangular quadrat of $0.1m^2$, while epifauna density was estimated by enumerating epifauna in the field within a square quadrat with an area of $0.25m^2$. In the CHIA study, sites from five initial habitat types were visited in 1989, whereas sites from 3 habitat types were visited in the NOAA study. Treatment histories are assumed to be known for sites within the NOAA study, whereas less is known about treatment histories on the CHIA sites. A list of factors such as those mentioned will be compiled. Each site from both studies will be evaluated based on these factors. Other factors such as salinity, aspect, exposure, and slope will be compiled for all sites when available. Measures of distance between sites will be developed.

c. Statistical Methods for Comparing the Studies

Several levels of statistical comparisons will be made between the data collected from the CHIA studies and the data collected from the NOAA studies. For those species, parameters, habitat types, and time periods common to both studies, univariate comparisons of means and variances (site to site variability) for oiled/treated CHIA sites and oiled /treated sites from the NOAA studies will be made using standard parametric

methods (eg, t-tests) if assumptions are met, and standard non-parametric methods otherwise. Reference sites from both studies will also be compared using the same procedures. Density of organisms and all other measurements will be standardized to the same units for both studies. For habitat types, species, parameters, and time periods that are judged to be comparable, data will be pooled from both studies for tests for overall oil/treatment effects using standard ANOVA or Generalized Linear Modelling (GLM) procedures. For cases where species are common between the two studies, but methods may differ, meta-analysis procedures (Folks 1984) will be used for combining data or effect levels from the two studies.

Profile analyses will be used to investigate the trend in results over time for the two studies on comparable parameters. For example, mean percent cover of *Fucus* within the third meter of vertical drop (CHIA) and the lower intertidal (NOAA) on oiled sites may be plotted over time and compared. Percent cover was estimated using a point contact technique in the CHIA study, and estimated by visual observation in the NOAA study. Although the methods for estimating the mean percent cover may differ between the two studies, a test for interaction using ANOVA or GLM procedures would indicate whether or not the studies show the same trends. See Figures 1-4 for an illustration of the interaction. This method could be used to evaluate the evidence of recovery in both studies, and be used to identify sites having similar patterns over time.

Individual similar sites may be compared from the two studies. Factors used in identifying similar sites include but are not limited to: aspect, slope, proximity to one another, oiling, treatment, habitat features, etc. Means and variances (quadrat to quadrat variability) will be compared using standard parametric methods (eg, t-tests) if assumptions are met, and standard non-parametric methods (Mann-Whitney U) otherwise.

Programs previously developed for the CHIA study in Turbo PASCAL (Borland 1990) for standard parametric tests and C++ (Borland 1992) for meta-analysis procedures will be modified for use in the analyses outlined above. New programs will be developed in C++ and/or SAS for additional analyses not previously investigated.

d. Multivariate Methods for Evaluation and Grouping of Sites

Multivariate methods such as principal components analysis, multi-dimensional scaling (Field et al. 1982), or canonical correlation analysis will be used to ordinate the sites relative to one another from both studies. Sites may initially be ordinated based on physical characteristics of the site (oil code, proximity, habitat, aspect, etc.). Non-metric methods may be used (eg, data based on ranks) to standardize data. These same methods can be used to ordinate sites based on biota.

New programs will be developed in PARADOX, C++ and/or SAS for multivariate methods for evaluation and grouping of sites.

Power of statistical tests to detect important differences in the CHIA study has been investigated using bootstrapping and Monte Carlo methods (Manly 1991). The program

previously developed in C++ for power will be modified for use in investigating the power of the NOAA study. In addition, power to detect differences between results of the two studies will be calculated using a further modification of the existing program. If data are combined, a program to investigate the power of tests to detect impacts will be developed with C++ using similar computer simulation procedures.

e. Evaluation of Compatibility and Comparability of Data from Other Studies

Ongoing projects in Prince William Sound include the U.S. National Biological Service, U.S. Fish and Wildlife Service, and the *Exxon Valdez* Oil Spill Trustee Council funded NVP, SEA, and APEX studies of fish, seals, sea otters, river otters, pigeon guillemots, harlequin ducks, mussels, clams, urchins, and other invertebrates. We propose to investigate the feasibility of comparing survey data from those studies between oiled and reference sites in the CHIA and NOAA studies using the intertidal data as covariates in the analyses. Surveys conducted under these studies could be located relative to the NOAA and CHIA sites, and associations between results on a site by site basis investigated. For example, sea otter surveys have been conducted regularly in western Prince William Sound under very tight protocols and correction for visibility biases since 1992. It should be possible to determine the abundance of sea otters within, for example, 400 m of CHIA and NOAA oiled and reference sites. It would be informative to determine if significant differences can be detected between abundance of sea otters at oiled and reference sites. These comparisons can potentially be adjusted for covariates such as the abundance of blue mussels. If judged feasible, proposals to analyze data from one of more these studies relative to the CHIA and NOAA sites will be prepared.

Several other studies investigating the effects of the *Exxon Valdez* oil spill on organisms in Prince William Sound have been completed, or are still in progress. Page et al. (1993) conducted intertidal studies in Prince William Sound for Exxon. Intertidal experiments have been conducted within Herring Bay (Highsmith et al. 1995). Other experiments are currently being conducted as part of a study through Minerals Management Service (Coastal Marine Institute) on recruitment and succession after disturbance in the intertidal (Highsmith and Saupe 1996). In addition, a methods comparison study was conducted comparing several common methods of monitoring both algae and invertebrates on rocky substrates. We propose to conduct preliminary investigations of the feasibility of combining data from these studies with those of the CHIA and NOAA studies. If judged to be feasible, we will prepare proposals to carry out such a study during the last year of this project.

2. Supplemental Sampling - To be initiated in FY 98

The basic study design implemented in the CHIA project will be maintained as a means of monitoring the recovery of the randomly selected oiled sites compared to their matched controls. CHIA sites to be visited will be sheltered rocky, coarse textured, and estuarine in CIK and sheltered rocky and coarse textured sites in the KAP region. Selected habitats will be sampled in FY99 in PWS, if required from the results of the data comparisons. Measurements will be taken

from existing plots on CHIA sites. Specific data collection methods are outlined below.

a. Methods for Algal Sampling

Percent cover of benthic algae will be determined on all undisturbed quadrats using a point contact method developed by the CHIA studies. In addition, we will perform estimations of percent cover for understory ("turf") algae and characterize the substrate at each quadrat.

b. Methods for Invertebrate Sorting

Due to the time intensive nature of the taxonomic sorting, full sorting as was accomplished for the original CHIA study will not take place. On sheltered rocky and exposed rocky sites we will rely on percent cover data for major space occupiers such as barnacles and mussels. Other organisms, such as limpets, littorines, and *Nucella*, will be directly counted within each quadrat. On coarse textured and estuarine sites, sediment samples will be collected as during the CHIA study. However, limited sorting will occur on these samples, focusing on those organisms (e.g. oligochaetes) that showed significant differences between oiled and control sites during the CHIA study. These procedures will allow for comparisons of percent cover, abundance and/or biomass of individual taxonomic groups on oiled and control sites, but will not allow for community level analyses or direct comparisons to results collected during the earlier CHIA study using different data collection methods.

c. Methods for Statistical Analyses

Statistical analyses will be identical to those utilized in the CHIA study. The basic experimental design is an After Control-Impact Pair design in which an oiled site is statistically compared to a matched control or reference site that was unoiled. We will use fixed effects analysis between matched pairs (one-way ANOVA or t tests), Fisher's and Stouffer's meta analysis tests for combining p-values within a habitat, power analysis, and community level multi-dimensional scaling (MDS) analysis.

Recovery of a habitat will be said to occur when all species have the same biomass and abundance levels at oiled sites as at reference sites. Our operational definition for recovery for a particular taxon is when a taxon shows no significant difference between oiled and reference sites at $p < 0.05$ by both Fisher's and Stouffer's tests, and the statistical power of the data is high. Since the statistical power was not inherently high with most of the past CHIA data, we also will employ a secondary definition of recovery. This definition will use convergence of the site mean values as an indication of recovery in the absence of high power. We will thus rely on data collected in 1989 to 1991 (and sometimes to 1994) to estimate convergence. However, for some invertebrate species, a change in sampling methods will make these comparisons impossible. Convergence of site pairs from a community viewpoint will be estimated using MDS analysis where feasible.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The original CHIA project was implemented by the ADF&G (Phase I) and the USFS with a contract to the University of Alaska (Phase II). At this time the project will be implemented by the University of Alaska through the Habitat and Restoration Division of the ADF&G. The University possesses all historical records of the sites and all raw and processed data from 1989 to 1991. The University is in the best position to assure the consistency of the data to allow for comparisons to the previously collected data. The ADF&G is also currently involved in the monitoring and restoration of the nearshore through existing contracts with the University for work in the subtidal (S. Jewett) and the intertidal in Herring Bay (R. Highsmith and M. Stekoll).

Principal investigators from the University of Alaska School of Fisheries and Ocean Sciences will cooperate to provide expertise on algal and invertebrate taxonomy and ecology. All mobilization and demobilization efforts associated vessel charters will be accomplished through the Seward Marine Center in Seward, Alaska.

The National Oceanic and Atmospheric Administration (NOAA) Hazardous Materials Response and Assessment Division in Seattle will be cooperating with this project. Dr. Alan Mearns is currently leading the NOAA Prince William Sound Biological Monitoring Survey . This study has accumulated data on intertidal communities since 1989. We will need access to the data sets from the NOAA study to perform the data comparability study. Dr. Mearns has indicated that he will cooperate fully with the University and WEST for this project.

WEST, Inc. statisticians have had a central role in the design and analysis of studies of the effects of the EVOS. These investigations include the original CHIA intertidal and shallow subtidal studies and Herring Bay Experiments funded by the U.S. Forest Service Trustee. Currently WEST, Inc. is a member of the ecosystem study teams for the Alaska Predator Ecosystem Experiment (APEX) and Nearshore Vertebrate Predator (NVP) project and will provide coordination with those studies.. West, Inc. is familiar with Alaska through these studies and numerous other projects conducted for the U.S. Fish and Wildlife Service, U.S. National Biological Service, and the National Park Service. This project will sub-contract to WEST for database and statistical consulting work.

SCHEDULE

A. Measurable Project Tasks for FY97

This is a multi-year study involving sampling during a field season in one fiscal year with laboratory sorting and data analysis continuing into the next fiscal year. A list for those tasks that will be undertaken during FY97 is as follows:

Oct. 1, 1996:	CHIA database tuning/integration of invertebrate data
Nov. - Dec. 1996:	Incorporation of NOAA data/ feasibility of similar studies
January-March 1997:	Programming, statistical analysis, and interpretive reports
January 22-25 1997:	Attend Annual Restoration Workshop

April 15, 1997:	Submit revised proposal based on preliminary analyses
May-Sept 1997:	Assimilate results and conclusions for publication
Sept 30, 1997:	Completion of Database Comparisons and Draft Final Report

B. Project Milestones and Endpoints

The overall objective of this study is to determine the extent of continued injury and recovery of injured intertidal communities in the PWS, CIK, and KAP regions. The collection of samples in these areas will be divided into two field seasons, with field sampling occurring in FY98 and if needed FY99. A summary of the project milestones and endpoints is as follows:

FY 97

Oct. 1, 1996:	CHIA database tuning/integration of invertebrate data
Nov. - Dec. 1996:	Incorporation of NOAA data/ feasibility of similar studies
January-March 1997:	Programming, statistical analysis, and interpretive reports
January 22-25 1997:	Attend Annual Restoration Workshop
April 15, 1997:	Submit revised proposal based on preliminary analyses
May-Sept 1997:	Assimilate results into summary tables/graphs
Sept 30, 1997:	Preliminary draft report of Database Comparisons

FY 98

Oct.-Dec. 1997	Revision and finalization of database report
January 22-25 1998:	Attend Annual Restoration Workshop
April 15, 1998:	Submit annual report of database comparisons
March-April 1998:	Arrange logistics (boats, equipment, contracts, etc.)
May-July 1998:	Sample CIK/KAP CHIA sites
Aug-Sep 1998:	Begin sample sorting and data entry for CIK/KAP

FY 99

October-March 1998-99:	Continue sample sorting and analysis of CIK/KAP data
January 22-25 1999:	Attend Annual Restoration Workshop
April 1999:	Submit annual report for CIK/KAP data
March-April 1999:	Arrange logistics (boats, equipment, contracts, etc.)
May-July 1999:	Sample PWS CHIA sites if necessary
Aug-Sep 1999:	Begin sample sorting and analysis of PWS data

FY 00

October-March 1999-00:	Continue sample sorting and analysis of PWS data Integration of data from NVP, SEA, etc.
January 22-25 1900:	Attend Annual Restoration Workshop
April-June 2000:	Submit final report for PWS, CIK, and KAP data

July-August 2000: Changes to final report as per peer review-resubmit

C. Completion Date

This project will be completed and all objectives met by the end of the FY00. If there is no need to revisit the PWS area the project can be completed by FY99.

PUBLICATIONS AND REPORTS

A draft final report presenting preliminary results from the database comparisons for PWS will be submitted October 1, 1997. Publications will be prepared for peer reviewed journals. Annual reports will be submitted in April 1998 and 1999 summarizing results from the CIK and KAP areas. In June 2000, a final report will be submitted to the Trustee Council which will include all results including those from PWS. If PWS is not revisited in FY99 then a final report will be submitted in June 1999.

PROFESSIONAL CONFERENCES

Preliminary results of the data comparisons and analyses will be presented as appropriate to scientific meetings such as the International Oil Spill Conference or the annual meeting of the Society for Environmental Toxicity and Chemistry (SETAC).

NORMAL AGENCY MANAGEMENT

Not applicable to this project.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This multi-disciplinary study will be conducted by a team of scientists with first hand experience in the monitoring of the effects of oil on intertidal communities. These investigators have worked together over the past six years to evaluate the effects of the *Exxon Valdez* oil spill on intertidal algal and invertebrate communities across the entire spill region, including detailed studies conducted in Herring Bay. Coordination and cooperation with the NOAA HazMat studies will be done through Dr. Alan Mearns of Seattle who is the leader of the NOAA Biological Assessment Team. Principal investigators from the University of Alaska Fairbanks and University of Alaska Southeast and WEST personnel will coordinate efforts to study interactions between key algae and invertebrate species. The data will be combined for community-level analyses. Much of the equipment used during this study was acquired during other Trustee Council-funded research including the CHIA and Herring Bay Experimental and Monitoring studies. This proposed study will have direct utility to studies of oystercatchers, harlequin ducks and sea otters.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Not applicable for this project.

PROPOSED PRINCIPAL INVESTIGATORS

Michael S. Stekoll 8/Apr/96
Dr. Michael S. Stekoll, Co-Principal Investigator
JCSFOS
Anderson Bldg
11120 Glacier Hwy
Juneau, AK 99801
(907) 465-6279
Fax (907) 465-6447
jfmss@acad1.alaska.edu

R. C. Highsmith 4/11/96
Dr. Raymond Highsmith, Co-Principal Investigator
Room 217 O'Neil Building
UAF/SFOS
Fairbanks, Alaska 99775
(907) 474-7384
Fax (907) 474-5804
ffrch1@acad3.alaska.edu

Dr. Joe Sullivan
Restoration Program Mgr.
Habitat and Restoration Division / ADF&G
333 Raspberry Road
Anchorage, AK 99518-1599
(907) 267-2213
joes@fishgame.state.ak.us

PERSONNEL

Dr. Michael Stekoll, Professor, UAS and UAF/JCFOS, Juneau.

Dr. Stekoll has been a principal investigator on three *Exxon Valdez* Oil Spill projects: the Coastal Habitat Injury Assessment project, the Herring Bay Experimental and Monitoring Studies and the Shallow Subtidal Assessment project. His specialties include marine pollution biology, the biology and ecology of *Fucus, Macrocystis* and other seaweeds in Alaska, and the mariculture of kelps and red seaweeds.

Dr. Raymond Highsmith, Professor, Director West Coast National Undersea Research Center, UAF/SFOS, Fairbanks.

Dr. Highsmith has been the Coordinator and Principal Investigator of two *Exxon Valdez* Oil Spill projects; the Coastal Habitat Injury Assessment project and the Herring Bay Experimental and Monitoring studies. His specialties include ongoing research of recruitment and population biology in the intertidal zone and he is familiar with the effects of the oil spill on intertidal invertebrates throughout the spill-impacted area.

Dr. Lyman McDonald, Senior Biometrician, WEST, Inc., 2003 Central Avenue, Cheyenne, WY 82001.

Dr. McDonald has been or is presently the Chief Statistician on three *Exxon Valdez* Oil Spill projects: the Coastal Habitat Injury Assessment project, the Alaska Predator Ecosystem Experiment (APEX), and the Nearshore Vertebrate Predator (NVP) Project. He is responsible for the overall sampling strategies and statistical inference procedures in those studies. Dr. McDonald has twenty-seven years of comprehensive experience in the application of statistical methods to design, conduct, and analyze environmental and laboratory studies.

Wallace Erickson, Statistician/Biometrician, WEST Inc., 2003 Central Ave, Cheyenne, Wyoming, 82001

Mr. Erickson has been involved with Trustee Council funded projects since 1989 and the beginning of the Coastal Habitat Injury Assessment (CHIA). He has been extensively involved in the design, analysis and writing for these studies. He also has consulted with scientists on design, conduct, and analysis of the Herring Bay studies. His primary responsibilities on these projects were in the development and implementation of appropriate statistical procedures, interpretation of results, and report writing. He will develop and implement the statistical procedures to be used for analysis and integration of data.

Dr. Peter van Tamelen, Research Associate, UAF/JCSFOS, Juneau

Dr. van Tamelen has been working in Herring Bay on the intertidal algal studies since 1990. He has extensive experience in marine intertidal ecology, including studies on plant-herbivore interactions, succession, algal recruitment, and effects of physical factors on biological communities.

Susan Saupe, Field and Lab Supervisor/Technician, UAF/SFOS, Fairbanks.

Ms Saupe has been involved with Trustee Council funded projects since the field season of 1990. She has acted as a chief scientist on research vessels during the CHIA and Herring Bay studies from 1990-1994. She has had overall responsibility for invertebrate data analysis, presentation, and report writing for the CHIA project since 1991 and for the Herring Bay studies since 1993.

Mandy Lindeberg, Algal Lab Supervisor/Technician, JCSFOS, Juneau.

Ms Lindeberg has been involved with Trustee Council funded projects since the field season of 1990. She has worked extensively in the field and laboratory sampling and identifying intertidal algae. She helped develop sampling methods and trained many of the personnel involved with the collection and identification of algae during the CHIA and Herring Bay studies from 1990-1994. Ms Lindeberg was one of the key personnel responsible for the successful lab analyses, integration of data, and presentation of results for the final CHIA report.

Michelle Bourassa, Computer Programmer/Data Analyst, JCSFOS, Juneau.

Ms Bourassa has developed the CHIA algal database and much of the programming for the statistical and power analyses and graphical presentations for data obtained during the CHIA study. She has worked on Trustee Council funded projects for the past three years. She will be the project's principal computer programmer and will be in charge of the database used for statistical analysis of the data.

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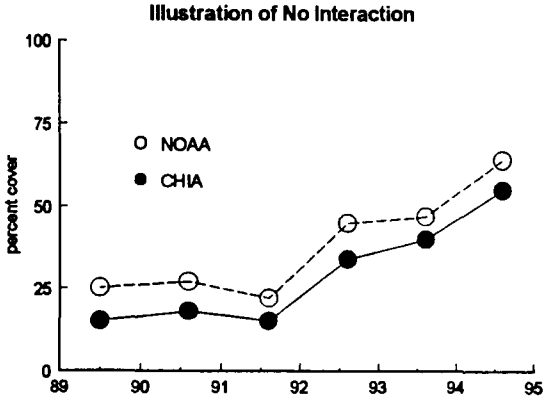

Figure 1

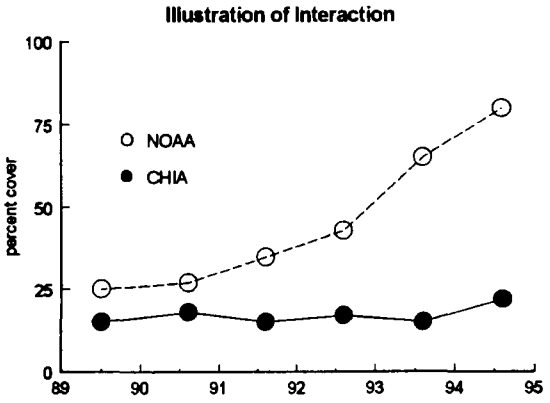

Figure 2

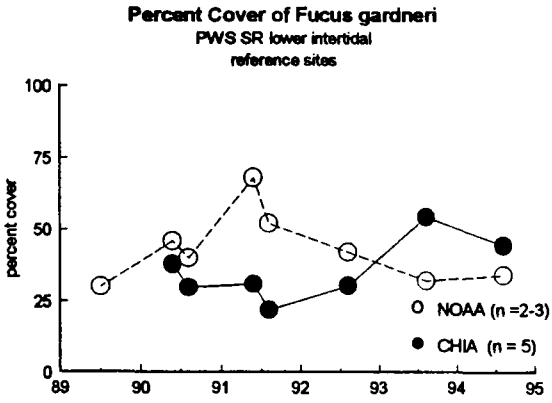

Figure 3

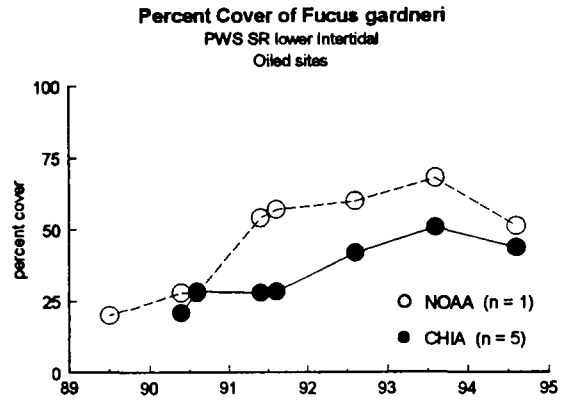

Figure 4

Figures 1-4. Figure 1 is an example of a comparison of CHIA and NOAA hypothetical data sets illustrating no interaction effects between the data sets on the parameter studied. This pattern would indicate similar trends, results and interpretation regarding recovery. Figure 2 shows an example of interaction between data sets. This pattern would indicate different trends, results and interpretation regarding recovery. Figure 3 is a plot of actual data from the CHIA and NOAA studies comparing reference sites. Figure 4 is a plot of actual data comparing oiled/treated sites.

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997
Personnel		$136.0
Travel		$5.3
Contractual		$60.4
Commodities		$4.9
Equipment		$0.0
Subtotal	$0.0	$206.6
Indirect		$51.7
Project Total	$0.0	$258.3
Full-time Equivalents (FTE)		27.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
$300.0	$250.0	$150.0			

Dollar amounts are shown in thousands of dollars.

Comments:

Indirect costs are calculated at 25% TDC. The FY97 budget will go towards comparisons of CHIA and NOAA data for Prince William Sound. The funds for FY98 will go toward field sampling in CIK and KAP with follow up work in the lab such as sorting and data entry. Fy99 funds will support statistical analyses and interpretation of CIK/KAP data and if deemed necessary, sampling in PWS. FY00 funds will support sorting, data entry, and statisitcal analyses of PWS. A final report will be submitted at the end of FY00.

The University of Alaska does not cover office, computer, lab, or field supplies nor does it cover long distance phone and Fax charges associated with research projects. Principal investigators must solicit support for these costs through the proposal process as done here.

1997

Prepared:

Project Number:
Project Title: Status and Recovery of Intertidal Communities
Name: M. Stekoll and R. Highsmith

FORM 4A
Non-Trustee
SUMMARY

4/9/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FFY 1997
M. Stekoll	Co-Principle Investigator		2.0	9,135.1	0.0	18.3
R. Highsmith	Co-Principle Investigator		1.0	10,365.8	0.0	10.4
P. VanTamelen	Research Associate		2.0	4,369.8	0.0	8.7
M. Lindeberg	Tech. (JCSFOS)		8.0	4,182.4	0.0	33.5
S. Saupe	Tech. (IMS/SFOS)		6.0	4,571.5		27.4
M. Bourassa	Database Mgmt		8.0	4,708.8	0.0	37.7
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		27.0	37,333.4	0.0	
					Personnel Total	$136.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FFY 1997
RT Juneau/Anchorage (Annual Oil Spill Workshop)	1 traveler	350	2	6	40	0.9
RT Fairbanks/Anchorage (Annual Oil Spill Workshop)	1 traveler	200	2	6	40	0.6
Car Rental (Anchorage)				18	40	0.7
RT Juneau/Seattle (database mgmt with NOAA)	2 travelers	400	3	9	34	1.5
Car Rental (Seattle)				9.0	40.0	0.4
Hotel (Seattle)				9.0	79.0	0.7
RT Juneau/PWS	1 traveler	400.0	1.0	2.0	40.0	0.5
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	5.3

1997

Prepared:

Project Number:
Project Title: Status and Recovery of Intertidal Communities
Name: M. Stekoll and R. Highsmith

FORM 4B
Personnel
& Travel
DETAIL

4/9/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed
Description	FFY 1997
West Inc. (statistical consulting)	56.6
Long distance telephone/Fax (1/2 Juneau and 1/2 Fairbanks)	2.0
Xeroxing/Printing of data sheets and reports	1.5
Computer Maintenance	0.3
Contractual Total	$60.4

Commodities Costs:	Proposed
Description	FFY 1997
Office Supplies (paper, pens, files....etc.) (1/2 Juneau and 1/2 Fairbanks)	1.0
Computer hardware for increased programming demands:	
2 GB IDE hard drive	0.5
2 GB SCSI hard drive	0.8
2 MB VRAM w/ MACH 64 bit accelorator	0.5
8 MB RAM	0.5
Backup tapes/disks	0.2
Computer software for increased programming demannds:	
SAS software package	0.4
misc. upgrades for existing programs	1.0
Commodities Total	$4.9

1997

Project Number:
Project Title: Status and Recovery of Intertidal Communities
Name: M. Stekoll and R. Highsmith

FORM 4B
Contractual & Commodities DETAIL

Prepared:

4/9/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
			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
486 computers	4
486 laptop computer	1

1997

Project Number:
Project Title: Status and Recovery of Intertidal Communities
Name: M. Stekoll and R. Highsmith

FORM 4B
Equipment
DETAIL

Prepared: 4/9/96

Status and Recovery of Intertidal Communities								
This budget covers costs of comparing CHIA and NOAA data in FY97								
1000 Personnel	mos	hrs	Regular	Total Wages	Leave	StBen	OT	Total
Stekoll - PI	2	173.3	$34.41	$11,926.51	$2,313.74	$4,029.99	$0.00	$18,270.24
Highsmith- co PI	1	173.3	$40.26	$6,977.06	$1,262.85	$2,125.90	$0.00	$10,365.80
VanTamelen	2	173.3	$16.46	$5,705.04	$1,106.78	$1,927.74	$0.00	$8,739.56
Bourassa	8	173.3	$16.46	$22,820.14	$4,837.87	$10,012.20	$0.00	$37,670.22
Sue Saupe	6	173.3	$15.98	$16,616.00	$3,522.59	$7,290.17	$0.00	$27,428.77
Lindeberg	8	173.3	$14.62	$20,269.17	$4,297.06	$8,892.98	$0.00	$33,459.21

Restoration of PWS Pink Salmon: Quantitative Genetic Assessment of Embryo Mortality and Developmental Stability in Offspring of Oiled Pink Salmon. Submitted Under the BAA.

Project Number:	97228-BAA
Restoration Category:	Research
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	NOAA
Cooperating Agencies:	
Alaska SeaLife Center:	
Duration:	2.5 years
Cost FY 97:	$90
Cost FY 98:	$84
Cost FY 99:	$44
Cost FY 00:	
Cost FY 01:	
Cost FY 02:	
Geographic Area:	Laboratory Experiments Only
Injured Resource:	Pink Salmon

ABSTRACT

Oil may have caused heritable damage to some PWS pink salmon stocks; excess embryonic mortality has been observed both in pink salmon exposed to oil by EVOS and in their progeny. Although detectable excess mortality has quickly (within a few generations) declined, it is not known if the injured stocks carry a genetic load of detrimental mutations that will continue to reduce fitness and productivity in these stocks for the indefinite future. A quantitative genetic analysis of embryonic mortality and other measures of developmental stability will be carried out. Estimates of genetic parameters for mortality (heritability, genetic correlations, non-additive and maternal sources of variation) will be important for management of pink salmon resources during restoration because they predict the rate at which genetic change can be expected to occur, i.e. the rate at which the inherited mortality will respond to natural selection. This project is an augmentation of project 076 being carried out by NOAA NMFS Auke Bay Laboratory. This project adds an important dimension to that project by providing a quantitative genetic analysis of embryonic mortality and of developmental stability caused by exposure of pink salmon embryos to oil.

INTRODUCTION

The EVOS event in 1989 exposed pink salmon embryos to oil, in particular embryos of stocks that were exposed geographically (in streams not protected by terrain from the advancing spill) and that were incubating in the intertidal zone where they were exposed to floating oil. Pink salmon, in addition to their signal economic importance in Prince William Sound, are biologically important and interesting--they provide a useful model species for investigating effects of toxins on the ecosystem. In particular they spawn in significant proportions, near 50%, in intertidal gravels of many streams; this is a particular characteristic of stocks in Prince William Sound. They are also well studied; population records have been maintained for several decades and reliable methods of census are in use. When the event occurred during the late stages of embryonic development of pink salmon in 1989, some embryos of some stocks were exposed to oil and other embryos weren't. Because pink salmon leave their natal stream immediately upon completing embryonic development the salmon in PWS were exposed only during early life stages.

Scientists studying pink salmon after the event were able to detect that embryonic mortality in affected streams was greater than mortality in non-affected streams (by censuses of embryos before emergence and emigration to sea), that the differential mortality between types of streams persisted in censuses of embryos produced by fish that had themselves been exposed to oil as embryos, and that embryos artificially spawned from mature fish sampled in oil-exposed streams (offspring of exposed salmon) exhibited higher mortality in clean water in artificial incubation--i.e. in an experiment in a hatchery.

This evidence suggests that an effect of oil exposure was to cause genetic damage that disrupted development, in some individuals causing death but in others being passed on to succeeding generations. This evidence has inspired several research programs including direct genetic investigations of chromosomal aberrations and DNA sequence changes associated with oil exposure (at the Alaska Dept. of Fish and Game Genetics Laboratory) and experimental replication of the event (at the NOAA Auke Bay Laboratory research station at Little Port Walter--LPW) in which the inheritance of the effect could be demonstrated. The latter project (number 076) is the basis for this proposed research; the proposed research will use the results of project 076, both information and fish, and will employ direct quantitative genetic experimentation to investigate the nature of the genetic effect of oil on pink salmon.

Products of project 076 include adult salmon in 1995 that were themselves experimentally exposed to oil at LPW as embryos in 1993-94 and offspring of those oil-exposed parents, spawned in 1995 and that will mature in 1997. The latter fish (F1's) and their offspring (F2's) to be produced in 1997 form the basis of this proposed research. We will use laboratory quantitative genetic experiments to investigate genetic variation of the effects of oil on embryonic development. We will observe mortality at different stages of development, rates of development, and other non mortal effects on developmental stability such as fluctuating asymmetry and developmental abnormality.

NEED FOR THE PROJECT

A. Statement of Problem

Mortality of pink salmon eggs has been attributed to effects of oiling of spawning beds and has persisted through more than one generation; apparently the damage is inherited. Loss of fitness and productivity has demonstrably occurred. Significant reduced fitness may persist for many generations due to genetic load and not be detectable by field observations.

B. Rationale/Link to Restoration

If the mechanism is genetic and is inherited, the rate at which natural selection will restore fitness to affected stocks will depend on the kind of genetic action involved, i.e. whether additive, dominance, epistatic, maternal effects are important. Restoration of pink salmon to full fitness and productivity will be obtained when natural selection has acted to remove deleterious mutations from affected stocks. The rate at which natural selection will accomplish restoration will be relatively slow if non additive genetic effects are important.

C. Location

The research will take place in conjunction with project 076 at Little Port Walter and at the University's Gastineau Salmon Lab in Juneau.

COMMUNITY INVOLVEMENT

Not Applicable--Laboratory Experiments.

PROJECT DESIGN

A. Objectives

1. Identify traits showing developmental instability in oiled fish (P1). Quantify developmental instability for oiled and unoiled fish (P1) and progeny of oiled and unoiled fish (F1).

2. Compare reproductive traits of sexually mature progeny of oiled and unoiled fish (F1) including body size at maturity, fecundity, weight of egg mass, egg size, and fertility rate. Compare developmental traits of their progeny (F2) including developmental stability, mortality, and rate.

3. Estimate genetic parameters for traits of developmental stability, mortality, and rate from a breeding experiment utilizing crosses of progeny of oiled and unoiled fish (F1). Utilize the parameter estimates to predict expected genetic change due to natural selection for a range of selection intensities.

B. Methods

We will be investigating the following hypotheses:

1. Oiled fish show and their progeny show increased developmental instability for traits including bilateral asymmetry and developmental mortality and rate.

2. Heritability estimates for bilateral asymmetry and developmental mortality and rate are higher for progeny of fish whose parents were oiled (F2) compared to progeny of control fish. Therefore, genetic change due to response to natural selection is expected to be higher for progeny of fish whose parents were oiled compared to progeny of control fish.

Developmental stability indicates the ability of an organism to have a consistent phenotype and can be used as an indicator of genetic or environmental stress in natural populations. (Graham et al., 1993). Typically, deviations from developmental stability are determined by quantifying deviations from bilateral symmetry. Fin-ray, gillraker counts and other countable characters (Leary et al., 1985). are used to measure developmental stability to reveal stress in fish populations exposed to pollutants (Graham et al., 1992).

In the next year, we will utilize carcasses of oiled fish (P1) to determine which bilateral characteristics reveal stress in fish exposed to oil. We will also measure the characters in their progeny (F1) when they return to spawn in the summer of 1997. Progeny of fish from oiled streams in natural populations have been observed to have higher developmental mortality when compared to progeny of fish from unoiled streams Lack of developmental stability for mortality in the progeny of oiled fish may be an indication of genetic stress since only their parents were exposed to oil. Genetic stress may also be revealed by our measurements of bilateral asymmetry in progeny of oiled fish (F1).

Progeny of oiled and unoiled fish (F1) will be returning to Little Port Walter to spawn during the summer of 1997. The fish will be used to four 10 x 10 mating sets: oiled females crossed with oiled males, oiled females crossed with unoiled males, unoiled females crossed with oiled males, and unoiled females crossed with unoiled males. Within each set, eggs from each female will be separately fertilized using semen from 10 males. Therefore, each set will produce 100 families, resulting in a total of 400 families (F2). Each family will be divided in 2 parts which will be randomly placed in an incubator compartment. Measurements of bilateral symmetry will be collected on the 40 males and 40 females used in the breeding experiment. Additional data to be collected on the females includes: body size at maturity, fecundity, weight of egg mass, egg size, and fertility rate. Data to be collected for each of the 800 incubator compartments includes:

developmental mortality rate at eye, hatch, and emergence, developmental rate to eye, hatch, and emergence, and measurements of bilateral asymmetry after first feeding.

Additive genetic, maternal, non-additive genetic, and phenotypic variances, heritabilities, and ratios of maternal and non-additive genetic variances to phenotypic variances will be estimated using an animal model solved by applying a derivative-free technique for estimating variance components employing restricted maximum likelihood (Graser et al., 1987). The derivative-free restricted maximum likelihood (DFREML) analysis procedure of Meyer (1988) will be utilized. Heritability estimates will be estimated for traits including bilateral symmetry and developmental mortality and rate. The technique has been utilized to analyze data from breeding experiments of fish (Crandell and Gall, 1993). Heritability estimates may be used to predict expected genetic change due to natural selection for a range of selection intensities (Van Vleck, 1987).

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, directly supports cooperative research at Little Port Walter research station. Approximately $56 thousand is budgeted each year to support technical personnel (about 50%), and expendable supplies, transportation, and equipment (about 50%). Indirect costs of the support amount to about $28 thousand. Total support by the University for research at LPW is about $84 thousand annually. This support is independent of this proposed research; however, this proposed research would be a major benefactor.

SCHEDULE

A. Measurable Project Tasks for FY 97

1. Oct. 1 - May 31 '97: Identify and analyze indicators of developmental stability in oiled salmon

2. June 1 - Sept 30 '97: Analyze indicators of developmental stability in offspring of oiled salmon

3. Oct. 1 - May 31, '97: Design breeding experiment for mature offspring of oiled salmon

4. June 1 - Aug 30 '97: Set up laboratory for breeding experiment

5. Sept 1 - Sept. 30 '97: Carry out breeding experiment, create families of F2 generation

B. Project Milestones and Endpoints

1. Identify traits showing developmental instability in oiled fish (P1). Quantify developmental instability for oiled and unoiled fish (P1) and progeny of oiled and unoiled fish (F1). Complete by 9/30/97.

2. Compare reproductive traits of sexually mature progeny of oiled and unoiled fish (F1) including body size at maturity, fecundity, weight of egg mass, egg size, and fertility rate. Compare developmental traits of their progeny (F2) including developmental stability, mortality, and rate. Completed by 9/30/98.

3. Estimate genetic parameters for traits of developmental stability, mortality, and rate from a breeding experiment utilizing crosses of progeny of oiled and unoiled fish (F1). Utilize the parameter estimates to predict expected genetic change due to natural selection for a range of selection intensities. Completed by 3/31/99.

C. Completion Date

The work will be completed midway in FFY 99, 3/31/99.

PUBLICATIONS AND REPORTS

No publications are anticipated in FY97.

PROFESSIONAL CONFERENCES

No results will be presented in FY97, the first year of the research.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is an augmentation of project 076 being carried out by NOAA NMFS Auke Bay Laboratory. This project adds an important dimension to that project by providing a quantitative genetic analysis of embryonic mortality and of developmental stability caused by exposure of pink salmon embryos to oil. This project will share laboratory facilities with Auke Bay Lab at Little Port Walter. The University directly supports shared use of those facilities by expenditures amounting to $84 thousand per annum. This project will use fish (salmon oiled as embryos and recovered as adults and their offspring) created by the Auke Bay Lab project.

PROPOSED PRINCIPAL INVESTIGATOR

William W. Smoker
University of Alaska
Juneau Center, School of Fisheries & Ocean Sciences
11120 Glacier Highway, Juneau, AK 99801
907-465-6444
907-465-6447 fax
FFWWS@aurora.alaska.edu

PERSONNEL

W.W. Smoker
Professor of Fisheries, SFOS
PhD, Fisheries, Oregon State University
Research in salmon ocean ranching, quantitative genetics of Pacific salmon.

Patricia A. Crandell
Research Associate, SFOS
PhD, Aquaculture Genetics, Biometrics, University of California Davis
Research on quantitative genetics of pink salmon, ploidy manipulation in Pacific salmon.
Expertise in experimental design and statistical analysis.

Robert Fagen
Associate Professor of Biometrics, SFOS
PhD, Biomathematics, Harvard University
Specialist in data analysis, biometrics.

LITERATURE CITED

Crandell, P.A. and G.A.E. Gall, 1993. The genetics of body weight and its effect on early maturity based on individually tagged rainbow trout (Oncorhynchus mykiss). Aquaculture, 117:77-93.

Graham, J.H., Freeman, D.C., and Emlen, J.M., 1993. Developmental Stability: a Sensitive Indicator of Populations Under Stress. Environmental Toxicology and Risk Assessment, ASTM STP 1179, Wayne G. Landis, Jane S. Hughes, and Michael A. Lewis, Eds.).

Graham, J.H., Emlen, J.M., and Freeman, D.C., 1992. Developmental stability and its applications in ecotoxicology. Ecotoxicology, 2:175-184.

Graser, H.U., Smith, S.P. and Tier, B., 1987. A derivative-free approach for estimating variance components in animal models by restricted maximum likelihood. J. Anim. Sci., 64:1362-1370.

Leary, R.F., Allendorf. F.W., and Knudsen, K.L., 1985. Developmental instability and high meristic counts in interspecific hybrids of salmonid fishes. Evolution, 39:1318-1326.

Meyer, K., 1988. DFREML programs to estimate variance components for individual animal models by restricted maximum likelihood. User notes. Univ. of Edinburgh.

Van Vleck, L.D., 1987. Genetics for the Animal Sciences, W.H. Freeman and Co., New York.

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997						
Personnel		$70.7						
Travel		$1.6						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$72.3	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Indirect		$18.1						
Project Total	$0.0	$90.4	$94.9	$49.8				
Full-time Equivalents (FTE)		19.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

1997

Prepared:

Project Number:
Project Title: Quantitative Genetic Assessment of Embryo Mortality and Developmental Stability in Offspring of Oiled Pink Salmon
Name: W. Smoker

FORM 4A
Non-Trustee
SUMMARY

4/12/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FFY 1997
W.W. Smoker	Professor, Principal Investigator		1.0	8.8		8.8
P.A. Crandell	Research Associate, Co-PI		12.0	3.8		45.6
R. Fagen	Associate Prof., Biometrician		0.5	8.6		4.3
To Be Named	Graduate Research Assistant, MSc		6.0	2.0		12.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		19.5	23.2	0.0	
					Personnel Total	$70.7

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FFY 1997
Anchorage, Attend EVOS Workshops		0.5	2	6	0.1	1.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$1.6

1997

Prepared:

Project Number:
Project Title: Quantitative Genetic Assessment of Embryo Mortality and Developmental Stability in Offspring of Oiled Pink Salmon
Name: W. Smoker

FORM 4B
Personnel
& Travel
DETAIL

4/12/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed FFY 1997
Description	
Contractual Total	$0.0

Commodities Costs:	Proposed FFY 1997
Description	
Commodities Total	$0.0

1997

Project Number:
Project Title: Quantitative Genetic Assessment of Embryo Mortality and Developmental Stability in Offspring of Oiled Pink Salmon
Name: W. Smoker

FORM 4B
Contractual & Commodities DETAIL

Prepared: 4/12/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
			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

1997

Project Number:
Project Title: Quantitative Genetic Assessment of Embryo Mortality and Developmental Stability in Offspring of Oiled Pink Salmon
Name: W. Smoker

FORM 4B
Equipment
DETAIL

Prepared:

4/12/96

City of Cordova - Solid Waste Disposal Site

Project Number: 97229

Restoration Category: General Restoration

Proposed by: City of Cordova

Lead Trustee Agency: ADEC

Alaska SeaLife Center:

Duration: 1st year, 1 year project

Cost FY 97: $888,000

Geographic Area: Cordova, Prince William Sound

Injured Resource/Service: Intertidal and subtidal organisms, salmon or herring, harlequin ducks, black oystercatchers, sea otters, harbor seals, and other seabirds, shorebirds, and marine mammals. The services most likely to benefit are commercial fishing, subsistence activities, and recreational activities, all of which are affected by the adverse environmental and visual effects of pollution.

ABSTRACT

This project will prevent wastes generated in the city of Cordova from entering Prince William Sound. This project will provide funding needed by Cordova to realize one of its primary waste management goals (as articulated in the recently completed Sound Waste Management Plan): determine how and where the community's municipal solid waste will be disposed of over the long term. Based on the Sound Waste Management Plan's findings, and in consultation with resident experts, Cordova leaders determined that the community's most cost-effective and responsible solid waste disposal option is to develop a new landfill site at 17 Mile of the Copper River Highway. The proposed project covers capital costs for the first year of that public works venture.

INTRODUCTION

Cordova's existing landfill is located at the edge of Orca Inlet on Prince William Sound, a few miles from the Copper River Delta. The landfill includes diked-off tideland areas, portions of which are inundated during high tides. Following severe storms, the receding tides drag newly-deposited solid wastes from the landfill into the Sound where they contaminate both the water and the seafloor. Paper and plastic litter blown from the landfill and nearby dumpsters also falls into the Sound, posing a hazard to marine life and creating an eyesore. Without a healthy Sound, the community of Cordova cannot thrive. Fully 90% of the commercial salmon and herring fishing permits in Prince William Sound are held by Cordovans. As well, Orca Inlet has the single largest pupping concentration of sea otters in Prince William Sound. Fishing and tourism are the city's two largest industries.

This project proposes to fund the first year of capital costs associated with the construction of a new solid waste disposal facility at 17 Mile of the Copper River Highway, an upland site approximately 17 miles from the city center. Cordova needs a new solid waste disposal site for several reasons: (1) the city's current landfill is nearing capacity[1]; (2) the existing landfill's permit expires in 1998 and is unlikely to be renewed by ADEC due to concerns about the site's environmental safety; and, (3) as described above, the existing site poses a localized marine pollution hazard to Prince William Sound. The City of Cordova will be responsible for funding the site's annual operations and maintenance costs and for paying other capital costs as they are incurred over the lifespan of the facility.

The decision to locate a new solid waste management facility at 17 Mile was made by Cordova's City Council upon consideration of seven options presented in the Sound Waste Management Plan (SWMP). (See Attachment A for a summary of the seven options.) The SWMP is the centerpiece of a year-long effort undertaken by five Prince William Sound communities, including Cordova, to reduce the volume of wastes entering Prince William Sound, support the regeneration of Prince William Sound, and develop practical waste management solutions that are cost-effective, environmentally sound, and sustainable over time. The SWMP Project was made possible with funding from the *Exxon Valdez* Oil Spill Trustee Council (Trustee Council) and is designed to engage communities in a proactive approach to environmental management. This project is one of several restoration projects currently proposed (or being undertaken) by the five communities who developed the original Sound Waste Management Plan and one of two SWMP-related projects being considered by the Trustee Council in this funding cycle.

Construction of a new solid waste disposal site at 17 Mile offers several distinct advantages to the people of Cordova and to Prince William Sound. Because the new site will not be inundated by the tides, solid waste will not flow from it directly into the Sound. The new site likewise will not pose significant blowing litter hazards either to the city or to the Sound. This helps to offset both the marine pollution problem and aesthetic issues associated with the old site and encourages development opportunities at the Cordova waterfront. The new site will be constructed in full compliance with ADEC's landfill regulations. As a result it should, in the future, be easier for the

[1] This capacity issue was precipitated by the unanticipated disposal of cleanup materials from the *Exxon Valdez* spill.

city's Public Works Program both to obtain operating permits and maintain an environmentally safe site.

NEED FOR THE PROJECT

A. Statement of Problem

This project is concerned with pollution entering Prince William Sound from Cordova's existing landfill. The landfill is situated on tidal flats and is partially inundated during high tides. Following severe storm events, receding tides sweep recently deposited solid waste into Orca Inlet, where it contaminates the water, stifles or otherwise insults marine life, and becomes an eyesore. Paper and plastic wastes blown from the landfill and other shore-based sources likewise threaten the health and beauty of Prince William Sound.

Several marine species are threatened by present solid waste management practices in Cordova. These include intertidal and subtidal organisms such as oysters and crabs, salmon and herring, harlequin ducks, black oystercatchers, harbor seals, and other seabirds, migrating shorebirds, and marine mammals. Sea otters, a large population of which use Orca Inlet as pupping grounds, may be especially susceptible to marine pollution.

B. Rationale/Link to Restoration

Cordova's current solid waste management practices permit pollution to enter Prince William Sound and further degrade local marine habitats. The proposed project modifies those practices significantly by relocating the city's solid waste disposal site away from the coast. The new site is not susceptible to tidal intrusion and will be constructed in the most environmentally responsible and cost-effective manner. These modifications both encourage restoration of marine resources such as salmon, herring, and sea otters, and speed the recovery of the Sound. A healthy Sound is the key to a healthy economy for Cordova. With healthy marine resources, the major industries in Cordova, commercial fishing and tourism, can thrive.

C. Location

The proposed project will be based in the city of Cordova (proper) and at 17 Mile, an inland site approximately 17 miles up the Copper River Highway. The benefits of the project will be realized primarily in Cordova and the adjoining natural marine, estuarine, and terrestrial environments. The project will improve the health of Prince William Sound, help speed the recovery of injured marine resources, and will assist in augmenting recreational opportunities, commercial fishing and oyster harvesting, development opportunities, and other vital services.

COMMUNITY INVOLVEMENT

This project is built on, and can only be successful with, extensive community involvement. Cordova citizens contributed to the drafting of the Sound Waste Management Plan and are likely to maintain a high interest in this project. On April 3, 1996, Cordova's City Council passed

Resolution 4-96-21 (Attachment B) which approved the selection of the 17 Mile Copper River Highway site as the location for Cordova's new landfill.

Over the course of this project, call-in radio shows, town hall meetings and/or guest editorials will be employed to keep citizens informed and engaged in the project. While these activities do not constitute capital costs, per se, the project sponsors recognize that this project depends on the active participation and support of the residents of Cordova. Wherever possible, the project will employ local labor and materials in the design and construction of the site.

PROJECT DESIGN

A. Objectives

1. To decrease the flow of Cordova's municipal solid waste into Prince William Sound

B. Methods

This proposal seeks to obtain funding to cover the first year of capital costs associated with the construction of a solid waste management facility that is not susceptible to tidal inflow and other environmental degradation. The chosen site is approximately sixty acres in size and is owned by the City of Cordova. It is connected to Cordova via the Copper River Highway and can be accessed year-round. Because the 17 Mile site is inland from Cordova, it experiences lower precipitation than the city. As a result, fewer special features (e.g., a liner) are needed at the site to obtain an ADEC operating permit. The following activities are proposed specifically to be undertaken through the course of this one-year grant:

- prepare Environmental Impact Statement and Feasibility Report, design system;
- develop site[2] (including ancillary buildings, monitoring wells, and utilities ports);
- improve access road to site (e.g., by "topping" the road and constructing culverts);
- acquire necessary operating permits from ADEC;
- purchase necessary equipment or vehicles; and
- supervise all aspects of the project, including design and construction of all site components.

This proposal seeks funding for first year capital costs, only. These costs represent approximately 50% of all capital costs that will accrue over the landfill's 20-year lifespan. (A breakout of capital costs is included as Attachment C.) The City of Cordova will be responsible for any future capital

[2] Site development costs are expected to incur throughout the life of the solid waste disposal site. This proposal seeks funding only for those costs associated with the construction and preliminary use of the site.

costs as well as all annual operations and maintenance costs[3] (approximately $195,000). As well, the City of Cordova will be responsible for procuring funds/materials to cap the existing landfill.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Tasks associated with the design and development of the 17 Mile site will likely be contracted to the private sector. Contractors will work with, and be supervised by, Cordova's Public Works Director. Specific tasks to be undertaken by a private sector consultant include:

- prepare the EIS and feasibility reports;
- design the solid waste disposal facility;
- prepare and construct facility (including monitoring wells);
- purchase necessary equipment and/or vehicles; and
- improve road access to the site.

The City of Cordova will obtain a road easement from the Eyak Corporation to access the Copper River Road to the landfill site as well as plan approval and all necessary operating permits.

SCHEDULE

A. Measurable Project Tasks for FY 97 (October 1, 1996 - September 30, 1997)[4]

9/1/96 - 10/1/96:	Issue RFP and award contract
10/1/96 - 2/15/97:	Research and prepare Environmental Impact Statement and feasibility reports
2/15/97 - 7/31/97:	Design system
5/1/97 - 12/31/97:	Obtain plan approval and permits
1/1/98 - 6/30/98:	Purchase necessary equipment/vehicles
4/1/98 - 8/30/98:	Construct landfill, including monitoring wells, and improve access road to site

B. Project Milestones and Endpoints

August 30, 1998:	The solid waste facility at 17 Mile will be ready to accept solid wastes for disposal. When the facility accepts waste, the volume of municipal solid waste flowing directly into Prince William Sound should decrease almost immediately.

The new solid waste disposal site will not be fully developed at the end of this funding cycle. As described in Attachment C, the 17 Mile disposal site's 20-year budget reflects that the site will

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[3] Annual costs include: cover material ($20k); site upkeep ($5k); maintenance ($3k); equipment O&M ($5k); transportation ($12k); utilities ($22k); salaries, etc. ($118k); and site monitoring ($10k).

[4] This contract activity is expected to extend beyond Fiscal Year 1997.

incur specific site development costs on four different years (Year 1, Year 6, Year 11, and Year 16) of its expected 20-year life. These incremental costs are associated with the ongoing development of disposal "cells" at the disposal site.

Any funds awarded by the Trustee Council will be obligated by the end of Fiscal Year 1997. Only Year 1 site development/construction activities, as outlined above, will be undertaken during this grant cycle.

C. Completion Date

All activities associated with this funding cycle are planned to conclude in August 1998. The City of Cordova will begin to meet the project's restoration objective as soon as the 17 Mile site accepts waste and the City caps the current landfill. The current landfill will be capped using City funds (estimated at $150,000 worth of materials). It is expected that improvement will be steady but incremental.

PUBLICATIONS AND REPORTS, PROFESSIONAL CONFERENCES

The project team will attend any conferences to which it is invited and/or assist in providing information to any organization which requests it. Site plans, reports, and studies will be kept on file and provided to the Trustee Council through regular project reporting activities.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will be coordinated with any other restoration efforts as needed. This project is one of two proposals linked to the Sound Waste Management Plan. The other proposed project involves several Prince William Sound communities, including Cordova. The project pertains only to Cordova. There are currently no other similar projects which have been funded by the Trustee Council.

The City of Cordova is seeking funds from at least two other sources to launch this public works venture: the Copper River Highway lawsuit settlement fund and the Alaska Department of Environmental Conservation's Grant and Low Interest Loan Program. As well, the City will use City funds (estimated at $150,000 worth of materials) to cap the existing landfill.

PROPOSED PRINCIPAL INVESTIGATOR

Mr. Scott Janke
City Manager, City of Cordova
P.o. Box 1210
Cordova Alaska 99574
907/424-6200
907/424-6000

ATTACHMENT A

TABLE 10: COSTS OF SOLID WASTE MANAGEMENT OPTIONS
CORDOVA

☐ – *preferred MSW management option*

TOTAL COSTS (present value) [1]	OPTION 1: Vertical Expansion of Balefill	OPTION 2A: Construct Balefill at 17 Mile (w/liner)	OPTION 2B: Construct balefill at 17 Mile (no liner)	OPTION 3: Regional Landfill: Glennallen	OPTION 4: Regional Landfill: Mile 70	OPTION 5A: Regional Landfill: Valdez (lat. expansion)	OPTION 5B: Regional Landfill: Valdez (vert. expansion)	OPTION 6: Ship to Southeast	OPTION 7: Ship to Lower 48
Management/ Disposal	$2,747,000	$5,325,000	$4,173,000	$6,120,000 - 6,438,000	$7,084,000 - 7,509,000	$7,258,000	$6,827,000	$7,209,000	$6,769,000
Collection	----------	----------	----------	$1,547,000 (same cost for all options)					
TOTAL	$4,294,000	$6,872,000	$5,720,000	$7,667,000 7,985,000	$8,631,000 - $9,056,000	$8,805,000	$8,374,000	$8,756,000	$8,316,000

ANNUAL COSTS/TON [2] (1995 dollars)	OPTION 1: Vertical Expansion of Balefill	OPTION 2A: Construct Balefill at 17 Mile (w/liner)	OPTION 2B: Construct balefill at 17 Mile (no liner)	OPTION 3: Regional Landfill: Glennallen	OPTION 4: Regional Landfill: Mile 70	OPTION 5A: Regional Landfill: Valdez (lat. expansion)	OPTION 5B: Regional Landfill: Valdez (vert. expansion)	OPTION 6: Ship to Southeast	OPTION 7: Ship to Lower 48
Management/ Disposal	$112	$217	$170	$249 - 262	$288 - 306	$295	$277	$293	$276
Collection	----------	----------	----------	$63 (same cost across all options)					
TOTAL	$175	$280	$233	$312 - 325	$351 - 369	$358	$340	$356	$339

[1] Present value calculations are in 1995 $s and are based on an 8% discount rate and 20-year timeframe.
[2] Cost per ton estimates are based on 1994 solid waste generation of 2317 tons.

ATTACHMENT B

CITY OF CORDOVA, ALASKA

RESOLUTION 4-96-21

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF CORDOVA, ALASKA, TO APPROVE THE SELECTION OF THE MILE 17 SITE, COPPER RIVER HIGHWAY, FOR THE NEW CORDOVA LANDFILL

WHEREAS, the Planning and Zoning Commission at their 3/13/96 meeting adopted Resolution 96-05 (attached) identifying the Mile 17 areas as the site for the new Cordova landfill; and

WHEREAS, the City Council concurs with the decision of the Planning and Zoning Commission;

NOW, THEREFORE, BE IT RESOLVED that the City Council of the City of Cordova, Alaska, hereby adopts the Mile 17 area, located along the Copper River Highway, for the development of a new landfill; and

BE IT FURTHER RESOLVED that the City Council of the City of Cordova, Alaska, requests the State of Alaska to appropriate $400,000 from the settlement of the Copper River Highway lawsuit as partial funding for the development of the new Cordova landfill site.

PASSED AND APPROVED THIS 3 DAY OF April, 1996.

Margy K. Johnson, Mayor

Lynda Plant, City Clerk

ATTACHMENT C:

17 MILE LANDFILL BREAKDOWN OF CAPITAL COSTS

Item	Unit	Cost/ Unit	Quantity	Total Cost (20-yr Operating Period) [1]	Year 1 Costs
» Predevelopment Engineering Svcs. (incl. EIS, Feasibility Report, System Design)	LS	$250,000	1	$250,000	$250,000
» Site Development [2]	AC	15,000	6	90,000	22,500
» Access Road	LS	50,000	1	50,000	50,000
» Utilities [3]	LS	25,000	1	25,000	25,000
» Ancillary Building	SF	150	1,000	150,000	150,000
» Monitoring Wells	EA	10,000	4	40,000	40,000
» Permitting	LS			49,500	49,500
» Equipment and Vehicles	LS	153,000	3	459,000	153,000
» Contingency (20%)	N/A	---		222,700	148,000
TOTAL CAPITAL COSTS				**$1,336,200**	**$888,000**

[1] The capital costs are assumed to occur in the first year except for the following. Site development and permitting costs will be incurred in years 1, 6, 11, and 16 (equal amounts in each of the four years). Equipment and vehicle costs will be incurred in years 1, 8, and 15.

[2] Assume only 6 acres of site are developed for disposal; remaining acreage is buffer.

[3] Without electric.

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$0.0						
Travel		$0.0						
Contractual		$735.0						
Commodities		$0.0						
Equipment		$153.0						
Subtotal	$0.0	$888.0	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Indirect								
Project Total	$0.0	$888.0						
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: This budget reflects first year capital costs associated with opening a new landfill in Cordova. The City of Cordova will be responsible for paying all future capital costs as well as operations and maintenance costs associated with the site.

re. equipment purchases: In the past, equipment used at the Cordova landfill also could be used for other purposes by the City. Given the distance between the new landfill site and the city center (17 miles), this arrangement will no longer be possible. As a result, the City is obligated to purchase new equipment to be permanently housed at the new site.

1997

Project Number: 97229
Project Title: Cordova Solid Waste Disposal Site
Name: City of Cordova

FORM 4A
Non-Trustee
SUMMARY

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FFY 1997
						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	FFY 1997
						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

1997

Prepared:

Project Number:
Project Title: Cordova Solid Waste Disposal Site
Name: City of Cordova

FORM 4B
Personnel
& Travel
DETAIL

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed
Description	FFY 1997
Engineering Services (contractor to be procured to conduct preliminary studies and design first landfill cell)	250.0
Construction company to be hired to :	
develop the site	22.5
construct monitoring wells	40.0
improve access road	50.0
install utilities	25.0
construct ancillary buildings	150.0
Permitting fees	49.5
Contingency	148.0
Contractual Total	$735.0

Commodities Costs:	Proposed
Description	FFY 1997
Commodities Total	$0.0

1997

Prepared:

3 of 4

Project Number:
Project Title: Cordova Solid Waste Disposal Site
Name: City of Cordova

FORM 4B
Contractual & Commodities DETAIL

4/15/96

1997 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
Loader	1	153.0	153.0
			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**	$153.0

Existing Equipment Usage: Description	Number of Units	

1997

Project Number:
Project Title: Cordova Solid Waste Disposal Site
Name: City of Cordova

FORM 4B
Equipment
DETAIL

Prepared: April 12, 1996 4 of 4

4/15/96

VALDEZ DUCK FLATS RESTORATION PROJECT

Project Number:	91230
Restoration Category:	General Restoration
Proposed by:	Prince William Sound Economic Development Council (PWSEDC)
Lead Trustee Agency:	Alaska Department of Natural Resources
Cooperating Agencies:	United States Fish and Wildlife Service
Duration:	Two Years
Cost FY 97:	253,000
Cost FY 98:	1,500,000
Geographic Area:	Prince William Sound
Injured Resource/Service	Common Loon, Harlequin Duck, Common Murre, Bald Eagle, Marbled Murrelet, harbor seal, pink salmon, sockeye salmon, sea otters, blue mussel, and various subtidal and intertidal organisms.

ABSTRACT

The Alaska Department of Natural Resources has identified the waters of Valdez Duck Flats and near shore waters east to the mouth of the Lowe River as crucial estuarine habitat in the Prince William Sound Area Plan (ADNR, 1989). Wildlife species injured by the *Exxon Valdez* oil spill are threatened by crowding, disturbance, plastics pollution, and active human disturbance. The area provides important habitat for water birds, anadromous fish, and other estuarine and intertidal species. Work set forth in this proposal would further identify injured resources, aid in the recovery of spill impacted populations, mitigate effects of visitor traffic, design a local, volunteer monitoring program, and educate the public about the value of tidelands.

INTRODUCTION

The Valdez Duck Flats (Duck Flats), also known as Island Flats, is a rich, intertidal zone directly east and adjacent to the downtown area of Valdez, Alaska. The Duck Flats provide habitats for many aquatic and near shore species and support numerous species of wildlife, especially aquatic birds, anadromous fish, marine mammals and other intertidal organisms impacted by the 1989 *Exxon Valdez* oil spill. Because of proximity to the town center, the Richardson Highway, and a salmon viewing area, the Duck Flats are at risk from commercial development and visitor overuse (Figures 1 through 3). There is, however, substantial agreement between property owners and local residents that the highest and best use of the area is as a reserved habitat with infrastructure improvements that will protect both habitat and resident species from visitor pressure.

The U.S. Forest Service (USFS) has an interest in acquiring several parcels of land in the Flats (USS 448 and USS 349) close to the site of the present Forest Service Visitor Center. Additional efforts are being made to acquire a large part of USS 447 also adjacent to the Duck Flats. Taken together, these would form a continuous belt of habitat reserve along the Richardson Highway, covering the area most threatened by development and visitor impact. An example of visitor impact would be habitat damage to the blue mussel beds found on the Duck Flats. Blue Mussels are a food resource for several trophic levels including sea ducks and juvenile sea otters. Blue mussel beds can be damaged by vehicular traffic and pedestrians walking through the Duck Flats.

The Duck Flats were reviewed for nomination (1992) as an Area Meriting Special Attention within the City of Valdez Coastal Management Program. The Duck Flats have also received consideration, by the National Marine Fisheries Service (NMFS), for the establishment of a National Estuarine Research Reserve (NERR).

The Duck Flat's ecological characteristics, including its biological productivity, diversity of flora and fauna, and capacity to attract a broad range of research and educational interests, have been previously demonstrated. Numerous spill-impacted species are part of the greater ecology of the Duck Flats including, but not limited to, Marbled Murrelets, Bald Eagle, Common Loon, Common Murre, Harlequin Duck, pink salmon (wild-run), sockeye salmon, sea otter, harbor seal, blue mussel, and various subtidal and intertidal organisms.

The area is an estuarine system, which has definable boundaries and which is readily accessible to the general public. The Duck Flats constitute a large complex of estuarine and palustrine emergent, scrub-shrub, and forested wetlands, as well as intertidal mudflats and open water. Four of the five species of pacific salmon (coho, chum, pink, and sockeye) depend upon the flats and its creeks to provide an important spawning and rearing habitat. The Duck Flats maintain

significant resting, feeding, nesting, and staging habitat for numerous species of water and shorebirds, as well as other migratory and resident birds (Hemming and Erickson, 1979. Irons et al. 1985). The area's abundance of benthic organisms and small fish provide a rich food source for many of these species. In addition, the islands and open water adjacent to the Duck Flats support Steller sea lions, harbor seals, and sea otters.

Taken together, the parcels of land referenced above constitute the core of a vital estuarine ecosystem which supports numerous injured resources and which is under significant and increasing pressure from pollution and overuse by residents and visitors. This proposal, which seeks to protect the Duck Flats and insure recovery of injured species, is in line with the priorities of local, state, and national agencies.

The proposal is submitted with the understanding that disbursement of requested funding and all further project planning are contingent upon the resolution of outstanding land issues. We believe that these issues will be settled early in FY 97. The Prince William Sound Economic Development Council (PWSEDC) will work to insure that property issues are brought to closure in good time to facilitate planning and committee work scheduled for FY 97. Officials of the City of Valdez have articulated support for the resolution of land issues and are willing to act as an active partner in that process. Valdez city officials have also expressed interest in assuming responsibility for proposed improvements to the Duck Flats, pending review of designs and public input to the project.

NEED FOR THE PROJECT

A. Statement of Problem

The protection of wetlands is a nationally recognized priority. In Prince William Sound, efforts of this type take on greater significance in the light of habitat and species damage attendant to the 1989 *Exxon Valdez* oil spill. Intertidal habitats are the key to a healthy marine ecosystem. Located along the Richardson Highway and subject to high and increasing visitor traffic, the Duck Flats, as a micro-environment, are at risk from overuse, trampling, and physical pollution.

In addition, commercial development is encroaching on tidelands in the Duck Flats area. The number of visitors to Valdez increases annually, as does the length of the visitor season. The salmon viewing area at Crooked Creek received 120,000 visitors in 1995. Proposed or pending visitor-related developments that will have direct impacts on the Duck Flats include: a large hotel, a proposed camper park, the Valdez Visitor Center, a new ferry dock, a proposed cruise ship dock, and the possible upgrade of the USFS Information Center at Crooked Creek. While

all of these developments can be viewed as positive for the Valdez economy, they are also within walking distance of the Duck Flats and promise increased user pressure.

To protect the Duck Flats and resident oil spill impacted species, an integrated approach is needed that will:

- Protect the area from user impacts.
- Aid in the recovery of spill-impacted wildlife populations.
- Mitigate the aggregate effects of visitor traffic and spill damage.
- Protect habitat and resident species from physical pollution.
- Educate residents and visitors about the value of tidelands.
- Promote the sustained, productive, and appropriate use of the resources.

B. Rationale/Link to Restoration

Work proposed by this project is needed to protect and restore tideland resources. The continuing and accelerating loss of habitat in the Duck Flats will exacerbate the impacts of the *Exxon Valdez* oil spill to both habitat and resident species.

Given present plans for accelerated upland development, the increasing population of Valdez, and the inevitable increase in visitor numbers, this project is vital for the protection, restoration, and rehabilitation of tidal wetlands. Under the program proposed here, damaged resources will be locally identified and user patterns will be redirected to facilitate use of the area in a way that will protect intertidal habitat and minimize impacts to damaged and recovering species.

The educational component of the project will provide pertinent public information in the form of interpretive displays located along the visitor corridor. The displays will provide users with information about the history of the Duck Flats, the ecology of Prince William sound tidelands, proper use and enjoyment of the area, and impacts of the *Exxon Valdez* oil spill to both habitat and resident species. Post-construction monitoring will chart the effectiveness of the improvements and insure that preplanned traffic patterns are maintained. The monitoring effort will be staffed by volunteers and will include a continuous improvement process to insure ongoing protection of spill damaged resources.

C. Location

The project will be undertaken in Valdez, Alaska. Benefits will be realized in Valdez and throughout the Prince William Sound region.

COMMUNITY INVOLVEMENT

It is the intent of this project to identify and involve as many stakeholders as possible. To this end, a Duck Flats Committee (Committee) has been formed which includes local residents, representatives of local and state government agencies and personnel from the PWSEDC. The Committee will provide input during all phases of project planning and realization and will aid in educating user groups and the general public about project goals, processes and time lines. The Committee includes:

Mr. Dave Dengel - City of Valdez, Assistant City Manager/Director Community Development
Ms. Linda Kelly - City of Valdez, Parks and Recreation Commission
Dr. JoAnn McDowell - President, Prince William Sound Community College
Ms. Nancy Lethcoe - Alaska Wilderness Recreation and Tourism Association
Mr. Ron Crenshaw - Alaska State Parks
Mr. John Schoen - Alaska Department of Fish and Game (ADF&G)
Mr. John Nowlin - ADF&G
Ms. Kathleen Osowski - Wetlands Biologist, Dames & Moore
Mr. Matt Stephl - Water Projects Engineering Director, CH2M Hill
Ms. Gina Stannard - Architect, Ivy & Company, Anchorage
Mr. James Winchester - Projects Coordinator, PWSEDC

Regular Committee meetings, open to the public, will be held in Valdez during the scoping for the project. Full use of available local public media including press, talk radio, and locally produced TV, will be used to keep the public informed about the progress of the effort. The Committee will also aid in the development of a volunteer monitoring program which will continue after completion of the project. Local resources will be used to the fullest extent possible during design, construction, and monitoring phases. Direct material aid from local corporations and businesses will be sought. The City of Valdez will also be a key participant in all phases of the project.

PROJECT DESIGN

A. Objectives

The major objectives of this project are to:

1. Aid in the recovery of oil spill impacted species.
2. Protect sensitive wetlands habitat.
3. Channel recreation use to support objectives one and two.

4. Provide public education about the value of wetlands and the effects of the spill.

I. FY 97 - Planning and Design

A. Conduct environmental review of both literature and site to establish:

1. Human impacts to tidelands in Prince William Sound and Port Valdez.

2. Recreational and use patterns in the Duck Flats.

3. Appropriate methods of mitigation, restoration, and visitor channeling.

B. Select and design appropriate structures and improvements to facilitate public use with adequate protection for resources by:

1. Reviewing literature concerning boardwalks, trails, and visitor services for tidelands and near shore applications.

2. Assembling climatic and snow load information to insure long-term viability of structures.

3. Working with the Duck Flats Advisory Committee to refine and specify scope of work.

4. Designing improvements that will facilitate restoration goals.

II. FY 98 - Construction

A. Construct project with maximum use of local and volunteer resources.

B. Continually monitor construction efforts to insure compliance with restoration goals.

C. Design, construct, and install interpretive signage and displays.

III. FY 99 - Ongoing Evaluation (Volunteer)

A. Design and implement local monitoring program.

B. Conduct random sampling to assess satisfaction level of users with project and to provide data for ongoing, continuous improvements to the restoration process.

B. Methods

I. FY 97 - Planning and Design.

A. Assist and enable agencies to acquire Duck Flats properties for set-aside. Property issues are central to any restoration work in the Duck Flats and this proposal is contingent upon resolution of those issues.

B. Review information concerning micro-ecology, history, and resident wildlife populations.

C. Survey proposed route of Americans with Disabilities Act (ADA) accessible improvements.

II. FY 98 - Construction

A. Construct all facilities to highest ADA standard feasible for specific application.

B. Solicit qualified local volunteers to help design the monitoring program and to assess the effectiveness of the program both in protecting the habitat and providing visitor satisfaction.

III. FY 99 - Ongoing Evaluation (Volunteer effort)

A. Initiate volunteer evaluation programs.

B. Initiate continuous improvement planning process.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

To move ahead, the project will require assistance from a variety of state and federal agencies. For land acquisition, the efforts of USFS, ADNR, and the City of Valdez will be key. Representatives of several important agencies are members of the Duck Flats Committee. Representatives from other agencies may be required to address additional issues as they develop.

Because of complex land issues, all agency roles have not, at this time, been clearly defined. We believe that outstanding land questions will be resolved early in FY 97. At that point agency involvement and responsibility will be more clearly delineated.

The project will be carried out by the PWSEDC with assistance from an advisory group consisting of individuals from the following agencies and groups:

- City of Valdez
- Alaska Wilderness Recreation and Tourism Association
- Prince William Sound Community College
- Alaska State Parks
- ADF&G
- ADNR

Scientists, engineers, and construction contractors will be hired to assist with the conceptual and final design, construction, determination of damage to resources, and development of a long-term monitoring program.

SCHEDULE

A. Measurable Project Tasks for FY 97

Start-up to April 15, 1997 (Contingent on land acquisition):

- Complete land acquisition process facilitated by PWSEDC;
- Acquire and review relevant data;
- Meet with Committee to review objectives and assess community needs;
- Determine extent of pre-existing damage;
- Determine areas with highest human impact and traffic;
- Develop criteria for limiting access to injured resources;
- Develop alternatives for assessing Duck Flats;
- Hold preliminary meeting with regulatory agencies to identify concerns;
- Meet with Committee to evaluate alternatives;
- Develop a conceptual plan that evaluates alternatives in relation to specific task requirements;
- Identify a recommended plan and present to Valdez City Council and Community;
- Refine alternatives as necessary and complete final draft of conceptual plan;
- Meet with Committee to review draft plan;
- Complete final conceptual plan; and
- Complete necessary permits applications and apply for permits.

April 15 to May 15, 1997 (Contingent on land acquisition):

- Begin preliminary survey for completing scope of work;
- Complete any geotechnical data gathering, if necessary;
- Complete preliminary design drawings;
- Gain final approval of agency permits; and
- Meet with Committee, Valdez City Council, and community to appraise them of progress;

May 15, 1997 to September, 1998:

- Complete final design;
- Construct improvements; and
- Design and implement volunteer monitoring program.

B. Project Milestones and Deliverables

The project objectives will be met when the scope of work designed by scientific staff and Committee members has been completed and monitoring program is in place. Local contributions will include labor and planning effort by local citizens and professionals, aid from the City of Valdez in land acquisition and ongoing maintenance of constructed facilities, and aid from local corporations in the form of materials and volunteer labor in creating and staffing an ongoing monitoring program. Measurable project milestones will include:

1. Completion of land acquisition process;
2. Completion of community needs assessment;
3. Completion of draft conceptual plan;
4 Completion of final conceptual plan;
5. Informational meeting with City Council, Committee and City Council;
6. Completion of final design;
7. Construction of designed improvements;
8. Design and implementation of volunteer monitoring program; and
9. Implementation of continuous improvement program.

C. Completion Date

All project work is scheduled for completion by September 30, 1998

PUBLICATIONS AND REPORTS - N/A

PROFESSIONAL CONFERENCES - N/A

NORMAL AGENCY MANAGEMENT - N/A

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

It is a stated goal of this project to coordinate all proposed work on the Duck Flats with restoration efforts by federal, state, and local agencies. Each year Valdez is host to an increasing number of visitors. While this is very good news for the Valdez economy, it means additional pressure on resources such as the Duck Flats wetlands. The area is adjacent to the Richardson Highway and is within walking distance of the entire Valdez business district.

One new camper park has been constructed directly across the highway from the Duck Flats. A second is planned bordering on the proposed wetlands set-aside. A visitor center is being planned for construction in 1996 or 1997. One of the most frequently mentioned sites is across the highway from the Duck Flats. The Crooked Creek Salmon viewing area and the USFS interpretive center located across the highway from the Duck Flats saw 120,000 visitors during the 1995 season. A new ferry dock and a new cruise ship dock are proposed for construction in this same general location, within walking distance of the Duck Flats.

In August of 1995, work was initiated on a series of improvements to Dock Point, a glacial drumlin largely owned by the City of Valdez and adjacent to the Duck Flats. The improvements, funded by Alaska State Parks in 1995, include restrooms, parking, and ADA accessible trails. The Dock Point project, when completed in July 1996, will be an excellent addition to visitor services in Valdez and will preserve a valuable habitat adjacent to the Duck Flats. This project will also attract additional visitors to the Duck Flats area.

A pattern of heavy and increasing human use is developing around the Duck Flats which makes it imperative that the site be hardened to protect spill impacted resources. It is also vital that the Duck Flats be included in comprehensive development planning for the area. Efforts are being made to insure that the plans of the City of Valdez, Parks and Recreation Department are consistent with the goals of the USFS, ADF&G, ADNR, and Alaska Department of Transportation (ADOT). The Committee formed to plan and guide this effort includes representatives form ADNR, ADF&G, the City of Valdez, user groups and the general public.

PERSONNEL

James Winchester will serve as the project manager for the Valdez Duck Flats program. Mr. Winchester has been managing projects in the Prince William Sound region for over nine years. He has extensive experience in construction management as well as community planning and facilitation. As the project manager, Mr. Winchester will have ultimate responsibility for all aspects of the work. This scope of responsibility will include technical, financial, administrative, and quality control issues.

James Winchester
Prince William Sound Economic Development Council
P.O. Box 2353
Valdez, Alaska 99686
(907) 835-3775

Matt Stephl P.E., has been selected as the design and construction manager for the restoration improvements portion of this project. Currently, Mr. Stephl is the Director of Water Projects at CH2M Hill in Anchorage with 11 years experience in design and construction for water-related projects. Mr. Stephl joined the Prince William Sound Economic Development Council Professional Advisory Board in 1993.

Matt Stephl, P.E.
CH2M Hill
301 West Northern Lights, Suite 601
Anchorage, Alaska 99503
(907) 278-2551

Gina Stannard will be the lead architect for this project. In this role, her responsibilities will include project design, construction feasibility and implementation. Ms. Stannard is an architect (licence pending) with Ivy & Company, Inc. in Anchorage and has been a Prince William Sound Economic Development Council Professional Advisory Board member since 1994.

Gina Stannard
Ivy & Company, Inc.
3702 Spenard Road
Anchorage, Alaska 99503
(907) 562-3366

Kathleen Osowski is the wetland scientist for this project. Ms. Osowski will conduct habitat evaluation studies and environmental monitoring. These studies will include a threatened or endangered species inventory, wetland delineation, function and value assessment, pathway

migration studies, and impact studies. Ms. Osowski is a biologist with the Alaska Region of Dames & Moore. She is certified in wetland delineation, as well as wetland construction and restoration, and is a member of the Alaska Chapter of the Society of Wetland Scientists.

Kathleen Osowski
Dames & Moore
5600 B Street, Suite 100
Anchorage, Alaska 99518
(907) 562-3366

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1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997
Personnel		$0.0
Travel		$5,000.0
Contractual		$215,000.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$220,000.0
Indirect		$33,000.0
Project Total	$0.0	$253,000.0
Full-time Equivalents (FTE)		0.0

LONG RANGE FUNDING REQUIREMENTS

Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
1.5 mil				

Dollar amounts are shown in thousands of dollars.

Other Resources

Comments:

Travel - Amount listed for travel is primarily for Duck Flats Committee use. Five Committee meetings will be held in Valdez. Representatives from Anchorage will need to fly to Valdez to attend these sessions. Additional funds are needed for Prince William Sound Economic Development Council staff to attend agency and permitting meetings in Anchorage.

Commercial - Two primary contractors will work on the project. Engineering, construction, planning, and surveying will be managed by a civil engineering firm. Environmental work will be conducted by certified wetland scientists from an environmental consulting firm.

General Administration - The Prince William Sound Economic Development Council will administer the project and facilitate all Committee work and public involvement. The rate for administrative costs is 15.34%.

1997

Prepared:

Project Number:
Project Title: Valdez Duck Flats Project
Name: Prince William Sound Economic Development Council

FORM 4A
Non-Trustee
SUMMARY

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:

Name	Position Description	Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1997
[redacted]	[redacted]				0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
	Subtotal [redacted]	0.0	0.0	0.0	[redacted]
				Personnel Total	$0.0

Travel Costs:

Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FFY 1997
[redacted]	160.0	25	25	40.0	5,000.0
Five personnel needed to travel from Anchorage to Valdez for four meetings; and					0.0
Project Director traveling from Valdez to Anchorage for approximately five meetings.					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5,000.0

1997

Prepared:

Project Number:
Project Title: Valdez Duck Flats
Name: Prince William Sound Economic Development Council

FORM 4B
Personnel
& Travel
DETAIL

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Contractual Costs: Description	Proposed FFY 1997
Environmental monitoring and review;	65,000.0
Planning and design of restoration improvements.	150,000.0
Contractual Total	$215,000.0

Commodities Costs: Description	Proposed FFY 1997
Commodities Total	$0.0

1997

Prepared:

Project Number:
Project Title: Valdez Duck Flats
Name: Prince William Sound Economic Development Council

FORM 4B
Contractual & Commodities DETAIL

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
			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

[redacted]

1997

Prepared:

Project Number:
Project Title: Valdez Duck Flats
Name: Prince William Sound Economic Development Council

FORM 4B
Equipment
DETAIL

4/15/96

MARBLED MURRELET PRODUCTIVITY RELATIVE TO FORAGE FISH AVAILABILITY AND ENVIRONMENTAL PARAMETERS

Project Number:	97231
Restoration Category:	Research (new)
Proposer:	U.S. Fish and Wildlife Service (PI - Kathy Kuletz)
Lead Trustee Agency:	DOI
Cooperating Agencies:	NOAA, ADFG, University of Alaska, Fairbanks
Alaska SeaLife Center:	NA
Duration:	4 years
Cost FY 97:	$217.7 K
Cost FY 98:	$200 K
Cost FY 99:	$200 K
Cost FY 00:	$ 95 (data analysis, reporting, publications)
Geographic Area:	Prince William Sound, Kachemak Bay
Injured Resource:	Marbled Murrelet

ABSTRACT

This project investigates the hypothesis that forage fish abundance is limiting marbled murrelet reproductive success and thus recovery. We will compare forage fish abundance, as determined by APEX and SEA studies, to an index of murrelet productivity. Intra- and inter-annual comparisons will be made among 6 sites in Prince William Sound and between Prince William Sound and Kachemak Bay. We will also integrate data on terrestrial and marine habitat use to make a descriptive model of adult and juvenile murrelet distribution, and examine historical data for changes in the present distribution of murrelets indicative of ecosystem-level changes. This project responds to the Trustees' suggestion that a murrelet project be done in the context of the APEX project. Because this is a new project, it is submitted separately for an independent review.

A. INTRODUCTION

Marbled murrelets (*Brachyramphus marmoratus*) are the most abundant seabird in Prince William Sound (PWS) in the summer, but their population has declined significantly since the early 1970's (Klosiewski and Laing 1994). Murrelets depend on forage fish such as Pacific sandlance, (*Ammodytes hexapterous*), capelin (*Mallotus villosus*), juvenile herring (*Clupeidae spp*) and juvenile pollock (*Gadidae spp*) (Oakley and Kuletz 1979, Krasnow and Sanger 1986, Sanger 1987, Kuletz, unpubl. data). The limited data available on the distribution of these fish in PWS suggest, circumstantially, that they determine murrelet distribution. Although some areas of PWS have higher densities of murrelets than others, marbled murrelets are typically observed as singles or in pairs, and they are the most evenly dispersed seabird in PWS (Klosiewski and Laing 1994, Agler et al. 1994). Forage fish are also widely dispersed in PWS, often in very small patches < 3 m across (Ostrand and Maniscalco 1996, Coyle, University of Alaska, Fairbanks, pers. comm.). Thus, in a crude sense, the distribution of marbled murrelets reflects the distribution of their prey.

On a smaller scale, marbled murrelets appear to forage on small schools of fish in nearshore, shallow waters, or areas of upwelling (Kuletz et al. 1995, Ostrand and Maniscalco 1996). The foraging locations of radio-tagged birds (Kuletz et al. 1995) and density of murrelets relative to marine habitat (Kuletz et al. 1996) have suggested that some hydrographic features attract murrelets, presumably because prey are consistently available there. The mechanisms of how murrelets obtain food, or what physical and biological features they respond to, will be examined by the seabird/fish interaction portion of APEX (Project 97163B). APEX results will be used by this project to model murrelet distribution based on nesting and marine habitat use.

The foraging behavior and unique nesting ecology of marbled murrelets may explain why they dominate the avifauna of Prince William Sound. Because they are not colonial and can disperse inland, they are not limited by the amount of cliff-type habitat that restricts the nesting distribution of many seabirds. Lacking the restriction of central colony locations, murrelets may be better able to exploit dispersed prey at relatively low abundance.

Other seabirds, such as puffins, murres and auklets, may require larger abundance thresholds of prey to forage and breed successfully (Piatt 1990). Large colonies of these birds are located in lower Cook Inlet, where forage fish are more abundant than in the Sound by at least an order of magnitude (Haldorson et al. 1996, J. Piatt, National Biological Survey, Anchorage AK, unpubl. data). An exception among the colonial seabirds is the black-legged kittiwake, the second-most abundant bird in PWS. This species feeds in close association with the marbled murrelet, and may partially rely on the foraging activity of the murrelet to make prey available (Ostrand and Maniscalco 1996).

Although murrelets can use small, dispersed patches of prey typical of PWS, certain hydrographic features probably result in regions of relatively high prey abundance (Haney and McGillivary 1985, Hunt et al. 1990, Coyle et al. 1992), or bring prey to the surface at frequent

and predictable intervals (Burrell 1987, Hunt 1995). Such regions should support higher densities of murrelets than less productive or less predictable sites. If murrelets nest preferentially in the vicinity of these 'hot spots' (ie., an average of 20 km from nest to forage locations, based on the forage range of murrelets radio-tagged in PWS [Kuletz et al. 1995]), productivity, as measured by the abundance of juveniles at sea, should also be higher there.

As a result of the 'hot spot' phenomena, one prediction of this project is that areas with more prey will have more adults breeding nearby and thus consistently higher density in that area. The second prediction is that areas with greater prey availability will have locally higher productivity, and thus among areas, the ratio of juveniles to adults will be positively correlated with local prey biomass. Finally, in years with greater prey abundance, productivity will be higher, even though the density of adults remains stable. During murrelet surveys in 1994 and 1995, although there is no comparative data on prey abundance, we found significantly higher juvenile murrelet ratios at two sites in 1995, while adult densities remained stable (Kuletz et al. 1996).

There is evidence of ecosystem-wide changes in the Gulf Alaska (Piatt and Anderson 1996) that likely affected PWS. Between 1979 and 1981 pigeon guillemots at Naked Island fed their chicks fewer sandlance each year (Kuletz 1983), and between 1989-1995, gadids and blennies were the predominant food (Oakley and Kuletz 1996, Hayes 1996). Additionally, murrelets collected in 1978 were feeding heavily on sandlance, whereas murrelets collected in 1989 contained more gadids (Oakley and Kuletz 1979, Kuletz, unpubl. data). In contrast, sandlance are still the primary prey of murrelets in Kachemak Bay (J. Piatt, unpubl. data).

Changes in prey species, as well as general abundance, might have caused the decline in murrelets since the 1970s. For many seabirds, sandlance are associated with higher reproductive success (Pearson 1968, Harris and Hislop 1978, Hunt et al. 1981, Vermeer 1979, 1980, Monaghan et al. 1989), and in most of its range, murrelets appear to select sandlance (Sealy 1975, Carter 1984, Burkett 1995). To examine the effect of prey species, we will compare murrelet diet with the relative abundance of species as determined by APEX, to determine if there are regional differences in diet and if there is a general correlation with intra- and inter-annual productivity.

The PWS murrelet population declined by 67% between 1972 and 1989, and the hypothesis of the APEX project is that lack of food has been the primary cause of decline by marine species. If there are hydrographic features associated with preferred prey types, or better prey availability, seabirds might concentrate in such areas. Conversely, changes in prey might be evident in the relative distribution of a population. For example, excluding the year of the oil spill, murrelet counts around Naked Island from 1978-1980 were not significantly different from 1990-1992 (Kuletz 1996). This suggests that either the larger population decline occurred before 1978, or that some areas (such as Naked Island, which has a large shallow shelf), now draw a larger proportion of PWS birds than previously. We will attempt to use historic data to determine if there has been a distributional shift in murrelet density in PWS consistent with forage fish / habitat associations defined in PWS by APEX. Such changes from historical distribution should

be consistent with proposed ecosystem-wide changes in food supply.

The overall hypothesis of this multi-year study is that food availability is limiting the recovery of the PWS murrelet population. This hypothesis will be investigated by making multi-scale comparisons of intra-annual differences in murrelet productivity to relative prey abundance - among six sites in Prince William Sound and between the regions of Prince William Sound and Kachemak Bay. Inter-annual differences in productivity relative to forage fish abundance will be analyzed after the final field season of the study (1997 - 1999). This project builds on knowledge obtained from previous restoration studies that investigated murrelet nesting habitat (Projects R15, 93051B) and foraging patterns (94102), and developed the productivity index (95031). It will depend on integration of data from concurrent studies on the mechanisms of foraging ecology of seabirds in PWS and measures of forage fish abundance (APEX [97163A-P], SEA [97320])

NEED FOR THE PROJECT

A. Statement of Problem

The marbled murrelet is a threatened species under the Endangered Species Act in California, Oregon and California and a species of concern in Alaska. The *Exxon Valdez* oil spill caused the largest single-event mortality of marbled murrelets in the world (Carter and Kuletz 1995). Although murrelets suffered high mortality in the 1989 spill (Ecological Consulting, Inc. 1991, Piatt et al. 1990, Kuletz 1996), the spill cannot account for the 67% reduction in numbers observed in post-spill years (Klosiewski and Laing 1994); nor has the population increased since 1989 (Agler et al. 1994).

In other areas, marbled murrelet populations have declined primarily due to the loss of old-growth forest nesting habitat (Stein and Miller 1992). However, a comparatively small proportion of potential nesting habitat has been harvested in PWS. Changes in the food supply can also affect seabird populations (Cairns 1989, Monaghan et al. 1989, Furness and Nettleship 1991). Murrelet reproduction may be limited by food if adults can not provide sufficient quantity or quality of prey to their chicks. Because other piscivorous birds and marine mammals in PWS have declined as well, (Frost et al. 1994, Klosiewski and Laing 1994), a lack of food resources is the main hypothesis of the APEX project.

B. Rationale / Link to Restoration

If food is limiting murrelet reproductive success, it is likely that recruitment is limiting recovery of the population. Because murrelets are probably long-lived (Beissinger 1995), changes in the population due to low reproduction may not be evident for a decade or more, which may preclude timely management decisions. We will use information on the physical and biological factors (terrestrial and marine) that influence murrelets, to develop a descriptive model of

murrelet productivity and to fine-tune the productivity index for future cost-effective monitoring. The concurrent studies of forage fish abundance, distribution, species and processes affecting prey availability provide a unique opportunity to approach the restoration of murrelets in the context of its ecosystem. Examining historic data for changes in murrelet distribution may identify spatial patterns of change indicative of ecosystem changes. Ultimately we will improve our ability to predict how management options will affect the recovery of murrelets.

C. Location

This project will occur in Prince William Sound, and through a cooperative effort with project 97163M (Cook Inlet studies), in Kachemak Bay. The six PWS study sites will be lower Valdez Arm, Unakwik Inlet, Naked Island, northern Knight Island, Port Nellie Juan and Jackpot Bay/Dangerous Passage. These areas were selected because of the availability of historic data on murrelets and overlap with the APEX fish sampling. They are separated by approximately 16 km, the average distance traveled between feeding and nest sites by murrelets in PWS, and twice the distance that a juvenile murrelet tagged at its nest moved over a 2 week period (Kuletz et al. 1995).

The National Coast Guard dock at Valdez and local hotel facilities will be used during surveys of Valdez Arm. In 1995, the PWS Aquaculture Association allowed use of their facilities at the Cannery Creek hatchery in Unakwik Inlet during our surveys there, which we will request again. Near Port Nellie Juan we will request temporary boarding at the Main Bay hatchery. At Naked Island and northern Knight Island we will share field camps used by projects 97163E (kittiwakes) and 97163F (guillemots), which will require U.S. Forest Service permits. The camp site at Jackpot Bay, which will be shared with project 97163G (seabird energetics), is owned by the Chenega Native Corporation, and will require leasing of that land.

In Kachemak Bay the Homer boat harbor will be used, but primary residence and operations will be on the south side of the bay, and we will stage from Seldovia or the University of Alaska Marine Lab at Kasitna Bay. Our operations in Kachemak Bay will be done in conjunction with Project 97163M (Cook Inlet studies). Both projects will also be coordinating with the Alaska Maritime National Wildlife Refuge for occasional logistical support.

COMMUNITY INVOLVEMENT

Murrelets are not used for subsistence by local communities. They are, however, subject to gillnet mortality (Wynne et al. 1992, Carter et al. 1995). Gillnet by-catch, and observations by fishermen, could identify areas with high juvenile murrelet activity or concentrations of post-breeding adult murrelets. The principal investigator is currently a member of the Seabird Network Bycatch Working Group (fish1ifr@aol.com), an international group of biologists, fisheries managers and conservation organizations working to develop options to reduce seabird, and especially marbled murrelet bycatch.

In late summer, dead juvenile murrelets have been found by residents in the spill area. These carcasses often show evidence of starvation and they can be a valuable source of data. Such opportunistic samples will be solicited through educational posters and notification of local fishing and recreation groups. In 1994 and 1995 we displayed a poster soliciting murrelet carcasses in Whittier and Cordova, and local residents contributed samples. We will continue this effort. We will also maintain contact with the Bird Treatment and Learning Center in Anchorage, which has notified us of murrelet fledglings they receive and raise. These contacts have provided data on body weight and photographs of juvenile plumages.

PROJECT DESIGN

A. Objectives

The goal of this project is to determine if food is limiting marbled murrelet productivity. The specific objectives are:

1. Assess the relationship between relative prey abundance and murrelet productivity.

2. Describe the distribution of adult and juvenile murrelets in Prince William Sound relative to terrestrial and marine features.

3. Compare historic and current murrelet distribution in Prince William Sound to determine if it has changed, or is consistent with hypothesized ecosystem effects.

B. Methods

Objective 1: Assess the relationship between food and murrelet productivity.

The main hypothesis of this objective is that murrelet productivity will be higher in areas and in years when forage fish availability is relatively higher. Data on food availability will be obtained primarily through the APEX forage fish studies (see below). It is not possible to study murrelet reproductive success by standard means at nest sites because of their highly dispersed, secretive, inland nesting habits. We will use a productivity index, based on the at-sea ratio of juveniles to adults, that was developed for southcentral Alaska (Kuletz et al. 1995, 1996) in conjunction with researchers at lower latitudes (Ralph and Long 1995, Strong 1995). We used the foraging ranges of adults (Kuletz et al. 1995) to determine dispersal of study sites.

Data Collection

Murrelet Productivity.-- We will conduct shoreline at-sea surveys at the same six sites surveyed in 1995 (Fig. 1). Two crews (1 driver and 2 observers each) will survey from 25 ft. Boston

Whalers using standard FWS protocol (Klosiewski and Laing 1994). The surveys will follow established FWS shoreline transects that are digitized on Atlas/GIS files (Strategic Mapping, Inc. 1992). At each site, a total of 45 - 60 km of shoreline will be surveyed. Surveys will be conducted between 0600-1600 hours (murrelet counts vary significantly earlier or later in the day [Carter and Sealy 1990, Kuletz 1994, Appendices]). Each site will take one day to survey per sample.

In 1995 we found a significant relationship between the number of adults at a site in June and the number of juveniles there in late summer. Because adults leave in late summer, the June population is most representative of the local breeding population, and thus June adult counts may be the most reliable for juvenile : adult ratios (Kuletz et al. 1996). We will continue the June surveys in 1997, and our baseline surveys will be conducted 1-15 June. The numbers of murrelets in each area in June will be used for comparison to late summer juvenile counts.

Juvenile surveys will be conducted at the same 6 locations between 25 July and mid August. At least two crews will be needed to obtain replicates of all 6 sites during the juvenile survey window (Kuletz et al. 1996). The 6 sites will be surveyed twice per week, with the 2 crews rotating among sites to minimize temporal effects. In early June, day-to-day variability is relatively low, and 2 or 3 replicates per site is adequate. Juvenile surveys in late summer must accommodate inter-annual changes in peak fledging dates, and higher day-to-day variability (Kuletz et al. 1996), therefore, each site will have 6 replicates. Thus there will be a total of 18 surveys in June (6 sites x 3 replicates) and 36 surveys in late July/mid August (6 sites x 6 replicates).

At Kachemak Bay, murrelets are concentrated along the south side (Kuletz 1988, 1996), where transects along approximately 40 km of shoreline will be selected. As in PWS, murrelet counts in June are less variable than in July and August (Kuletz et al. 1988). Two or three June baseline surveys will be conducted concurrent with hydroacoustic surveys by Project 97163M (Cook Inlet studies). The same transects will be surveyed 5 times between 25 July and mid-August. Observers will count all birds $\leq$ 200 m from shore. Observers will be trained to score birds by plumage and behavioral characteristics (Carter and Stein 1995, Kuletz et al. 1996), using photos, study skins, drawings and on-sight training to standardize observers.

Hydroacoustics. -- The main hypothesis, that food is limiting murrelet productivity, will be tested by comparing the average juvenile ratio among sites relative to local prey availability. Four of the study sites overlap with the APEX sampling grid, and relative prey abundance will be obtained from that project. Due to budget constraints, the APEX effort can not extend into Port Nellie Juan and Unakwik Inlet. Hydroacoustic data for these 2 sites will be gathered by this project using the same Biosonics DT4000 digital echosounder. (Purchase costs to be shared with Project 97163B, seabird foraging). To reduce costs, ground-truthing by sampling prey during hydroacoustics at these 2 sites will only be supplemental. Prey sampling will be done opportunistically from the Boston Whaler using dipnet and thrownet.

Because the main goal of this project is to obtain a relative index of prey abundance among sites to correlate with fledgling density, we can use the index of backscatter from the digital data without sampling prey to calculate biomass. However, studies are currently underway to allow calibration of digital hydroacoustic data that will identify prey species and thus enable us to use the backscatter data we collect for calculating prey biomass at a later date, if so desired. Such techniques may be available by the 1997 field season (G. Rose, University of Newfoundland, St. John's, pers. comm.).

Diet. -- The diet of murrelets will be ascertained in the context of the APEX study by collecting birds during APEX hydroacoustic surveys. It is necessary to collect birds because murrelets usually swallow prey underwater, observations of birds with fish at the surface are rare, and it is usually not possible to discern prey species from a boat (Kuletz et al. 1995). Stable isotope analysis can not provide specific information on prey species, and fatty-lipid analysis has not been developed for seabirds. Attempts to force alcids to regurgitate have not been successful (J. Piatt, pers. comm.).

In 1997 we propose to collect up to 30 birds, 10 at each of 3 sites sampled by APEX. To avoid or minimize additional collecting of murrelets, we will first determine if the prey taken by murrelets is equivalent to that sampled by APEX during foraging events. Second, black-legged kittiwakes will be sampled during the same events (in conjunction with 97163E, kittiwake foraging), to determine if they are using the same prey as murrelets. Finally, murrelets foraging without kittiwakes will be sampled to determine if the diet of murrelets in single-species flocks is similar to that of murrelets foraging with kittiwakes. No further murrelets will be taken if a) murrelets take the same prey sampled in trawl or other ground-truthing techniques, b) murrelets take the same prey as kittiwakes during a foraging event and c) murrelets foraging alone take the same prey as those foraging with kittiwakes. In this scenario, the diet of murrelets will be inferred from human sampling of prey during ground-truthing, or from the collection of kittiwakes over schools of fish. If the diet of murrelets varies from that of kittiwakes, we may request additional collections in 1998 and 1999.

Data analysis. -- As in 1995, we will test for differences in the absolute numbers and ratios of juveniles : adults among sites, using Z tests on the standard error of the ratios (Manley et al. 1993). The ratio of juveniles will also be calculated relative to total murrelets in June (presumably the local breeding population), and compared among sites with a Kendall *taub* correlation test. A non-parametric ranking test will be used to determine if relative prey abundance among the six sites is correlated with relative murrelet and juvenile murrelet density.

Objective 2: Factors affecting murrelet distribution

The marine habitat requirements of murrelets are only partially understood. Project 97163B, the seabird/fish interaction component of APEX, will examine the mechanisms that influence seabird distribution at sea. However, the study of seabird/fish interactions often examines small-scale relationships to describe mechanisms. Because of the distribution and scarcity of juvenile

murrelets, the murrelet productivity project will work primarily on a larger scale, with the six study sites as sample units. The murrelet project will use criteria developed by 96163B and 97163B that describe small-scale characteristics of 'good' foraging habitat to rank marine habitats contained in each study area. These results will be integrated with data collected by 97163A (fish populations) and the murrelet project to describe murrelet distribution relative to mid-scale food availability and environmental factors.

The distribution of adults and juveniles at sea may be partially determined by nesting distribution, or the combination of terrestrial and local marine habitats. Therefore, environmental data for the murrelet study areas will include spatial data from GIS bathymetric and terrestrial coverages as well as temporal data collected on-site. Temporal data will be collected during the murrelet surveys prior to each transect (11- 18 per site), and will include air and surface temperature and salinity, presence of glacial ice, water clarity (by Secchi disk), sea conditions, weather, time and observed feeding activity. We will calculate tide with a Paradox (Borland, Inc. 1992) script (Kuletz / FWS files). Shoreline and bathymetric features will be taken from GIS at the transect level (small scale) and averaged for the area (mid scale). We will test for differences between adult and juvenile habitat associations with log-linear analysis at the transect level. Descriptive statistics and non-parametric ranking will be used to distinguish study areas of low and high murrelet density.

Integrated into the above will be the results of two field tests. In conjunction with 97163B (seabird foraging), we will examine murrelet feeding and abundance at a known foraging 'hot spot' identified in Port Nellie Juan (Kuletz et al. 1995 and 1996; see also 97163B proposal). Additionally, we will compare temporal and spatial changes in fish around the Naked Island area with changes in the distribution of murrelets. In 1991 and 1992 Kuletz et al. (1994) found that murrelets concentrated closer to shore in late summer compared to early June, presumably because of seasonal changes in the local distribution of fish. In 1997 this project and 97163B will conduct a similar 2-day survey in June. The late summer survey will be part of the forage fish population surveys (97163A). We will compare murrelet distribution to fish distribution based on hydroacoustic surveys conducted by 97163A and 97163B.

Objective 3: Examine historical data

Historical data primarily consists of the 1972/73 USFWS boat surveys of PWS, which were used to derive the pre-spill population estimates. We propose to use a Geographic Information System software (such as CAMRIS; Computer-Aided Mapping and Resource Inventory System; see Piatt and Ford 1993) to map abundance estimations in PWS. From these maps, regions of high and low murrelet densities will be defined. Post-spill densities for these regions will then be calculated from 1990-1996 boat surveys and tested for rank correlations. Hydrographic and landform features will also be examined between regions of high and low murrelet density in pre and post-spill years to determine if the murrelet's relationship to these factors has remained consistent.

C. Cooperating Agencies, Contracts and Other Agency Assistance

We have the expertise and technical support to perform the majority of our geographic information system (GIS) needs. As coverages are developed for nearshore and pelagic areas of Prince William Sound by other projects, we may require agency support to obtain files. Our study will integrate data on forage fish and oceanographic conditions obtained by APEX (NOAA) and the SEA studies. Training and assistance in use of BioSonics hydroacoustic equipment will be contracted. Analysis of hydroacoustic data will be done under agreements with cooperating universities or agencies conducting hydroacoustic work.

SCHEDULE

A. Measurable Project Tasks for FY 97

Oct. 1 1996 -	Preliminary examination of historical data
December 31 1997:	Prepare data from 1994 & 1995 surveys and GIS coverages
	Prepare NEPA compliance documents and USFS permits
	Rewrite and submit manuscripts submitted to journals
November 13-17:	Present paper at International Symposium on Forage Fish
January:	Present paper at Pacific Seabird Group meeting
Feb 1-March 15:	Arrange logistics for boats, equipment, contracts
March 1-May 30:	Training in hydroacoustics, safety, hiring
June 1 - 15:	Conduct baseline surveys at study sites
June 15-July 20:	Enter data, prepare for late-summer surveys, APEX work
July 21-August 20:	Juvenile surveys
Aug 21-Sept 1:	Store field equipment, data entry and management
September 1- 30:	Hydroacoustic analysis, analysis of field data

B. Project Milestones and Endpoints

The primary objective of this project depends on obtaining a reliable index of relative forage fish abundance to correlate with the juvenile : adult murrelet productivity index. The success of this portion of the project will be determined by the end of the first season. Data with finer resolution, specifically biomass calculations based on ground-truthing of digital hydroacoustic data, may be obtainable in 1997, but can be accomplished in FY 98 or FY 99 and still provide additional results. Intra-annual comparisons of the productivity and fish indices will be made available in annual reports. Inter-annual comparisons will be reported in the final report. Spatial comparisons will also be made between PWS and Kachemak Bay, in cooperation with project 97163M (Cook Inlet studies), to be presented in the final report.

The second and third objectives will be partially met by preliminary examination of terrestrial and historic data (respectively) in FY97. Following that, comparison with present-day data will begin in FY 98. The data on forage fish distribution and mechanisms of fish availability to

murrelets (APEX studies) will be necessary to complete these objectives, so that interim analyses will be finalized a year after all field work is completed.

C. Completion Date

PUBLICATIONS AND REPORTS

April 15, 1998:	Annual Report and Summary of work accomplished in summer 1997, and preliminary findings.
April 15, 1999:	Annual Report and Summary of work accomplished in summer 1998, and preliminary findings.
April 15, 2000:	Annual Report and Summary of work accomplished in summer 1999, and preliminary findings.
April 15, 2001:	Draft final report of research, 1997-1999.

Interim aspects of this study will be submitted for publication in journals periodically between 1997-2000. Following the final field season, synthesis papers will be submitted. In addition, the Principal Investigator will be co-author on papers related to the pigeon guillemot project in FY97 (see 96163E, kittiwakes and 97163F, guillemots). Proposed articles derived from the murrelet project are listed below:

Oct. 1997	Comparison of the historic and current distribution of *Brachyramphus* murrelets in Prince William Sound, Alaska. Colonial Waterbirds.
May 1998	Changes in the distribution of murrelets around Naked Island, Prince William Sound, Alaska, relative to the distribution of forage fish. J. Field Ornithology.
Nov. 1999	Factors influencing the detection and distribution of juvenile marbled murrelets in Prince William Sound, Alaska. Wilson Bulletin.
May 1999	Terrestrial and marine factors determining the at-sea distribution of marbled murrelets in Prince William Sound, Alaska. Condor
Nov. 2000	Spatial and temporal differences in the diet of marbled murrelets in southcentral Alaska and possible effects on productivity. Auk
April 2001	The relationship between indices of forage fish abundance and marbled murrelet productivity between 1997-1999 in southcentral Alaska. Auk.

PROFESSIONAL CONFERENCES

Annual findings will be presented at symposia and conferences. Portions of the historic data on diet will be presented at the November 1996 International Symposium on the Role of Forage Fishes in Marine Ecosystems in Anchorage. Preliminary findings of the population changes will

be presented at the International Symposium on Changes in Pacific Seabirds in Asilomar, California in 1998.

NORMAL AGENCY MANAGEMENT

It is not part of normal agency management in Region 7 of U.S. Fish and Wildlife Service to monitor the productivity of marbled murrelets. Periodically, seabird diets may be examined by collection of seabirds, which may include marbled murrelets.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The marbled murrelet is one of the injured species that is targeted by the APEX project (97163). Because the marbled murrelet requires specific methods and protocols not consistent with that of other seabirds being studied, the murrelet project is proposed independently. However, it will be fully integrated with APEX and the study design has been developed interactively with APEX principal investigators.

This project is dependent on the APEX project to provide fish abundance data to test the main hypothesis (Project 97163A). The mechanistic interactions between murrelets and forage fish described by Project 97163B (seabird foraging) will be used to develop the integrated terrestrial/marine murrelet distribution model. Productivity comparisons among years will be made in the context of other seabirds (Projects 97163E, kittiwakes and 97163F, guillemots). The relative value of different prey species, critical to the diet hypothesis of this project, will be described by Project 97163G (seabird energetics). Historic examination of murrelet distribution will be supplemented by the historical analysis of forage species (Project 97163L, historical analysis).

The spatial comparison between PWS and Kachemak Bay will be done in conjunction with Cook Inlet studies (97163M), which will also provide relative forage fish abundance for that region. Information exchange relative to herring and other nearshore prey will occur between this project and the SEA and NVP projects. Although this project was initiated for the marbled murrelet, data for both *Brachyramphus* species (marbled and Kittlitz's) can be collected simultaneously, and thus will benefit the Kittlitz's murrelet restoration effort.

PROPOSED PRINCIPAL INVESTIGATOR:

Project Leader: Kathy Kuletz
U.S. Fish and Wildlife Service
1011 E. Tudor Rd, Anchorage, AK 99503
Phone:907-786-3453 Fax:786-3641
E-mail: kathy_kuletz@mail.fws.gov

Kathy Kuletz received her B.S. degree in Biology from California Polytechnic State University, San Luis Obispo (1974), and her M.S. degree in Ecology and Evolutionary Biology from University of California, Irvine (1983). Her thesis was on the foraging and reproductive success

of pigeon guillemots at Naked Island, Prince William Sound. Ms. Kuletz has worked in Alaska since 1976 for Dames and Moore Consulting, LGL Alaska Research and the U.S. Fish and Wildlife Service. Since 1989 she has been Principal Investigator for the marbled murrelet damage assessment and restoration studies. She has been working with the Pacific Seabird Group Marbled Murrelet Technical Committee to develop protocols for inland and at-sea murrelet surveys. She participated in and assisted in the writing of the Pacific Seabird Group Restoration Workshop in 1995.

PERSONNEL

Field Supervisor/GIS Assistant: Steve Kendall

Mr. Kendall will supervise data collection in the field in the absence of the project leader. He will prepare maps, coordinate logistics with other projects, assist in data entry, conduct at-sea surveys and provide GIS data and analysis for reports. He has extensive experience conducting at-sea surveys in Alaska from his work on USFWS boat surveys, as a boat operator and biologist. Mr. Kendall has provided GIS support and analysis for previous murrelet studies and marine bird surveys of Prince William Sound, lower Cook Inlet and Southeast Alaska.

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Signed: Katherine J. Kuletz

Katherine J. Kuletz
U.S. Fish and Wildlife Service

Date prepared: 4/15/96

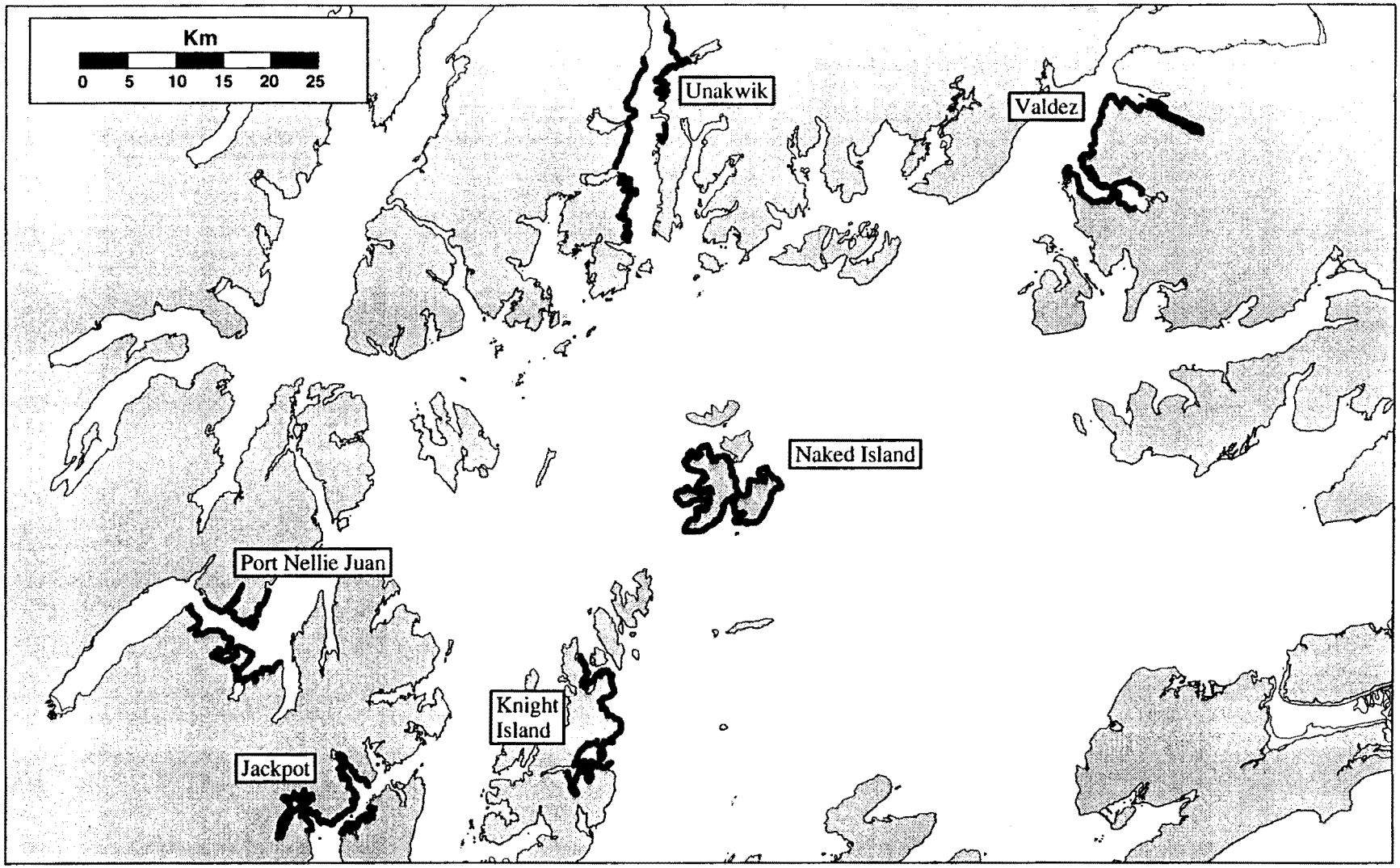

Figure 1. Survey areas for marbled murrelet productivity study, 1997

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997						
Personnel	$65.8	$126.8						
Travel	$1.4	$12.6						
Contractual	$0.5	$16.0						
Commodities	$0.0	$21.0						
Equipment	$0.0	$21.2	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$67.7	$197.6	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
General Administration	$9.9	$20.1						
Project Total	$77.6	$217.7	$200.0	$200.0	$95.0	$0.0	$0.0	
Full-time Equivalents (FTE)	1.3	2.9						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:
Transport to Whittier for 6 people includes 5 people @ $16 RT, plus 1 vehicle w/ driver @ $123 RT.

Boat maintenance & repair for two 25 ft. Boston Whalers used for murrelet surveys. Each has twin 150 hp motors. Before the 1997 field season we may need >$1.8 K to mount new motors one 1 boat. This also covers spare parts, fuel filters, required safety equipment, etc. carried aboard the boat. An unforseen repair to the hull or motors can cost $1.0 to $2.0 K, including cost for a mechanic to travel to Whittier. Both boats will need end of the season motor maintenance, winterizing and storage.

PI time prior to March will be spent on preparation & preliminary analysis of historic data, writing and preparation of FY98 proposal, and coordinating with APEX PI's.

1997

Prepared:

Project Number: 97231
Project Title: Marbled Murrelet Productivity & Fish Abundance
Agency: DOI - Fish and Wildlife Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
Kuletz	Project Leader	GS/11/5	12.0	5.0		60.0
Kendall	GIS/Field Supervisor	GS/9/4	6.0	4.0	1.6	25.6
?	Biological Technician	GS/5/	4.0	2.1	1.1	9.5
?	Biologicial Technician	GS/5	4.0	2.1	1.1	9.5
?	Biologicial Technician	GS/5	3.0	2.1	1.1	7.4
?	Biologicial Technician	GS/5	3.0	2.1	1.1	7.4
?	Biologicial Technician	GS/5	3.0	2.1	1.1	7.4
						0.0
						0.0
						0.0
						0.0
	Subtotal		35.0	19.5	7.1	
					Personnel Total	$126.8

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
Train, truck & boat, Anchorage to Whittier (for 2 boats)	1.2	2			2.4
Train, 6 people, Anchorage to Whittier (driver + vehicle/$123 ea)	0.2	24			4.8
Field per deim ($3/day/person - 6 people 40 days)			240	0.0	0.7
Per deim (travel rate), 6 people, 3 d training, 4 d summer			42	0.0	2.0
Float Plane Trips to Study Site	0.3	2			0.6
Travel to Scientific Meeting (PSG Portland OR, plane & perdiem)	1.5	1			1.5
Lodging, 3 people, 6 nights (Valdez)			18	0.0	0.6
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$12.6

1997

Prepared:

Project Number: 97231
Project Title: Marbled Murrelet Productivity & Fish Abundance
Agency: DOI - Fish and Wildlife Service

FORM 3B
Personnel
& Travel
DETAIL

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed
Description	FFY 1997
Delivery of equipment & supplies to study site: $4000 (cost split with PIGU & BLKI)	1.3
Delivery of fuel to study site, 2 trips @ $2000/trip (cost split with PIGU & BLKI)	1.3
Safety training for 5 new people @ $830/person, includes travel & per diem in Whittier	4.1
Boat maintenance and repair (Whalers or other solid-hull boats)	5.0
Telephone services in office and field	0.5
Computer, printer, network repair and maintenance	0.5
Film processing	0.1
Postage and freight	0.4
Publication page charges	0.5
Maintenance and cleaning of camp equipment for 6 people @ $200/person	1.2
Maintenance and cleaning of binoculars, scopes and cameras	1.1
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$16.0

Commodities Costs:	Proposed
Description	FFY 1997
Food: 6 people; 240 people days @ $10/day	2.5
Boat fuel: 100 gal/day for 45 days (includes training), 2 boats @ $1.50/gal, plus oil (2 gal/day/boat) @ $12/gal	14.6
Camp supplies (stove & lantern fuel, mantles, head nets, bug spray, batteries, cleaning materials)	0.4
Scientific supplies (batteries for radioes & other equipment, film, waterproof notebooks, sample basgs, preservative, scales, calipers)	1.2
Rain gear, rubber boots and gloves for 4 new people @ $200/person	0.8
Lines, anchors, propellers for boats	1.0
Software updates for computers (SAS, Paradox & Atlas GIS)	0.4
First aid kits	0.1
Commodities Total	$21.0

1997

Prepared:

Project Number: 97231
Project Title: Marbled Murrelet Productivity & Fish Abundance
Agency: DOI - Fish and Wildlife Service

FORM 3B
Contractual & Commodities DETAIL

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FFY 1997
Leasing or purcahse of BioSonics hydroacoustic equipment (share of total with 97163B, Seabird Foraging Project)			20.0
Emergency replacement of equipment			0.0
Camp equipment (stoves, lanterns, tents, tools, batteries, dishes)			1.2
			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**	$21.2

Existing Equipment Usage:	Number	Inventory
Description	of Units	Agency
Survival Suits	6	DOI-FWS
Mustang Suits	6	DOI-FWS

1997

Project Number: 97231
Project Title: Marbled Murrelet Productivity & Fish Abundance
Agency: DOI - Fish and Wildlife Service

FORM 3B
Equipment
DETAIL

Prepared: 4 of 4

4/15/96

Endowment of an Engineering Research Center at the University of Alaska Anchorage

Project Number: 97232

Restoration Catagory: General Restoration

Proposer: University of Alaska Anchorage

Lead Trustee Agency:

Cooperating Agencies:

Duration: Perpituity

Cost FY 97: $2,200,000
Cost FY 98: $0
Cost FY 99: $0
Cost FY 00: $0
Cost FY 01: $0
Cost FY 02: $0

Geographic Area: All regions affected by the *Exxon Valdez* oil spill

Injured Resource/Service Multiple resources

ABSTRACT

Proposed is a plan for the establishment of an endowed engineering research and community education center at the University of Alaska Anchorage. The program will be created within the Environmental Quality Engineering program of the School of Engineering. Establishing the center will achieve two goals. First, it will provide a mechanism for funding continuing recovery work and community education long after 2002 when funds are no longer received by Alaska. Such activities will help Alaska develop local expertise and permanent solutions for the protection and restoration of areas affected by the *Exxon Valdez* oil spill. Funding the center at UAA will also serve as a test program that will allow the Trustee Council to resolve the existing questions concerning endowed academic centers and chairs.

INTRODUCTION

Although it is clear that complete recovery from the *Exxon Valdez* oil spill will not occur for decades, annual payments from the Exxon Corporation will end in the year 2002. Implementing a plan that enables restoration and protection efforts to continue beyond 2002 is a serious challenge facing the Trustee Council and all Alaskans.

This proposal presents a plan to establish an endowed engineering research and community education center at the University of Alaska Anchorage. The center would be in the Environmental Quality Engineering program within the School of Engineering. Within this environment, the facilities of UAA can be utilized to continue restoration and protection efforts in perpetuity.

As currently proposed, the center would consist of a research, community education/technology transfer, and student education branch. The flowchart shown in Figure 1 lists some of the major areas of activity that would be conducted by each branch. These include:

- Research and development activities for improved recovery and remediation techniques.
- Courses on oil spill technology and recent developments in remediation techniques by national experts.
- Distance delivery course presentations to high schools, universities, and industry.
- Outreach mentoring programs to surrounding areas.
- Student education and internships on oil spill recovery projects.
- Cooperative efforts with other University departments as well as state and federal agencies.

There are many benefits to the communities effected by oil spills from the establishment of endowed academic centers and chairs. Since the exact mechanism for implementation of academic programs is not known, many concerns and questions exist. Establishing an academic center at UAA as a working pilot program will allow the Trustee Council to find answers to the outstanding questions about the use of settlement funds for funding academic programs and chairs.

NEED FOR THE PROJECT

A. Statement of the Problem

It has become apparent restoration efforts need to continue beyond 2002. As an initial response, the Trustee Council established the Reserve Account to aid in the recovery of affected areas after 2002. This account will eventually total approximately $108 million plus interest. Presently, the State receives about 70 million per year. Thus, the Reserve Account represents less than two years of payments.

The threat of another oil spill is a major concern to Alaskans. In the case of the *Exxon Valdez* oil spill, a settlement was reached between Alaska and Exxon in a relatively short period. It cannot be assumed that another spill will result in a similar amount of funds so soon after a spill. In addition, the next spill could result in a legal battle with Alaska for many years. Alaska needs to be prepared to recover from another spill, and a mechanism is needed for preparing the State to respond to future spill events.

New approaches are also needed to make the most of the remaining *Exxon Valdez* funds. One mechanism is for the Trustee Council to fund an endowment that will support research and education activities relevant to oil spill cleanup and ecosystem recovery for the foreseeable future. Such a commitment of funds would guarantee that the State will continue to develop its capabilities to respond to a major oil spill in a timely and economic manner.

B. Rational/Link to Restoration

It is proposed that an endowed center for engineering research and education be established in Environmental Quality Engineering program at the University of Alaska Anchorage. As shown in Figure 1, the center will have research, community education, and student education components. The center will incorporate the objectives of the *Exxon Valdez* settlement for restoration and protection of the areas affected by the spill by conducting research and education programs that will enhance Alaska's ability to respond to a major oil spill. In addition, research on oil spill technology has the potential to generate income through patents on developed processes, publication, and distance delivery courses. Thus, the proposed endowed center will become a self perpetuating mechanism for increasing funds available for restoration.

The University of Alaska Anchorage has an ideal location to serve the areas affected by the *Exxon Valdez* oil spill. With the construction of the road to Whittier currently planned to begin in 1998, Prince William Sound will be even more accessible to Anchorage. Thus, the facilities at the University of Alaska Anchorage can be readily utilized to conduct research. In addition, Anchorage is a traffic center for airlines servicing many of the rural areas affected by the spill. These factors make UAA a natural hub for cooperative spill recovery efforts.

The School of Engineering is located in the Engineering Building at the main University of Alaska Anchorage campus. It houses over 26,500 square feet of classrooms, laboratories, and a modern computer facility. Laboratories are conveniently available for the study of fluids, soils, materials, surveying structures, environmental quality, and cold regions engineering.

Modern distance delivery facilities are also available on the main University of Alaska Anchorage campus. Facilities include equipment for video production, broadcast and delivery, interactive presentations, and reproduction. Thus, video production of techniques for improved recovery, course development for students, and technological short courses for presentation to industry can be readily performed and distributed.

Utilization of existing facilities and personnel can be a substantial help in extending recovery efforts. The proposed plan incorporates the objectives of the Trustee Council through the use of these resources. In addition, structure of the proposed plan implements a mechanism that results in recovery efforts to become self-supporting with growth in a relatively short period of time.

C. Location

All areas affected by the *Exxon Valdez* oil spill will benefit from the proposed plan. In fact, the objectives of the Trustee Council are to be incorporated into the charge of the endowed center. Thus, recovery and protection of affected areas can continue long after 2002 when funds are no longer received by Alaska.

COMMUNITY INVOLVEMENT

Involvement of the community is a major objective of the proposed plan. This includes the development of outreach programs for recruiting and education of high school students, research positions for students, as well as the incorporation of existing high school and university programs such as ANSEP (Alaska Native Student Engineering Program), AISES (American Indian Science and Engineering Society), and other mentoring programs. Also, high school programs such as the Youth Area Watch could easily be incorporated. In this manner, students from the community can obtain a technical education while also gaining valuable work experience with a variety of state and federal agencies.

PROJECT DESIGN

A. Objectives

The following are objectives of the proposed program:

1. Establish an endowed academic center at the University of Alaska Anchorage School of Engineering in Environmental Quality Engineering.

2. Establish the infrastructure and activities of the endowed center to achieve the objectives of the Trustee Council for restoration, enhancing, and protection of areas affected by the spill.

3. Establish community and student education opportunities.

B. Methods

The proposed plan calls for $200,000 the first year to establish the infrastructure needed for the center. An additional, $2,000,000 will be placed in an endowment fund of the UA Foundation.

Three UAA engineering faculty in conjunction with Trustee Council, UA Foundation, UA Board of Regents, and UAA administration will coordinate the establishment of the endowed center. The exact mechanism for implementation will be determined that will achieve the goals of the Trustee Council. Initial efforts would include the preparation of laboratory facilities to conduct research on oil spill remediation and establishing education needs.

Endowment funds managed by the UA Foundation have earned an average of about 13% over the past 5 years. The maximum withdrawal rate on an annual basis is limited to 5%. Thus, if a conservative 10% average earnings is assumed, the principal of a $2,000,000 endowed fund would grow by about $130,000 each year after about 5 years. In addition, another $130,000 would be available to conduct the work of the center.

Moneys received through the foundation will be matched whenever possible with external funding from agencies such as National Science Foundation (NSF). Also, part of the proposed plan is to develop processes for patent. Patented recovery processes, such as for beach remediation and containment, will be marketed to oil producers throughout the world. The patent licensing facilities of the University of Alaska can provide the needed expertise and services. The proposed plan will provide unique mechanisms for enhancing the principal beyond the usual inflation proofing techniques.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

It is foreseen that several agencies will be utilized to accomplish the work of the endowed center. These include local and rural high schools, Alaska SeaLife Center, Alaska Department of Fish and Game (ADF&G), Alaska Department of Environmental Conservation (ADEC), in addition to other state and federal Agencies.

SCHEDULE

A. Measurable Project Tasks for FY97

Oct. 1 - Nov. 1, 1996:	Academic center committee is formed. Schedule is set for needed reviews by Trustee Council, UA Foundation, UA Board of Regents, University and Trustee Legal Councils, and UAA administration.
Nov. 1- Dec. 1, 1996:	Exact criteria and structure for endowed center in Environmental Quality Engineering is established in cooperation with Trustee Council.
Dec. 1 - March 1, 1997:	Research and education plans completed.
March 1 - April 1, 1997:	Final report with recommendations is prepared for Trustee Council and research and education activities begin.
Beyond April 1, 1997:	Annual report on recovery work with financial updates.

B. Project Milestones and Endpoints

October 1, 1996:	Approval and commitment by the Trustee Council for establishment of endowed center.
Feb. 1, 1997:	Center is established.
April 1, 1997:	Final presentation of results to Trustee Council.

C. Completion Dates

The initial work to establish an endowed center will be completed by April 1997. The work of the endowed chair is intended to be self-supporting and continue in perpetuity.

PUBLICATIONS AND REPORTS

It is foreseen that substantial contact with the Trustee Council members and advisory boards will occur as the proposed plan is developed and implemented. By April 1997, a complete report will be presented to the Trustee Council. The report will present the status of the center and provide answers to the questions confronting the Trustee Council concerning the establishment of additional endowed academic centers and chairs.

PROFESSIONAL CONFERENCES

Research and other activities funded by the endowed center will be presented in the many usual forums available to faculty at the University of Alaska. These forums include presentation of papers at conferences, publication of books and research journal articles. Also, student work will be presented in papers through professional student organizations at national competition.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Part of the proposed plan is to determine the best avenues for incorporation of Trustee Council objectives for restoration with the activities of the endowed center. It is expected that these efforts will be reported to the Trustee Council throughout FY97 until the best working mechanism is determined and approved by the Trustee Council.

PROPOSED PRINCIPLE INVESTIGATORS

Dr. Grant C. Baker - Director, Student Education
School of Engineering
University of Alaska Anchorage
3211 Providence Drive
Anchorage, Alaska 99508
Phone: (907) 786-1056
Fax: (907) 786-1079
E-Mail: AFGCB@orion.alaska.edu

Dr. Herbert P. Schroeder - Director, Community Education
School of Engineering
University of Alaska Anchorage
3211 Providence Drive
Anchorage, Alaska 99508
Phone: (907) 786-1860
Fax: (907) 786-1079
E-Mail: AFHPS@orion.alaska.edu

Dr. Craig R. Woolard - Director, Research
School of Engineering
University of Alaska Anchorage
3211 Providence Drive
Anchorage, Alaska 99508
Phone: (907) 786-1863
Fax: (907) 786-1079
E-Mail: AFCRW@orion.alaska.edu

PERSONNEL

Dr. Grant C. Baker, Assistant Professor of Civil Engineering at the University of Alaska Anchorage. He has eight years of university teaching experience. Dr. Baker has conducted research in chemical treatment of soils, development of oil refining catalysts, and corrosion prevention engineering, and is active in program development of engineering courses within the School of Engineering. Dr. Baker holds a B.S degree in Chemical Engineering, M.S. in Mining Engineering, and a Ph.D. in Geophyics.

Dr. Herbert F. Schroeder, Associate Professor of Civil Engineering at the University of Alaska Anchorage. Dr. Schroeder is Chairman of ANSEP (Alaska Native Science and Engineering Program) at UAA. Dr. Schroeder worked more than twenty years in the Alaska oil industry prior to joining the faculty in 1991. He holds a B.S. in Mechanical Engineering from UAF, an M.S. in Civil Engineering, Construction Engineering and Management from Oregon State University, and a Ph. D. in Civil Engineering, Construction Engineering anManagement from the University of Colorado Boulder.

Dr. Craig R. Woolard, Assistant Professor of Civil Engineering and Environmental Quality Engineering at the University of Alaska Anchorage. He holds a B.S. in Civil Engineering from Montana State University and a Ph.D. in Environmental Engineering from the University of Notre Dame. Dr. Woolard has an active, externally funded research program focused on the fundamental and applied aspects of biological treatment of municipal, industrial and hazardous wastes. Specific interests include treatment of hazardous wastes in saline and cold environments, engineering implications of microbial physiology and selection, bioremediation of contaminated sites, nutrient removal, industrial waste and leachate treatment. In addition to his research and teaching responsibilities, Dr. Woolard is Chairman of the Alaska Water and Wastewater Management Association's Research and Development Committee and a member of the National Research Foundation's program on water quality in Russia.

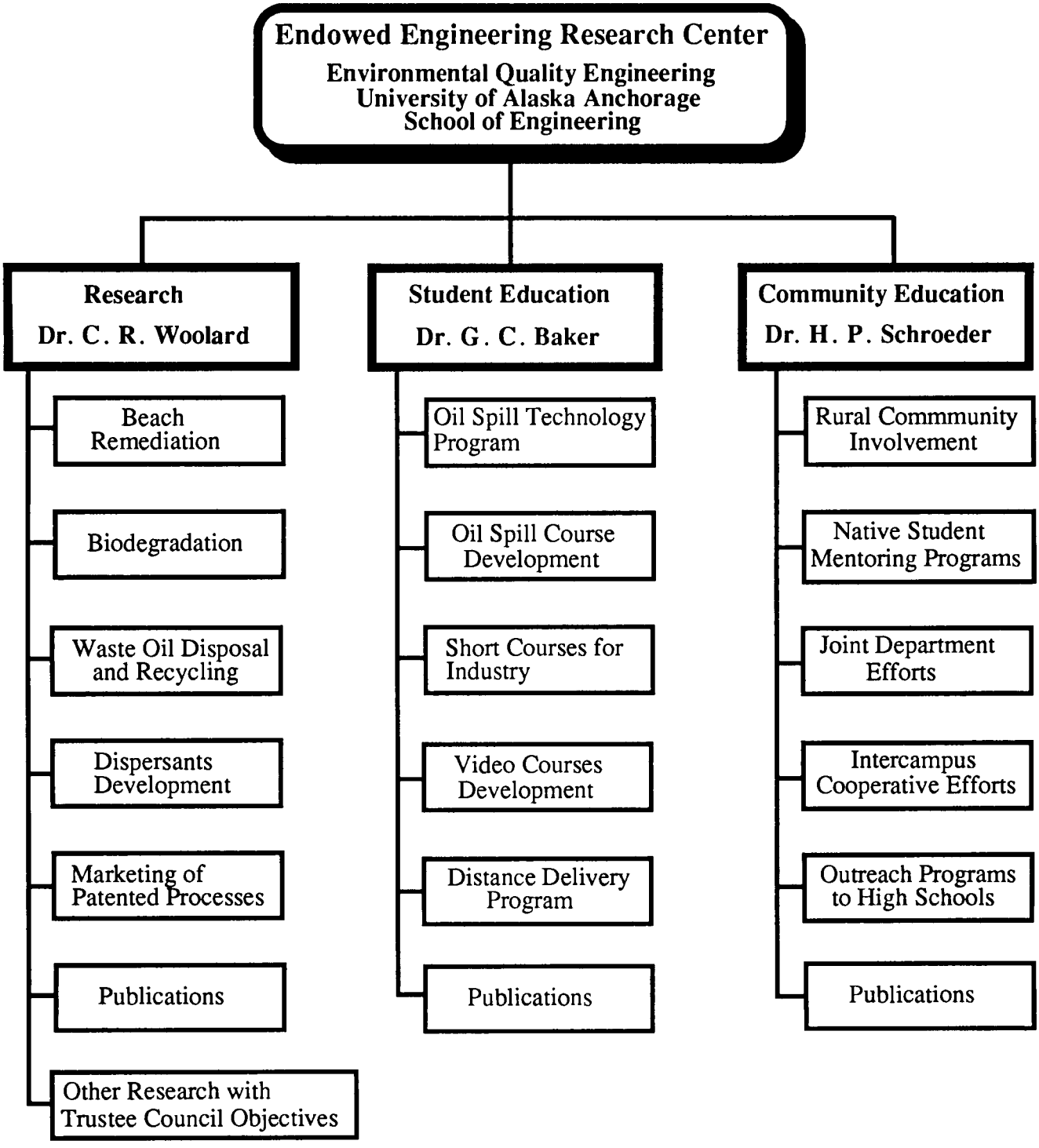

Figure 1: Flowchart illustrating the multiple disciplinary functions of the proposed endowed Engineering Research Center at the University of Alaska Anchorage.

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997						
Personnel		$46.5						
Travel		$0.0						
Contractual		$2,000.0						
Commodities		$1.0						
Equipment		$152.5	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$2,200.0	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Indirect								
Project Total	$0.0	$2,200.0						
Full-time Equivalents (FTE)		9.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:
This proposal requires a one-time payment of $2,200,000 to support an endowed academic center at the University of Alaska Anchorage. Of this amount, $2,000,000 will be deposited in an endowment fund of the UA Foundation. The remaining $200,000 will be used for initial establishment of the Center (salaries and equipment) in the first year. This preliminary budget is contingent upon approval by the UAA business office.

1997

Project Number:
Project Title: Endowed Academic Center
Name: University of Alaska Anchorage

FORM 4A
Non-Trustee
SUMMARY

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FFY 1997
Dr. G. Baker	Program Coordinator		3.0	4.8		14.4
Dr. H. Schroeder	Program Coordinator		3.0	5.3		15.9
Dr. C. Woolard	Program Coordinator		3.0	5.4		16.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		9.0	15.5	0.0	
					Personnel Total	$46.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
					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

1997

Prepared: 2 of 4

Project Number:
Project Title: Endowed Academic Center
Name: University of Alaska Anchorage

FORM 4B
Personnel
& Travel
DETAIL

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed
Description	FFY 1997
Endowment Fund	2,000.0
Contractual Total	$2,000.0

Commodities Costs:	Proposed
Description	FFY 1997
Preparation materials for multiple reports and presentations.	1.0
Commodities Total	$1.0

1997

Prepared:

Project Number:
Project Title: Endowed Academic Center
Name: University of Alaska Anchorage

FORM 4B
Contractual & Commodities DETAIL

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

New Equipment Purchases:	Number of Units	Unit Price	Proposed FFY 1997
Description			
Equipment appropriate for establishment of Center's facilites as approved by Trustee Council			152.5
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.	**New Equipment Total**		$152.5

Existing Equipment Usage:	Number of Units	
Description		

1997

Prepared: 4 of 4

Project Number:
Project Title: Endowed Academic Center
Name: University of Alaska Anchorage

FORM 4B
Equipment
DETAIL

4/15/96

Body Condition of Sea Otters in Prince William Sound, AK

Project Number: 97233

Restoration Category: Research and Monitoring

Proposer: Lisa M. Rotterman, Ph.D. and Charles W. Monnett, Ph.D., Enhydra Research

Lead Trustee Agency:

Cooperating Agencies:

Alaska SeaLife Center:

Duration: FY 97, 1st year, multiple years if needed

Cost FY 97: $10,912.00

Cost FY 98:

Cost FY 99:

Cost FY 00:

Cost FY 01:

Cost FY 02:

Geographic Area: Prince William Sound

Injured Resource/Service: Sea Otters and the Nearshore Ecological Community

ABSTRACT

This project will result in acquisition of data on the body condition of sea otters in Prince William Sound, in acquisition of samples to evaluate whether sea otters continue to be exposed to EVOS hydrocarbons, and in acquisition of samples to evaluate their overall health. Because of pre-spill baseline information on body condition from the Principal Investigator's studies, body condition information will be a useful index of whether sea otters in the spill-affected region are recovering.

INTRODUCTION

The project investigators propose to undertake capture efforts to obtain information about the body growth of sea otters in Prince William Sound. They have undertaken such studies between 1984-1990. Additionally, they previously proposed to undertake this project (as well as the collection of samples for toxicological and clinical blood studies, surveys, and other study elements) in restoration proposals submitted to Trustee Council staff in 1990 and 1991.

The Principal Investigators propose to undertake such activities and to obtain such information for a very minimal budget. This is because it is important to them to maintain their long-term studies in the region, and because, since they hold most of the relevant baseline data that make this project worthwhile as a population monitoring method, they feel strongly that they should undertake this work. They are spill area residents whose long-term studies of sea otters in PWS were begun in 1984.

Sea otters were severely impacted by the T/V *Exxon Valdez* oil spill (EVOS) and could not yet have recovered fully from the impacts of the spill, due to constraints of their reproductive biology. While they are listed as "not recovering" in current Trustee Council publications, their current status is not clear, because the monitoring methods being employed lack clear benchmarks for normalcy and because they lack sensitivity. For example, the Request for Proposal indicates that recent surveys did not indicate a significant increase in population size. However, the survey methods are probably not sensitive enough to detect the level of increase which would occur through natural population growth in a sea otter population. The project will result in new important information for the following reasons:

1) Previous findings (Monnett and Rotterman, unpubl. data) have shown that in 1989 and 1990, the adjusted body mass of sea otter adults residing in oiled habitat was significantly lower than that of their pre-spill counterparts and their concurrent counterparts residing in unoiled habitat.

2) This project would result in current information about the body condition (body mass adjusted for total length) of sea otters in oiled versus non-oiled habitat. Current values, relative to pre-spill benchmarks, will indicate whether full recovery of body condition has occurred. Because of the previous demonstration of measurable negative spill-related impacts on this measure, if body mass is still depressed relative to pre-spill, comparison of current values with 1989 and 1990 post-spill information will permit evaluation of whether there has been improvement, or whether sea otters in the oiled areas appear to be in worse health than in the 1990.

3) Because of the aforementioned, this project will enable a clear evaluation of whether, with respect to body condition, sea otters in the oil spill area are in a state of declining or improving health.

Because it has been shown in studies in the Aleutians (Kenyon, 1969) and elsewhere that adjusted body mass is sensitive to prey availability, this project will potentially answer the question: Is food limiting sea otter recovery? Thus, if the adjusted body mass of sea otters in oiled habitat is essentially normal, then food is not limiting recovery.

Pre-spill and post-spill adjusted body mass data are from the investigators' studies between May 1984 and Nov. 30, 1991 in both Eastern Prince William Sound (EPWS) and western Prince William Sound (WPWS).

A. Relevant Background

Dr. C. Monnett and Dr. L. Rotterman, who will undertake this project, began studies of sea otter development, reproduction, survival, population structure, behavior, growth, body condition, and movements in 1984. They have many years of pre-spill data on body condition from their studies of sea otters in the sound, and elsewhere in Alaska, and they specifically collected body condition information before the spill as an index of population status relative to the underlying prey base.

When the spill occurred, they were halfway through a study of 59 radio-instrumented sea otter females.

The proposers were the Principal Investigators on key sea otter damage assessment studies. Between 1989 and Nov. 30, 1991, they conducted year-round intensive field studies, including studies of: 1) female reproduction, health, and survival (PI: C.M.); 2) post-weaning survival (PI: L.M.R.); 3) movement patterns (PI: C.M.); 4) determination of the fate of sea otters released from EVOS treatment centers (PI: C.M.); 5) blood chemistry and hematology of adult females and weanlings (PI: L.M.R.); and 6) pre- and post-spill aerial (and to a lesser extent, boat) marine mammal surveys in Prince William Sound (using funding from the Mineral's Management Service).

As part of their post-spill investigations they obtained significant information on body condition, which, as noted, indicates a significant, measurable, spill-related, negative impact on sea otters.

Their post-spill studies, which were unprecedented in both scope and content, were highly successful resulting in the acquisition of key information on the spill's impacts on sea otters. Dr. Monnett and Dr. Rotterman captured hundreds of sea otters, radio-instrumented 100 adult females and 64 pups, monitored 45 radio-instrumented otters from the treatment centers, and collected samples and carcasses for studies of toxicology, pathology, and clinical blood studies.

A key finding from their post-spill studies was that the post-weaning survival of sea otters born into the spill area more than a year after the spill was very poor, and was significantly lower than their concurrent counterparts in the unoiled eastern Sound.

This finding remains, to date, the most definitive evidence of chronic damage to sea otters from EVOS.

Additionally, they demonstrated that female reproductive and survival rates were normal in the spill region in 1990 and 1991, but that adult females in the spill region may have higher rates of liver dysfunction compared with their counterparts in the eastern sound. Their study of treatment center otters showed that survival and pupping rates of the animals released from the treatment centers was very low and was followed by an increase in mortality in the recipient population. Their study of movements confirmed that significant interchange was not occurring among oiled (in WPWS) and unoiled (in EPWS) sea otter study populations, a finding crucial to evaluation of all post-spill studies. These movement studies also produced data that provides insight into the recovery process by showing that sea otters from EPWS were not emigrating to the west, and thus, would not be affecting recovery rates.

These aforementioned results were summarized in reports to the U.S. Fish and Wildlife in 1992. The population studies were highly praised by key sea otter peer reviewers advising the Chief Scientist.

This project is relevant to the Nearshore Vertebrate project which seeks to monitor the recovery of sea otters and to determine factors that may be limiting recovery. The proposed projects within this umbrella project include an investigation of body condition in sea otters.

This project is also related to the proposed project entitled "Integration and Publication of Pre- and Post-Spill Data on Sea Otter Reproduction, Survival, Development, and Health", which the investigators have submitted under the BAA. In that project, a paper on the investigators' prior findings on body condition will be prepared and published in the primary scientific literature. This project, which would occur after that manuscript has been submitted, would build on work published therein.

NEED FOR THE PROJECT

A. Statement of Problem

Sea otters were severely impacted by the T/V *Exxon Valdez* oil spill (EVOS) and could not yet have recovered fully from the impacts of the spill, due to constraints of their reproductive biology. While they are listed as "not recovering" in current Trustee Council publications, this is not clear, because the population-level monitoring methods being employed lack clear benchmarks for normalcy and because they lack sensitivity. For example, the Request for Proposal indicates that recent surveys did not indicate a significant increase in population size. However, the survey methods are probably not sensitive enough to detect such the level of increase which would occur through natural population growth in a sea otter population.

Benchmarks of key population and development variables are needed against which to gauge current population status relative to recovery.

The proposers have such a benchmark, due to their pre-spill data on body condition, and their post-spill body condition data collected in 1989 and 1990. The proposers have unpublished data which demonstrate that adjusted body mass was significantly lower in sea otters in oiled habitat than for their pre-spill counterparts, or for their post-spill counterparts residing in unoiled habitat. Without the amount of such baseline pre-spill data and the post-spill data showing impact, it would not be clear whether body condition would be a useful indicator of recovery. Additionally, without those other data sets, interpretation of new body condition data would be problematic.

B. Rationale/Link to Restoration

This project will aid restoration by providing data needed to determine if further damage is occurring to sea otters from the EVOS, to determine whether recovery is proceeding, and to determine if further damage measurable with this index has occurred.

The data to be collected here also may permit evaluation of whether prey availability is limiting (if they are limited) sea otter population recovery. This is because adjusted body mass is sensitive to prey shortages. If adjusted body mass is normal, as compared with pre-spill benchmarks, then it is unlikely that prey is a problem. Such a finding could greatly alter the experimental design of the Nearshore Vertebrate Predator Project, at least that portion aimed at studying prey availability to sea otters.

C. Location

This project will be undertaken in western Prince William Sound.

COMMUNITY INVOLVEMENT

In this project, only the two senior researchers will be involved in field work in order to enhance efficiency of the capture effort and reliability of the data by having the same measurement procedures as followed in previous studies. However, the Principal Investigators strongly support greater involvement of spill-area residents in Trustee Council restoration activities and Dr. Rotterman has published on the issue of involvement of Native people in marine mammal research. The Principal Investigators would be willing to coordinate with the Spill Area-Wide Coordinator for the Trustee-sponsored Community Involvement Project to enhance communication of study design and objectives prior to undertaking field research and to enhance communication of research findings after conclusions are reached.

Both before and after the spill, the Principal Investigators have ensured that interested members of the Native community had

access to the findings from their research. For example, in the past, the authors have provided summaries of findings from their studies orally at meetings of the Alaska Sea Otter Commission, and provided copies of research publications to local Native corporations and to the Alaska Sea Otter Commission. Communication of the results from this project could take similar forms, or could involve non-technical oral presentations to community groups or the dissemination of reprints to local libraries. At present, no funds are requested to permit such enhanced communication. If the project is funded and activities such as community visits or reprint dissemination is requested by the Spill Area-Wide Coordinator, the budget will need to be adjusted accordingly.

PROJECT DESIGN

A. Objectives

The major objective of this project is to obtain information on the body condition (as reflected in body mass adjusted for total length) of sea otters in the spill area so as to determine whether previously detected damage still exists, whether recovery of this type of damage is proceeding, or whether such recovery is essentially complete.

A second objective is to evaluate the consistency of evidence from this project with the hypothesis that food availability is limiting sea otter population recovery in the spill area.

A third goal is to obtain information about sea otter health and oil exposure through the collection of samples necessary to undertake toxicological and clinical blood analyses.

B. Methods

Study protocols will attempt to duplicate the investigators' 1990 study as closely as possible. Thus, a minimum of 30 adult female sea otters will be captured in April in western Prince William Sound using well- established methods involving the use of modified gill nets and dip nets. Data on weight and length will be obtained using previously established protocols (for all of the above, see Monnett 1988). Blood samples will be collected according to protocols followed in the previous studies on sea otter females in 1989 and 1990.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The Principal Investigators would propose to cooperate with the Nearshore Predator Ecosystem Project to ensure comparability of sample collection and sample analysis. Thus, they would propose to collect the aforementioned samples and collaborate with those specialists working with the other Nearshore Predator Projects. Because of this, sample analysis is not budgeted, but funding would come from the Nearshore Vertebrate Project using funding already allocated for those purposes.

SCHEDULE

A. Measurable Project Tasks for FY 97 (October 1, 1996-September 30, 1997)

Below is a tentative schedule of primary activities in 1997.

Acquisition of Permit.-A marine mammal research permit will be obtained within 60 days of authorization of funding.

April 13- 27: Capture sea otters in PWS

July 15: Draft report completion

Sept. 15 Final report completion-submission for publication

B. Project Milestones and Endpoints

The project milestones are provided above. The project objectives will be met when the final report is written and submitted for publication.

C. Completion Date

The project will be completed when the final report (formatted as a publishable manuscript) is submitted for publication.

PUBLICATIONS AND REPORTS

An as yet untitled paper based on this work will be submitted for publication in 1997.

PROFESSIONAL CONFERENCES

None requested

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is directly relevant to the Nearshore Vertebrate Ecosystem Project. The Principal Investigators would propose to cooperate with the Nearshore Predator Ecosystem Project to ensure comparability of sample collection and sample analysis. Thus, they would propose to collect the aforementioned samples and collaborate with those specialists already working with the other Nearshore Predator Projects with funding to come from those already allocated for this purpose under the Nearshore Vertebrate Project. Because of this, no costs associated with samples are budgeted. If funds for sample acquisition, shipping, etc. are to come from this budget, the total amount would have to be adjusted accordingly.

PROPOSED PRINCIPAL INVESTIGATORS

Lisa M. Rotterman, Ph.D. and Charles Monnett, Ph.D.
Enhydra Research
P.O. Box 3448, Homer, AK 99603
Telephone: 907-235-6099
Fax: 907-235-6099

PERSONNEL

Dr. Lisa M. Rotterman will be Principal Investigator on this project and Dr. Charles Monnett will be co-Principal Investigator. In addition to having extensive research experience in the spill region, both individuals are spill area residents and have resided in the spill region since 1984.

Working in full collaboration, Dr. Monnett and Dr. Rotterman have conducted original research on sea otter population ecology, behavior, development, and genetics in Alaska since 1984. Their sea otter research has included, but not been limited to, research on sex-, age-, and locality-specific: survival rates and causes; reproductive patterns and rates; movement patterns; morphology; body condition; and growth. They have also conducted studies on sea otter population structure and molecular and population genetics. Their sea otter studies have been multi-year, year-round studies in which hundreds of radio-instrumented individuals are studied intensively. They have developed indices by which to assess and compare sea otter populations status generally, and under different resource regimes, specifically.

Dr. Monnett and Dr. Rotterman pioneered studies on sea otter pups and weanlings. At the time of the spill, and until their studies were taken over by government researchers in 1992, they were the only scientists in the world to have conducted large-scale growth and telemetry studies on these age classes. This work permitted the post-spill studies on weanling survival, which produced the most definitive evidence of chronic damage to sea otter populations from the spill to date.

Dr. Monnett and Dr. Rotterman hold the best, most comparable, and in many cases the only baseline data available on the growth, reproduction, body condition, survival and movements of sea otter females, pups and weanlings in Prince William Sound.

As discussed more below, Dr. Monnett and Dr. Rotterman collaboratively conducted much of the post-spill field research on sea otters until 1992. They conducted pre- and post oiling marine mammal surveys in WPWS in 1989, including surveys initiated on the day of the spill. They captured, instrumented and monitored approximately a hundred and sixty sea otters in order to evaluate the impacts of the spill on adult female and weanling survival, health, and movements, and on female reproduction. They collected hundreds of samples for toxicology, pathology, blood chemistry and other studies. They also successfully undertook studies to evaluate the efficacy of the post-spill sea otter rehabilitation program by monitoring the post-release fate of sea otters from the treatment centers.

Dr. Monnett and Dr. Rotterman have written over 30 reports and publications based on their sea otter research.

Individual information about the qualifications of the two researchers are provided below.

Dr. Rotterman was the Principal Investigator on two major facets of the post-spill sea otter studies: 1) studies aimed at determining the impact of the spill on weanling survival; and 2) the impacts of the spill on the health of adult female and weanling sea otters as assessed through evaluation of blood chemistry and hematology. She has a Ph.D. and a M.S. from the Department of Ecology and Behavioral Biology at the University of Minnesota and a B.S. from the University of Maryland in the field of Conservation and Resource Development, with speciality in Fish and Wildlife. The specialities of her Ph. D. program were population and community ecology, evolution, and behavior. She has a second area of Ph.D.-level expertise in the fields of population, quantitative, and molecular genetics and earned a minor in Genetics as part of her Ph.D. program.

The topic of her Ph.D. dissertation was the impacts of population fragmentation and reduction on genetic variability and structure within and among populations of sea otters, and the implications of current genetic status to long-term viability. The field portions of her doctoral research were undertaken in Alaska, particularly in Prince William Sound. She was twice appointed as a Guest Researcher in the Laboratory of Viral Carcinogenesis in the Genetics Section at the National Cancer Institute, National Institutes of Health where the laboratory portions of her doctoral research was undertaken.

In addition to her research on sea otter ecology and genetics, she has many years of experience conducting research in the fields of avian ecology and non-human primate toxicology and infant development. She has additional research experience on other marine mammals, and caribou.

Dr. Monnett was the Principal Investigator on several key portions of the post-spill sea otter studies: 1) studies aimed at evaluating the impact of the spill on female health, reproduction and survival; 2) studies of the movement patterns of sea otters after the spill; 3) studies aimed at determining the efficacy of the sea otter rehabilitation program; and 4) pre- and post-spill aerial (and to a lesser extent, boat) marine mammal surveys (sea otters, harbor seals, sea lions, and other marine mammals) in oiled and adjacent areas of PWS, which he initiated on the morning of the spill.

Dr. Monnett has a Ph.D. from the Department of Ecology and Behavioral Biology at the University of Minnesota and a B.S. from the University of Washington in Zoology. He also has training in the veterinary sciences and is a certified veterinary technologist. He holds a private pilot's license and is certified as a commercial diver.

The topic of Dr. Monnett's Ph.D. dissertation was "Patterns of Movement, postnatal development and mortality of sea otters in Alaska" in which studies of sea otter pups and weanlings were pioneered.

In addition to his research on sea otters, he has many years of experience conducting research in the fields of avian ecology and

non-human primate toxicology and infant development. He also has additional research experience on other marine mammals.

LITERATURE CITED

Kenyon, K. W. 1969. The sea otter in the eastern Pacific Ocean. USFWS. North American Fauna, No. 68, 352.

Monnett, C. 1988. Patterns of movement, postnatal development and mortality os sea otters in Alaska. Unpubl. Ph.D. dissertation. University of Minnesota, Minneapolis, MN. 134 pp.

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$7,500.0						
Travel		$920.0						
Contractual								
Commodities		$1,500.0						
Equipment		$0.0						
Subtotal	$0.0	$9,920.0	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Indirect		$992.0						
Project Total	$0.0	$10,912.0						
Full-time Equivalents (FTE)		1.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Indirect costs = 10% of direct costs

1997

Prepared: 1 of 4

Project Number: 97233
Project Title: Body condition of Sea Otters
Name: Lisa M. Rotterman

FORM 4A
Non-Trustee
SUMMARY

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FFY 1997
	Rotterman, Lisa	Research Ecologist	1.0	5000.0		5,000.0
	Monnett, Charles	Research Ecologist	0.5	5000.0		2,500.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	1.5	10000.0	0.0	
					Personnel Total	$7,500.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FFY 1997
	Cordova (perdiem @ 15/d)			32	15.0	480.0
	Boat to Whittier	500.0	1			500.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$980.0

1997

Prepared:

Project Number:
Project Title: Body Condition of Sea Otters
Name: Lisa M. Rotterman

FORM 4B
Personnel
& Travel
DETAIL

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed
Description	FFY 1997
Contractual Total	$0.0

Commodities Costs:	Proposed
Description	FFY 1997
Boat fuel	1,500.0
Commodities Total	$1,500.0

1997

Prepared:

Project Number:
Project Title: Body Condition of Sea Otters
Name: Lisa M. Rotterman

FORM 4B
Contractual & Commodities DETAIL

4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FFY 1997
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	
Description	of Units	

1997

Project Number:
Project Title:
Name:

FORM 4B
Equipment
DETAIL

Prepared:

4/15/96

SYNOPSYS: An Ecosystem Synthesis Model of EVOS Restoration Findings for Resource Management

Project Number: 97234

Restoration Category:

Proposer: The Environmental Services Corporation of the Americas (ESCA), a private company.

Lead Tustee Agency:

Cooperating Agencies:

Alaska SeaLife Center:

Duration: 1st year, one-year project

Cost FY 97: $185,400.00
Cost FY 98:
Cost FY 99:
Cost FY 00:
Cost FY 01:
Cost FY 02:

Geographic Area:

Injured Resource/Service:

ABSTRACT

Previous research sponsored by the *Exxon Valdez* Oil Spill Trustee Council has generated considerable data on the abundance and distribution of many species and the productivity of many ecological communities throughout the spill-affected area. This project proposes to integrate study results into a relatively simple model (SYNOPSYS) to provide an ecosystem-level assessment capability to assist resource managers, the Trustee Council and staff in its administrative and communication responsibilities. This model can serve as an interim alternative to more complex modelling efforts requiring significantly more time and resources to fully develop. The approach discussed here builds on previously supported work and synthesizes results from various damage assessment and restoration studies, combined with expert analysis and interpretation.

INTRODUCTION

The *Exxon Valdez* Oil Spill has been consistently cited as the most studied oil spill in history. Along with numerous articles, reports and books, the recent publication of the proceedings from the American Society of Testing and

Materials (Wells, *et al.* 1995) and the *Exxon Valdez* Oil Spill Symposium Proceedings by the American Fisheries Society this year will infuse a large information base into the public domain. However, even in light of the volume of information disseminated, the number of attempts to synthesize overall findings of the effects of the spill on biological resources through some type of whole or ecosystem perspective has been limited. Why has such scientific effort been unable to provide a comprehensive picture to more effectively aid the Trustee Council in its administrative and policy responsibilities? Spies (1993) discusses many of the problems that science has faced in assessing overall effects, and how unpreparedness resulted in increased initial costs of data gathering and its impact on policy decisions. The lack of pre-spill baseline data resulted in a large number of studies, many of them complex, and slowed the pace in synthesizing an overall scientific picture of recovery.

Since the settlement agreement, the Trustee Council has taken steps to invest in a broader understanding of the natural mechanisms and cycles that drive the populations and communities in Prince William Sound and the Gulf of Alaska. The restoration phase has shifted paradigms from assessing recovery of individual species, to focussing on regional and local ecosystems. This phase has now developed to a point where integration and synthesis of a broad range of research and monitoring programs may begin to offer insights into long-term restoration and management from this ecosystem perspective.

Early examples of various kinds of synthesis work at an ecosystem or community level include the Coastal Habitat Injury Assessment studies managed by the USFS, similar studies conducted by NOAA, ecological/economic systems work by H.T. Odum and associates (supported by the Cousteau Society; Brown, *et al.* 1993), and research supported by Exxon (e.g. Gilfillan *et al.* 1995). More recently, long term studies such as the Sound Ecosystem Assessment and related projects, the Nearshore Ecosystem projects, and the Apex Predator studies focus on ecosystem-level dynamics and trends.

However, the Trustee Council still does not have a tool that aids them or resource managers in synthesis and understanding the broad range of research results, and how such findings may affect future resource, economic and administrative policies of the Council. While there are synthesis and compilation efforts underway, such as the Information Management Project coordinated by the Executive Director's office, most are still under development.

As knowledge continues to evolve in applied environmental fields such as natural resource damage assessment and restoration, it is important to develop tools that can effectively communicate scientific information with other disciplines that also play important roles in resource management, environmental policy and economics. In his keynote address in the *Exxon Valdez* Oil Spill Forum commemorating the five year anniversary of the spill, George Rose (1994) commented on the role of science in restoration and resource management. In a portion of his address, he stated:

"Science can certainly help solve these problems, but science cannot solve them alone. In the long term, I believe it is the involvement of the people, particularly of the users, that will solve this problem, and without that all the

science in the world is not going to get you very far. I would go so far as to say that the future will bring more experimental management involving people who are users of the system."

This proposal suggests developing a system (SYNOPSYS) that synthesizes research information on the spill and combines it with collective expertise, so that a dynamic model can be viewed, discussed and adjusted to aid resource management, result tracking and policy deliberations. This proposed model is not intended to replace more complex modelling efforts that may be under long-term development; however, in the short and mid-term, it can be a highly functional product with practical application.

NEED FOR THE PROJECT

A. Statement of Problem and Link to Restoration. The restoration phase of the *Exxon Valdez* oil spill has developed to a point where synthesis of various restoration and monitoring programs may offer insights into long-term management and ecosystem assessment. The *FY 97 Invitation to Submit Restoration Proposals* specifically identifies a need for ecosystem synthesis projects. The Trustee Council is currently supporting some modelling efforts through institutions such as the Prince William Science Center, however, these efforts and require significant time and development before their findings will be of ultimate value.

Synthesis is not simply an objective compilation of data and models, but also needs to address the subjective views of experts and stakeholders involved. In the short-term, the Council has to assess resource status and make decisions based on varying levels of uncertainty. Although the use and sophistication of model development is consistently improving through advancement in technology, ecological modelling continues to operate with high levels of uncertainty. However, uncertainty can be minimized through use of existing data combined with current expert knowledge and organized within a logical framework. Use of collective expertise was a hallmark of the *Exxon Valdez* oil spill habitat acquisition process and has been used throughout various aspects of response, damage assessment and restoration (i.e. Habitat Protection Workgroup 1993). Our team's specific experience with model development has proven effective in stimulating dialogue between different disciplines and interest groups.

B. Location

Major parts of this project will be conducted in Anchorage, Washington, DC and Delft, The Netherlands. The project is research-oriented and based on use of existing information and expertise. Local communities may be involved through contributions from their experts, but will not be affected during the project's implementation.

COMMUNITY INVOLVEMENT

Expert opinion does not lie only with scientists, but with other individuals intimately involved with Alaska's resources. The importance of local communities and their expertise in understanding qualitative trends in the populations of resources on which they rely or subsist should be included in synthesizing findings from the spill. We propose to also incorporate the expertise of local residents by requesting contributions of specific knowledge of affected areas. Local experts identified by our research will be contacted individually and through a general public meeting to be held in Anchorage. Also, several local meetings may be proposed in which the objectives and methods described below will be discussed and additional contributions sought.

PROJECT DESIGN

A. Objectives

Our overall objective is to provide the Trustee Council with a simple model for use by its staff and resource managers that can effectively synthesize relevant restoration studies at an ecosystem level, while providing clear pathways to specific restoration projects, study results and expertise. To accomplish this the following specific objectives are proposed:

1) Build on existing work sponsored by the Trustee Council, such as the Comprehensive Review and Critical Synthesis Reports for various components of the spill (e.g. Zedler 1992), and the Executive Director's Information Management Project

2) review all relevant damage assessment and restoration studies

3) create a framework to serve as the foundation for an ecosystem model

4) develop an Exploratory Analysis System type model that helps resource managers compare variable scenarios while verifying accuracy of existing information (e.g. populations and stocks affected by the spill).

5) provide a software-based tool (SYNOPSYS) that can be used by the Trustee Council and its representatives to assess and present a synthesis of research and spill-related findings.

B. Methods

Our approach involves several steps in developing this model. In a first step, existing information is collected, evaluated, and summarized from sources such as the oil spill public information library in Anchorage, coordination with ongoing information management projects, and discussions and interviews with relevant experts.

The second step defines "compartments" (representing part of the system like a function or activity, such as hydrology, primary producers, or predators), state-variables (a minimum set through which the state of each compartment can be

sufficiently defined), relations (the positive or negative feedback of change in one of the state-variables on all the others) and the "strength" of the relations. No description of a current state or starting-condition is necessary, because only the changes are evaluated.

Through this system, the effect of change in one or more of the state-variables (e.g. a result of damage assessment or restoration finding), on other state-variables can be evaluated. In the early stages, these changes may be qualitative (minor, medium, major effect), but can eventually be represented quantitatively through research findings and expert knowledge.

In areas with high levels of uncertainty, that require expert involvement, it is important to develop a shared view on a given representation. The "Group Decision Room" (GDR) or "collective subjectivity" (Smith and Theberge 1987) is a proven environment to gain such an understanding. As stated previously, this strategy has already been used in other restoration activities. Through a GDR, the exchange of views is supported by a software instrument, allowing efficient, rapid, and independent interaction between the participants. The results of steps 1 and 2 are documented in an inception report which will form the basis of the system model.

Step 3 involves a refinement in representation. In this step some of the compartments (or combinations of compartments) will be refined through qualitative modelling. Inputs (such as physical parameters, season) and outputs (such as herring, or salmon stock, status of injury) will be established with qualitative ranges (e.g. scarce, low, normal, good, high). Experts then will then be polled on the relationships between inputs and outputs, thereby defining the solution space of the sub-systems.

For easy access and evaluation, the results of steps 1-3 are incorporated into supporting software (SYNOPSYS). This software product, will encapsulate all the ideas and views developed in the course of the project, will be presented and tested with experts involved in steps 2 and 3. This will be a Windows-based program that allows users to evaluate the effects of the spill and restoration measures on an ecosystem level, and will allow users to compare variable scenarios against the documented information base. The information management work already sponsored by the Trustee Council could also be linked to the model as background information through a Document Retrieval System (for example, the georeferenced database currently under development) and include multi-media type presentations if desired[1].

C. Cooperating Agencies, Contracts and Other Agency Assistance

The specific software programming tasks for SYNOPSYS will be contracted to Resource Analysis (RA), an independent firm located in Delft, The Netherlands, with a professional staff of over 30. The subcontractor is multi-disciplinary with main strengths in the planning and management of decision support systems

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[1]A document retrieval system and multimedia linkages to the model have not been factored into the budget for this proposal.

for water resources, coastal and marine resources,

natural resources management, and assessing the impacts of climate change on society. RA is specialized in model development, structuring and executing complex multi-disciplinary studies, and use of computers in data handling and information-generating processes to support planning. Some of the models developed by RA are:

EDSS Decision Support System (including Exploratory Analysis System and Qualitative Modelling Modules) for the Western Scheldt Estuary
DONZ Ecological Indicators for the North Sea
FARAO Foodweb Accumulation Rate Analyzer and Overviewer
RAMING Water and sediment quality model
RAPSODIE Program Shell for Data Storage, Analysis, Exchange and Multi-Criteria Decision Making
CALMOD Shipping Calamity Modelling Shell
PRELUDE A model describing the source-receptor pathways for main pollutants in waterbodies in Western-Europe
WESTOOL Prototype Decision Support System for the Western Scheldt Estuary.
COSMO A demonstration Decision Support System for Coastal Zone Management
COSMO/W Demonstration DSS for the Western Scheldt Estuary
CORONA An interaction system for the various factors in Coastal Zone Management
SAMPAK Coastal Zone Management Model for Thailand
CORAL Coastal Zone Management Model for Coral Reefs
COMA Coastal Zone Management model for the African West Coast

SCHEDULE

A. Measurable Project Tasks for FY 97 (October 1, 1996-September 30, 1997)

October 1-December 31: Conduct comprehensive data collection of damage assessment and restoration studies, for development of a synthesis matrix. Incorporate results and sources from ongoing information management project managed by the Executive Director's Office and ADNR and other summary data. Submit first status report.

January 1-March 1: Begin design and development of the model. Continue with data compilation. Contact principal investigators of various restoration studies for input and any needed clarifications. Attend Annual Restoration Workshop January 22-25. Hold public meeting focussing on contacts and contributions from local communities. Submit second status report.

March 1-June 1: Design and Development of SYNOPSYS

June 1-August 1: Expert consultation/peer review, review and correction/refinement of model components. Submit

third status report.
August 1-September 15: Prepare written report and model for presentation.

September 15-October 1. Present SYNOPSYS to the Trustee Council or designated representatives.

B. Project Milestones and Endpoints

The methods and time table described above outline the course of information synthesis and model development. We also propose to submit brief status reports to the Executive Director's office to update progress on project development. The endpoints of this project include
a workshop to present and review the model and software, with subsequent changes incorporated in conjunction with a final report.

C. Completion Date

Data synthesis and model development will be researched and completed during FY 97.

PUBLICATIONS AND REPORTS

In addition to a final report delivered to the Trustee Council, this project proposes to submit a manuscript for publication in one of the following refereed periodicals:

Ecological Modelling
Journal of Restoration Ecology
Conservation Biology

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This work proposes to use information from and complement ongoing synthesis or summary programs supported by the Trustee Council. Examples include the Information Management Project supported by the Executive Director's office and ADNR, and existing comprehensive reviews and critical synthesis studies.

PROPOSED PRINCIPAL INVESTIGATOR

Anthony J. Hooten, Ecologist
The Environmental Services Corporation of the Americas (ESCA)
4005 Glenridge Street, Suite 100
Kensington, MD 20895-3708
Phone Number: (301) 942-8839
Fax Number: (301) 942-8839 E-Mail: 76260.2413@compuserve.com

PERSONNEL

Anthony J. Hooten directed biological studies in the scientific support division of ADEC's Oil Spill Response Center in Valdez during 1989 and 1990. He managed several response and damage assessment projects, and served as co-principal investigator for the 1989 ADEC winter scientific sampling survey of oil-affected areas in Prince William Sound. Mr. Hooten served as state coordinator for the 1990 Beachwalk to assess condition of the oiled shorelines one year after the spill, and supported response planning for 1990 clean-up operations. He served as team leader and a co-principal investigator for the Herring Bay experimental station in Prince William Sound, from 1990 to 1994, and designed and conducted studies and surveys to assess environmental impacts and restoration efforts at over 50 study sites in the marine intertidal. Mr. Hooten consults with the World Bank's Environment Department, U.S. Agency for International Development, the EPA and the Department of Defense. Mr. Hooten is experienced in database applications development and information management for environmental data.

Peter Kouwenhoven, Ph.D. is the director of environmental programs for Resource Analysis and has over 15 years of experience with microcomputers (IBM and Apple) and mainframes (PDP & VAX). Dr. Kouwenhoven is proficient in the use and programming of many software packages including spreadsheets, statistics and modelling (STEM, CSMP, Dynamo), programming (Pascal, Fortran, APL), and other tools (MathCad, PC-Matlab) and has developed a variety of computer models for water quality and ecosystem processes. His experience includes the design and development of the software package STEM for the simulation and calibration of sets of first order differential equations, especially suited for the modelling of ecosystems. Dr. Kouwenhoven has served as a consultant to the World Bank and other organizations in decision support systems and database management in the following areas: Aral Sea Wetland Restoration Project, design of pilot projects to mitigate the negative ecological and economical effects of the decrease of the Aral Sea level; Broad contribution to the Land Water Environment Information Technology Investment Programme, to develop generic tools for decision support systems in coastal areas; Development of FARAO, Foodweb Accumulation Rate Analyzer and Overviewer, to evaluate contaminant uptakes by organisms in a foodweb; Development of COSMO/W, demonstration software of a decision support system for the Western Scheldt Estuary, The Netherlands; Development of WESTOOL, a prototype decision support system for the Western Scheldt Estuary; Development of COSMO and CORONA, software for a computer network environment, demonstrating and teaching economical and environmental aspects of coastal zone management, and development of PRELUDE, the integration of several submodels describing the source-receptor pathways for main pollutants in waterbodies in Western-Europe.

Frank Rijsberman, Ph.D. is the managing director of Resource Analysis and provides consulting services in water engineering, water and natural resources planning and management. He is experienced in policy analysis and systems design projects in coastal and fresh water systems, soil erosion, environmental management and climate change. He has applied experience with projects in developed countries (the Netherlands, USA, Scandinavian countries) as well as developing countries (Afghanistan, Burkina Faso, China, India, Indonesia, Mexico,

Nigeria, Turks and Caicos Islands). Dr. Rijsberman has worked at the United Nations-Department on Technical Cooperation for Development (UN-DTCD) Secretariat in New York, carrying out a number of consulting assignments for the United Nations Development Program and UN-DTCD, and has been a consultant to the Organization for Economic Cooperation and Development since 1986. Dr. Rijsberman has over ten years experience with computer applications for natural resources management. He developed and published a guide on the use of micro computers in developing countries, has developed many computer programmes, a water resources database (Turks and Caicos Islands), consulted on the development of computer centers and water resources information systems (Afghanistan and Nigeria) and is responsible for various computer training.

Jonathan Simpson is a senior scientist with over 16 years experience in water resources management, lake restoration, nutrient modelling, writing and editing for technical and public audiences and community relations/consensus building for natural resource issues. He has applied experience in wetland and riparian restoration, pollution and toxic substances assessment, and modelling. Mr. Simpson co-authored with Dr. Kenneth Reckhow the U.S. EPA document: *Modeling Phosphorous Loading and Lake Response Under Uncertainty: A Manual and Compilation of Export Coefficients.* This work established a method for quantifying the relationship between land use and trophic quality that has been in popular use for over a decade. As a consultant Mr. Simpson has served over 100 clients ranging from homeowner associations to the U.S. EPA. Currently, Mr. Simpson is involved in developing and editing a national environmental goals report for the EPA administrator. Mr. Simpson serves on the editorial board of the Center for Watershed Protection, and is general editor of a quarterly technical publication. He has performed environmental education seminars for local community involvement, coordinating meetings, issuing public notices and press releases, and working with schools.

Mark T. Bryer holds a graduate degree from Yale University School of Forestry and Environmental Studies. Mr. Bryer designs and manages databases that globally track, describe, and record occurrences of terrestrial and aquatic ecological communities. He is responsible for data analysis, preparing technical reports and conducting research on ecological community classification and measurement. Mr. Bryer has provided technical and programmatic support to the U.S. Environmental Protection Agency's Office of Wetlands, Oceans, and Watersheds. Researched and prepared technical guidance, case studies, and analyses related to watershed and ecosystem management, ecological restoration, and nonpoint source pollution. Proficient in Wordperfect, Microsoft Word, Microsoft Power Point, Advanced Revelation, Excel, Lotus 1-2-3, IDRISI, pcARC/Info, ARC/View, BASIC, and FORTRAN.

LITERATURE CITED

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1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997
Personnel		$102.0
Travel		$34.9
Contractual		$30.0
Commodities		$1.0
Equipment		$0.0
Subtotal	$0.0	$167.9
Indirect		$17.5
Project Total	$0.0	$185.4
Full-time Equivalents (FTE)		15.5

Dollar amounts are shown in thousands of dollars.

Other Resources

FUNDING REQUIREMENTS				
Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	

9723c

Prepared 04/11/96

Personnel Costs:

Name	Position Description	Months Budgeted	Monthly Costs
A. Hooten	PI	4.5	7.0
P. Kouwenhoven	Modeller	7.0	6.5
J. Simpson	Technical Support	1.0	6.0
F. Rijsberman	Modeller	2.0	7.0
M. Bryer	Technical Support	1.0	5.0
	Subtotal	15.5	31.5

Travel Costs:

Description	Ticket Price	Round Trips	Total Days
Amsterdam-Anchorage	1.3	6	45
Amsterdam-Washington, DC	0.7	2	8
Washington, DC-Anchorage	0.9	6	45

Rest of budget being faxed.

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET– October 1, 1996 - September 30, 1997

Budget Category:		Authorized FFY 1996	Proposed FFY 1997					
Personnel			$102.0					
Travel			$34.9					
Contractual			$30.0					
Commodities			$1.0					
Equipment			$0.0	LONG RANGE FUNDING REQUIREMENTS				
	Subtotal	$0.0	$167.9	Estimated	Estimated	Estimated	Estimated	Estimated
Indirect			$17.5	FFY 1998	FFY 1999	FFY 2000	FFY 2001	FFY 2002
	Project Total	$0.0	$185.4					
Full-time Equivalents (FTE)			15.5					
		Dollar amounts are shown in thousands of dollars.						
Other Resources								
Prepared:	04/11/96							

97234

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET– October 1, 1996 - September 30, 1997

Personnel Costs:							
	Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1997
	A. Hooten	PI		4.5	7.0	0.0	31.5
	P. Kouwenhoven	Modeller		7.0	6.5	0.0	45.5
	J. Simpson	Technical Support		1.0	6.0	0.0	6.0
	F. Rijsberman	Modeller		2.0	7.0	0.0	14.0
	M. Bryer	Technical Support		1.0	5.0	0.0	5.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
			Subtotal	15.5	31.5	0.0	
						Personnel Total	$102.0

Travel Costs:						
Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FFY 1997
Amsterdam-Anchorage	1.3	6	45	0.2	17.3
Amsterdam-Washington, DC	0.7	2	8	0.2	3.0
Washington, DC-Anchorage	0.9	6	45	0.2	14.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$34.9

Prepared: 04/11/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET– October 1, 1996 - September 30, 1997

Contractual Costs:			Proposed
Description			FFY 1997
Subcontract to Resource Analysis for software programming & production			30.0
		Contractual Total	$30.0
Commodities Costs:			Proposed
Description			FFY 1997
Publication in peer reviewed journal			1.0
		Commodities Tol	$1.0
Prepared:	04/12/96		

Project Title: **Sand Lance Literature Review and Synthesis**

Project Number: 97235

Restoration Category:

Proposer: Bonita Nelson and Stanley D. Rice
NMFS Auke Bay Laboratory

Lead Trustee Agency: NOAA

Cooperating Agencies: All Trustee Agencies

Alaska SeaLife Center:

Duration: 1st year, 1-year project

Cost FY 97: 42,300

Cost FY 98:

Geographic Area: Worldwide

Injured Resource/Service: Sand lance literature review and qualitative synthesis

ABSTRACT

Trustee funded programs have highlighted the importance of Pacific sand lance (*Ammodytes hexapterus*) as a prey item in the nearshore environment, but have failed to describe sand lance distribution and abundance. The Trustee funded Sound Ecosystem Assessment (SEA), Apex Predator Ecosystem Experiment (APEX) and Nearshore Vertebrate Predator (NVP) programs are all predicated on understanding how the Prince William Sound ecosystem functions; sand lance have been identified as an important prey item in the nearshore environment, but these programs have not focused on the abundance and distribution of this species. The primary objectives of this proposal are to summarize the existing literature on sand lance into a comprehensive review and identify datasets which may contain information on sand lance distribution and abundance in the *Exxon Valdez* spill zone. The proposed review will summarize current information published in journals, agency reports and gray literature and will provide a qualitative synthesis of known sand lance information. An electronic annotated bibliography will also be produced and distributed upon request. Datasets that contain information on the abundance and distribution of sand lance in the spill zone will also be identified. The end products of this proposal will provide direction for trustee projects that need to incorporate account for sand lance biology into their models.

INTRODUCTION

This proposal requests funds to conduct a Pacific sand lance (*Ammodytes hexapterus*) literature review from all available sources including national and international work reported in journals, study reports, agency reports and gray literature. Datasets collected from studies in Alaska which contain information about sand lance will be identified and examined if possible for abundance and distribution information not contained in the literature. If the results of this literature review and dataset identification process indicate that the distribution, abundance as incidental catch, or frequency of occurrence of sand lance in stomach samples have diminished since 1989 in the spill zone, then a proposal would be offered for FY 98 to evaluate further options for investigating critical aspects of life history characteristics of sand lance.

Sand lance are important forage fish for several species of sea birds, neritic and demersal fish, and marine mammals which the *Exxon Valdez* Oil Spill Trustee Council has identified as injured biological resources in the spill zone (*Exxon Valdez* Oil Spill Trustee Council 1996). Specifically, sand lance are an important seasonal component of the diets of harbor seals, marbled murrelets, pigeon guillemots, and pink salmon -- all species classified by the Trustees as not recovering. Together with herring, sand lance are a key food source at the base of a food web that is highly valued ecologically and economically. Researchers in the Trustee funded SEA, APEX and NVP programs agree that a important functional relationships exist among sand lance and their predators and prey; however, many aspects of their biology, distribution, and abundance have not been documented, especially in Alaska.

A recent literature review and species synopsis of Pacific sand lance (Fields 1988) covered published information through 1986. Most of the literature reviewed by Fields (1988) focused on various *Ammodytes* species from the North Atlantic and Japan, and did not contain current information from research of this species in Alaska waters. Fields (1988) identified several important areas in which sand lance information was missing or circumstantial. These include taxonomy, size at age, spawning duration, biotic factors that affect larvae, effects of predation on juveniles, and specific habitat requirements. Several researchers have published significant new information on several of these areas -- taxonomic discrimination by electrophoresis (Donaghy et al. 1995), meristics (Winters 1988), and energy budgets (Gilman 1994) from North Atlantic species; population dynamics (Kimura et al. 1992) and environmental constraints on population size for sand lance off Japan (Nakat et al. 1991); early life history (McGurk et al. 1992), factors affecting prey concentrations (McGurk and Warburton 1992), and using sea birds to gauge sand lance recruitment (Bertram and Kaiser 1993) or as samplers of sand lance (Hatch and Sanger 1992) from studies in Alaska waters.

Comprehensive and systematic studies have not been undertaken to quantify the abundance and locations of Pacific sand lance populations. Fields (1988) reported that sand lance populations do not migrate. Therefore, an exhaustive search for datasets from plankton surveys, stomach analyses, and nearshore and demersal fish censuses documenting the occurrence of sand lance would help establish temporal and spatial distributions. Looking at datasets collected over several years from work preformed in Alaska would not only identify areas and times of sand

lance occurrence, but also show if those factors change over time. The Trustees have funded several projects within the SEA, APEX and NVP programs that contain data where sand lance were captured or were identified through analysis of stomach contents.

NEED FOR THE PROJECT

A. Statement of Problem

Several species of birds, fish, and marine mammals injured by the *Exxon Valdez* oil spill, which are known to consume sand lance as prey, continue to show poor recovery. The cause of the reduced survival is under investigation by various Trustee projects and could be related to a change in availability of prey, including sand lance. Although sand lance populations were not directly assessed following the spill, populations were probably negatively impacted from the spilled oil for the following reasons: 1) all life history stages were probably exposed to oil because newly hatched larvae reside in the water column during spring and adults school in nearshore habitats and were vulnerable to oil deposited along shorelines; and 2) the length of exposure was probably lengthy because sand lance burrow in sediments each night and for several months during winter, which may have had a negative impact on their ability to successfully turn fat into eggs (Pinto et al. 1984). A current qualitative literature synthesis and an understanding the distribution and abundance of this key forage fish and how or whether these factors have changed since 1989 would be vital to understanding the energy flow between trophic levels when developing multi-species management plans for the nearshore ecosystem.

B. Rationale/Link to Restoration

The proposed project would provide data on the current information known about Pacific sand lance, a key forage fish for many species of birds, fish, and marine mammals impacted by the oil spill. This study would complement and help in interpreting results from Trustee funded projects such as those in the SEA program, Nearshore Ecosystem Projects (NVP Project \025) which address the question of whether food is limiting the recovery of species in the nearshore environment, as well as Seabird/Forage Fish & Related Bird Projects (APEX\163) which focus on understanding the key factors influencing the survival of pink salmon and herring. Information on sand lance distribution and abundance would directly enhance efforts in the APEX and NVP projects because sand lance is food for many of their target species. This project relates directly to the Oil Spill Restoration Plan objectives to understand large-scale ecosystem processes and assess potential mechanisms constraining recovery of the nearshore ecosystem.

C. Location

The literature review, qualitative synthesis and dataset review will occur at the Auke Bay Laboratory, Juneau, Alaska.

COMMUNITY INVOLVEMENT

This project does not involve field work. Science centers, public schools, native corporations, universities, environmental organizations, and other concerned groups will have access to the synthesis. Efforts will be made to contact people in communities within the spill zone to gain traditional and local knowledge of the occurrence and abundance of sand lance. This may be coordinated closely with the APEX project leader's efforts in obtaining local and traditional knowledge.

PROJECT DESIGN

A. Objectives

The major objectives are to assemble all available information on sand lance in Alaska, describe what is known and identify deficiencies in the current knowledge. Specific objectives are:

1. Conduct a detailed literature search of refereed and non-refereed material about Pacific sand lance:
   - A. generate an electronically accessible annotated bibliography;
   - B. incorporate traditional or local sources of knowledge collected from residents of the spill zone;

2. Identify datasets and sample collections which are pertinent to the sand lance biology in Alaska and report on their potential to describe:
   - A. species interactions with other forage fish species during life history stages;
   - B. temporal and spatial patterns of distribution of adults juveniles, and larvae;
   - C. identification of important habitats in spill zone if possible;

3. Write a review paper which summaries and integrates all of the available information which includes a qualitative synthesis of the literature and dataset information organized by themes, and;

4. Prioritize and recommend future research to address deficiencies identified by the first two objectives.

If results indicate that sand lance abundance or distribution have significantly diminished or changed since the oil spill, further work would be proposed in outlying years to gather additional information on this species as it relates to the restoration work in the nearshore environment.

B. Methods

Literature would be searched with library services at the Auke Bay Laboratory. Results of the literature search will be placed into a bibliographic software package. Datasets and fish collections which contain potential information about sand lance would be identified by

contacting SEA, NVP and APEX principle investigators as well as researchers from other natural resource agencies.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

No contracts are anticipated. Other Trustee agencies will be contacted and requested to provide reports, bibliographies and datasets.

SCHEDULE

A. Measurable Project Tasks for FY 97

Oct. 1 - Dec. 31 1996:	Conduct Literature Search
Nov 1 - Feb 29 1997:	Conduct Dataset Search
Mar 1 - Sept. 30 1997:	Write final report

B. Project Milestones and Endpoints

December 1996:	Literature search completed.
March 1997:	Dataset search completed.
September 1997:	Final report submitted.

C. Completion Date

The completion date for analyses and reporting of objectives would be during FY 97.

PUBLICATIONS AND REPORTS

Proposed products of the project all completed by September 30, 1997:
Nelson, Bonita. 1997. The sand lance (*Ammodytes hexapterus*) in Alaska. NOAA Technical Memorandum

Exxon Valdez Oil Spill Restoration Project Final Report. Pacific sand lance (*Ammodytes hexapterus*) literature review.

A computer annotated bibliography will be produced.

PROFESSIONAL CONFERENCES

This proposal requests funds to attend the International Conference on Forage Fish held in Anchorage during November 1997 (where a poster will be presented) and the annual Trustee meeting in Anchorage during January, 1997.

NORMAL AGENCY MANAGEMENT

NOAA/NMFS has statutory stewardship for all living marine resources; however, if the oil spill had not occurred NOAA would not be conducting this research project.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project would be coordinated with other projects conducted by the Auke Bay Laboratory and other agencies and universities. Some coordination has already been achieved during preliminary literature acquisition and in developing the objectives for this project. The data from this project would be directly relevant to ongoing Restoration projects dealing with the recovery of nearshore vertebrates.

PROPOSED PRINCIPAL INVESTIGATORS

Bonita D. Nelson and Stanley D. Rice
NOAA NMFS
Auke Bay Laboratory
11305 Glacier Hwy
Juneau, AK 99801
Phone: (907) 789-6071
Fax: (907) 789-6094
E-mail: bnelson@abl.afsc.noaa.gov

PERSONNEL

Principal Investigator: GS-9 Fisheries Research Biologist - Bonita D. Nelson

Bonita D. Nelson
Education:
BS 1979, University of Illinois, Urbana (Ecology, Ethology , Evolution)
MS 1986, University of Alaska-Juneau (Fisheries)
Experience:
Present database manager of the Trustee hydrocarbon data . Responsibilities include supervision of data entry of sample and analytical data; processing and dissemination of data for principal investigator; database management. Nelson has designed and managed databases as well as analyzed data for the radio telemetry program at the Auke Bay Laboratory for 10 years. She has managed the Trustee hydrocarbon database for 1 year.

Co-Principal Investigator: GM-14 Physiologist - Stanley D. Rice

Dr. Rice received a BA (1966) and MA (1968) in Biology at Chico State University, and Ph.D. (1971) in Comparative Physiology at Kent State University. Employed at the Auke Bay Laboratory since 1971 as a research physiologist and task leader, Dr. Rice has been Habitat Program Manager since 1986. He has researched oil effects since 1971 and has published over 70 papers. His studies have ranged from field to lab tests, behavioral to biochemical studies, and salmonids to invertebrates. Dr. Rice has conducted and managed cooperative projects since 1974, including the Auke Bay Laboratory's *Exxon Valdez* damage assessment and restoration studies. Activities since the oil spill include oversight management of damage assessment projects, establishment of chemistry lab and analyses, establishment of hydrocarbon database management. Dr. Rice has provided principal investigators and managers in NOAA and other agencies with reviews and critical input into agency decisions, and he has interacted closely with other agencies on logistics coordination, critiquing study design, and interpreting observations.

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Exxon Valdez Oil Spill Trustee Council. 1996. Invitation to submit restoration proposals for federal fiscal year 1997.

Fields, L. J. 1988. Pacific sand lance, *Ammodytes hexapterus*, with notes on related Ammodytes species, p. 15-33 *In* N.J. Wilimovshy, L.S. Incze, and S. J. Westerheim [ed.] Species synopsis: life histories of selected fish ad shellfish of the northeast Pacific and Bering Sea. University of Washington, Seattle, Wash.

Gilman, L.J. 1994. An energy budget for northern sand lance, *Ammodytes dubius*, on Georges Bank. 1977-1986. Fish Bull. 92:647-654.

Hatch, S. A. and G. A. Sanger. 1992. Puffins as samplers of juvenile pollock and other forage fish in the Gulf of Alaska. Mar. Ecol. Prog. Ser. 80(1): 1-14.

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McGurk, M. D., H. D. Warburton, M. Galbraith and W. C. Kusser. 1992. RNA-DNA ratio of herring and sand lance larvae from Port Moller, Alaska: comparison with prey concentration and temperature. Fish. Oceanog. 1(3):193-207.

McGurk, M. D., and H. D. Warburton. 1992. Pacific sand lance of the Port Moller estuary, southeastern Bering Sea: an estuarine-dependent early life history. Fish. Oceanog. 1(4):306-320.

Nakata, H., S. Kimura, M.J. Kishi and T. Fujowara. 1991. Environmental constraints on the sand lance population in the Eastern Seto Inland Sea. Marine Pollution Bulletin. 23: 343-346.

Pinto, J. M. W.H. Pearson and J. W. Anderson. 1984. Sediment preferences and oil contamination in the Pacific sand lance *Ammodytes hexapterus*. Marine Biol. 83:193-204.

Winters, G. H. 1988. Meristic composition of sand lance (*Ammodytes* spp.) from the coastal waters of Eastern Newfoundland. J. Northw. Atlant. Fish. Sci. 9:5-11.

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997
Personnel		$30.6
Travel		$4.9
Contractual		$0.0
Commodities		$2.2
Equipment		$0.0
Subtotal	$0.0	$37.7
General Administration		$4.6
Project Total	$0.0	$42.3
Full-time Equivalents (FTE)		0.5
Other Resources		$5.8

LONG RANGE FUNDING REQUIREMENTS

Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	

Dollar amounts are shown in thousands of dollars.

Comments:
NOAA Contribution:
Habitat Program Manager, S. Rice, 0.5 mo = $5.8K

1997

Prepared:

Project Number: 97235
Project Title: Sand Lance Synthesis
Agency: National Oceanic and Atmospheric Administration

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/12/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
						0.0
B Nelson	Fishery Research Biologist	9/6	6.0	5.1		30.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		6.0	5.1	0.0	
					Personnel Total	$30.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
					0.0
Anchorage January Workshop	0.4	1	4	0.2	1.2
Anchorage, Forage Fish Symposium	0.4	1	4	0.2	1.2
Informational trip/scientists/museums in Fairbanks, Anchorage	0.7	1	6	0.3	2.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.9

1997

Prepared:

Project Number: 97___
Project Title: Sand Lance Synthesis
Agency: National Oceanic and Atmospheric Administration

FORM 3B
Personnel
& Travel
DETAIL

4/12/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed
Description	FFY 1997
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FFY 1997
Report Production Costs (Disks, NOAA Tech Memo)	1.5
Library Search Time	0.2
Bibliographic software	0.5
Commodities Total	$2.2

1997

Prepared:

Project Number: 97___
Project Title: Sand Lance Synthesis
Agency: National Oceanic and Atmospheric Administration

FORM 3B
Contractual & Commodities DETAIL

4/12/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

New Equipment Purchases:	Number of Units	Unit Price	Proposed FFY 1997
Description			
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number of Units	Inventory Agency
Description		
Computer	1	NOAA
NEC Monitor	1	NOAA

1997

Prepared:

Project Number: 97___
Project Title: Sand Lance Synthesis
Agency: National Oceanic and Atmospheric Administration

FORM 3B
Equipment
DETAIL

4/12/96

KACHEMAK BAY SHELLFISH NURSERY CULTURE PROJECT SUBMITTED UNDER THE BAA

Project Number: 97238

Restoration Category: General Restoration

Proposer: Kachemak Shellfish Mariculture Association

Lead Trustee Agency: Alaska Department of Fish and Game
Cooperating Agencies: University of Alaska, Anchorage

Alaska Sealife Center:

Duration: 2nd year, 3 year project

Cost FY 97: $76,700

Cost FY 98: $27,000

Geographic Area: Kenai Peninsula

Injured Resource/Service: Intertidal Organisms- Subsistence

ABSTRACT

The purpose of this project is to aid in the restoration of subsistence resources or services, lost or diminished by the *Exxon Valdez* oil spill, through shellfish nursery research at aquatic farms and other facilities in Kachemak Bay. This project will compliment the shellfish hatchery that will be constructed as a component of the Mariculture Technical Center as provided for in HCS CSSB 18 Section 5. The project will construct an upwelling nursery facility and develop techniques specific to Alaska to improve the survival and growth rates of hatchery produced bivalves.

INTRODUCTION

The purpose of this project is to aid in the restoration of subsistence resources or services lost or diminished as a result of the *Exxon Valdez* oil spill, through shellfish nursery research at aquatic farms or other facilities in Kachemak Bay as directed by the Eighteenth Legislature-First Session, in HCS CSSB 183(FIN) Section 5. The Department of Fish and Game mailed a request for Kachemak Bay nursery culture research proposals to all permitted aquatic farmers in Prince William Sound, Kachemak Bay and the Kodiak Island area. the Kachemak Shellfish Mariculture Association was the sole respondent to submit a preliminary proposal for the nursery culture research project.

A cooperative agreement to conduct this research was signed by ADF&G and KSMA early in 1995. The project was designed to complement the shellfish hatchery that will be built as a component of the Mariculture Technical Center. The information gained from this project will benefit Alaskan farmers by developing and testing the technology required to produce a stable source of large, high quality bivalve seed that will shorten the growing time for shellfish grown in Alaska. Nursery culture techniques developed by this project could also facilitate restoration of indigenous bivalve populations on oil spill impacted beaches or provide seed stock of indigenous species for use by Alaskan shellfish growers for farm product diversification.

The nursery culture project was designed to occur in the phases:

Phase I

A feasibility study to investigate prospective sites for the location of the research facility in Kachemak Bay was conducted. Three prospective sites were chosen to be investigated during this study. The sites were investigated by examining water quality, productivity and by conducting growth studies using oyster seed suspended in static culture gear. The prospective sites were evaluated for access to electrical power, operational costs, permitting requirements and potential conflicts with existing user groups.

The phase I study included designing a prototype FLUPSY (FLoating UPweller SYstem) suitable for operation in the climate of southcentral Alaska. FLUPSY systems operating in British Columbia and Washington State were evaluated. Potential maintenance and procedural problems were identified and addressed during the design phase of this study. Specific changes in design were incorporated to suit the cooler Alaskan environment. Construction materials were chosen for durability at colder operating temperatures. Galvanic corrosion between dissimilar metals was identified as a major maintenance problem with similar units in operation. Specific design changes and materials have been incorporated to attempt to address this problem.

The phase I study also included the development of equipment lists, staffing requirements and an operational plan for the project.

Phase I of this project has been completed and a site suitability report has been submitted to ADF&G. An interagency committee met on February 7, 1996 to evaluate the data collected during the study and to choose a site for the research project. After evaluating the data the committee made a unanimous decision to locate the nursery research project in Halibut Cove.

Phase II

During phase II of the project KSMA will obtain all the permits necessary to complete this project and will construct a nursery research facility according to design specifications approved by ADF&G. An electric power source will be secured for the project and the research facility will be installed and tested at the Halibut Cove site. After this work is completed a field inspection will be conducted by ADF&G and KSMA personnel.

Phase III

The nursery research facility will be stocked with shellfish seed obtained from approved sources. The condition of shellfish seed will be monitored for growth rate, mortality, biomass and quality. Sea water at the site will be tested for temperature, salinity and productivity. Water flow rates through the unit will be measured and recorded. Routine maintenance, sorting and corrosion control will be performed by project personnel. Accurate rearing records will be maintained for analysis. Seed reaching the target size will be distributed to aquatic farms for growout to harvest size. Their growth rates will continue to monitored after leaving the nursery facility and will be compared to those reared in facilities outside Alaska. Upon completion of the project a report describing the performance and operation of the nursery system will be made available for general distribution. This report will include financial, operational and design information as well as a practical operations manual.

NEED FOR THE PROJECT

A. Statement of the Problem

There are no existing nursery culture systems in Alaska that will be required to convert hatchery produced bivalve seed to a size suitable for outplanting on beaches injured by the *Exxon Valdez* oil spill. The Alaskan shellfish culture industry has been constrained by the lack of a reliable source of bivalve seed for stocking on developing farms. Since there are no shellfish seed production facilities located in the State of Alaska seed must be imported from facilities located on the West Coast of the United States. Currently there are only three production facilities, certified by the Department of Fish and Game, to ship oyster seed to Alaskan aquatic farms. In past years these facilities have not been able to supply enough seed to fill all the orders made by Alaskan farmers. This shortage of seed has hindered the development of the aquatic farming industry in Alaska.

By state regulation, to prevent the introduction of disease, only seed under 20mm in size may be imported from seed production facilities outside the Alaska. Limiting aquatic farmers to stocking small seed adds to the time required to grow oysters to market size. Small stocking sizes also add to the cost of labor and maintenance in the farming operation. Smaller seed are subject to greater losses due to mortality during the growout process. With these additional costs, Alaskan shellfish growers are at a disadvantage when competing with oysters grown in other areas of the world. The Alaskan aquatic farming industry considers solving these seedstock acquisition problems an important priority for the successful growth of the industry (Horne, 1993 - Ralonde,1994 - Hilde, ASTF, 1994.) The difficulties encountered by oyster growers and solutions required to successfully rear juvenile oysters are analogous to the techniques required to rear and outplant other bivalve species injured by the *Exxon Valdez* oil spill.

B. Rational/ Link to Restoration

The enhancement and recovery of injured bivalve species will be facilitated by this nursery technology which is designed to function in the harsh conditions of the southcentral Alaskan environment. This project will produce a functioning FLUPSY unit capable of producing bivalve seed for outplanting which will grow and survive at higher rates that would otherwise be possible.

C. Location

This project will be undertaken in Kachemak Bay at Halibut Cove. Components of the nursery system will be constructed at various sites on the Kenai Peninsula.

COMMUNITY INVOLVEMENT

This project has been actively supported by funds from the Kenai Peninsula Borough Economic Development District, the U.S. Department of Commerce and the Alaska Department of Commerce and Economic Development with in-kind contributions of material and labor from the Kachemak Shellfish Mariculture Association. In phase I of the project several actions were undertaken to mitigate any potential conflicts with other user groups in Kachemak Bay during the site selection process. The project has been described in local newspapers and in 33 information packets were sent to a list of individuals representing user groups, state agencies, elected officials and local governments. A tour of the potential sites was conducted with some of these representatives and a phone survey of the communities of Kachemak Bay was conducted and the project received a favorable response by most contacted. Letters supportive of the project were received from several community members including the President of the Halibut Cove Community Organization where the upweller will be sited.

PROJECT DESIGN

A. Objectives

1. In an effort to increase survival of hatchery produced seed, develop, test and evaluate shellfish nursery facilities and procedures appropriate to the Alaska environment that could provide the intermediate growth required to convert hatchery produced shellfish seed to an appropriate size for farm grow-out.

2. Construct, install, test, and operate the prototype FLUPSY nursery culture system designed during phase I of the project. Evaluate the design of the prototype for compatibility with the Alaskan environment.

3. Determine optimum stocking densities appropriate to assure maximum growth rates with minimum mortality.

4. Determine hatchery produced shellfish seed can reach target size (30 mm -40mm) in one growing season. holding seed in the nursery during the winter will add additional operating costs. Determine these costs and the impact on the financial feasibility of the nursery system.

5. Evaluate the overall economic viability of nursery culture in Kachemak Bay.

6. Provide a research facility designed to complement the Mariculture Technical Center being built in Seward, Alaska.

7. Provide the technical information necessary for the development of Alaskan shellfish nurseries.

B. Methods

Components of the nursery research facility will be constructed at various sites on the Kenai Peninsula. The individual components will be transported to the project site and assembled by project personnel. The following is a general description of the nursery system:

Inwater nursery components.
All in-water systems will be constructed of aluminum and stainless steel using stainless or inert fasteners to resist galvanic corrosion. The inwater system will consist of a 36 inch deep center trough with six to eight 36 inch square culture chambers positioned along each side. An aluminum superstructure will provide for positioning of the structure in relation to the flotation system. Sea water will be evacuated from the central trough creating a head differential between it and the culture chambers. This differential will cause sea water to flow up through the upwell bays and be discharged into the center trough. This upwelling flow will be adjusted in individual culture chambers to "fluidize" the beds of shellfish seed providing uniform distribution of nutrients and removing waste products.

The seawater trough will be evacuated by a mechanically powered paddle wheel. This paddle wheel will have eight vanes and will be 36 inches wide by 5 feet in diameter. It will operate in an outlet trough 36 inches wide by 20 inches deep. Power will be supplied by an SCR controlled DC motor and gearbox coupled to a gear and chain final drive. The drive system will have a 600/I speed reduction to provide a final paddle speed range of 0-9 RPM. A 3/4hp "Kasco" aeration pump and mounting system will be provided as a back-up in the event of a paddle wheel failure due to ice build-up or other causes.

The culture chambers will be constructed of welded marine aluminum measuring 36 inches square by 48 inches deep. The bottoms of these chambers will be covered by 10 mesh precision stainless steel screen supported by an aluminum frame. The stainless screen will be electrically insulated from the aluminum box by the use of UHMW plastic strips and nylon fasteners. This will be done in an effort to reduce galvanic corrosion. Zinc anodes will be installed on all in-water aluminum components.

Flotation System.
The flotation system will consist of a 20 foot by 32 foot wooden raft structure with a large opening in the center to accommodate the nursery system. The sub-frame will be assembled using treated dimensional lumber secured with galvanized steel brackets and fasteners. Flotation will be provided by 42 "Follensbee" PVC plastic covered styrofoam floats to provide a total of 16, 800 pounds of flotation. The deck of the flotation system will be 2 inch by 6 inch treated wood secured with stainless steel screws.

Additional Equipment.
An overhead 2-ton rated gantry crane with electric chain hoist mounted on casters
and track will have access to the entire length of the float. the crane will be used to access culture chambers for maintenance, cleaning and to remove the seed for sorting. The crane hoist will also be capable of lifting the entire nursery frame from the water for maintenance, towing and winter storage. Seed sorting for size classification will be accomplished using a 24 inch circular "Kason" vibroscreen. This unit will have two sorting decks and be constructed of stainless steel. Interchangeable screens will provide size classification in a range from 2 to 30mm. A 1/2 inch high pressure water pump will be used for cleaning the nursery unit and for washing shellfish seed.

Electrical System.
Electrical power will be supplied to the nursery system by a submarine cable from a meter loop located above the adjacent tidelands. This cable will be routed up through the floatation assembly to a water-tight distribution box. Circuits will be provided from the distribution box to supply power to the paddlewheel motor controller, electric submersible back-up pump, lighting system and a duplex receptacle. Circuits will be G.F.I protected when required and constructed to meet local electrical codes. A corrosion monitor and isolation transformer will be used to prevent stray electrical currents from accelerating galvanic corrosion.

Anchoring System.
The anchoring system of choice will be two 9 - 5/8 inch steel pilings driven into the sea-bed. The nursery float will then be attached to these pilings, with roller guides to allow for the rise and fall of the tide. If this is not possible, anchoring will be accomplished by the use of four steel "deadweight" anchors (700 lb. railcar wheels) connected to the float with galvanized steel chain.

The methods proposed to complete Phase II and Phase III have been organized by numbered tasks. They are as follows:

Phase II

201. Project Administration - Phase II.
Coordinate construction of the research facility as per ADF&G approved design specifications. Direct transportation of the facility to the project site and supervise installation and testing. Select construction contractors to build the nursery system. Supervise construction contractors and project staff. Arrange for transportation of nursery components to the project site. Perform all

accounting tasks necessary for the completion of phase II. Secure easements to route electrical power to the research project.

203. Obtain all permits necessary to complete the project.
Submit applications for all state and federal permits required to complete the research project. Monitor the permit process and submit additional information to permitting agencies as required. Coordinate with the Halibut Cove community organization and local upland owners to finalize project location. Represent KSMA at all public hearings concerning project permits. Permits required for this project are:

DGC - Coastal Consistency determination
DNR - Aquatic Farm Operation permit
ADF&G -Aquatic Farm Operation Permit, Seedstock acquisition permit, CH 16 Critical Habitat Permit, Shellfish seedstock supplier certification
U.S. Army C. O. E. - General permit

204. Purchase materials and equipment.
Purchase all materials and equipment required for the construction and operation of the nursery system. Arrange for transportation and shipping of materials to construction contractors or to the research site.

205. Develop the nursery culture research plan.
Establish criteria and procedures for the Biological Research plan. Design a data collection schedule to monitor spat growth, mortality, Bp-mass and quality. This plan will also monitor environmental quality; water temperature, salinity, and productivity. Design forms to be used to log data collected during this project. This plan will include monitoring seed growth performance at grow-out locations after leaving the nursery facility.

206. Fabricate the in-water nursery system.
Fabricate all aluminum and steel welded components including the main frame assembly, upwell bays, screen inserts, paddle wheel system and gantry crane tracks. Perform all forming and rolling of materials that may be required.

207. Fabricate and assemble mechanical systems.
Install paddle wheel drive system. Install submersible back-up pump. Assemble upwell bays and inserts. Fabricate and assemble precision stainless steel screen bottom sections. Assemble, install and test gantry crane.

208. Fabricate the flotation system.
Assemble the flotation sub-frame assembly. Install the galvanized brackets and fasteners. Coordinate with electrical contractor on sub-frame wiring. Install Follensbee Floats on sub-frame. Install decking on sub-frame. Arrange for transportation to Homer Harbor. Supervise loading of upweller for transportation by vessel or barge to the project site.
209. Fabricate the electrical system.
Install electrical system as per project plans and drawings. Insure compliance with electrical building code. Perform final on-site electrical connections.

210. Install and test nursery system at the research site.
Coordinate shipping nursery from point of fabrication to research site. Assemble and install nursery system at the research site. Install anchoring system. Test nursery prior to initial stocking.

211. Secure an electrical power source.
Apply for electrical service with Homer Electric Association. Coordinate utility installation with Homer Electric Association field personnel. Establish primary wire size and length requirements. Purchase all materials required for electrical supply system including; meter loop, wire, conduit, and fittings. Install wire and conduit from meter loop to nursery research site. Insure compliance with local electrical codes.

212. Field Inspection
Plan and conduct a interagency field inspection of the installed nursery research facility. This inspection should be attended by representatives of the Alaska Department of Fish & Game, Kachemak Shellfish Mariculture Association, University of Alaska, Kenai Peninsula Economic Development District, and representatives of other funding agencies.

213. Reporting - KSMA,ADF&G & EVOS Trustee Council
Prepare and submit the required monthly progress reports. Prepare and submit final Phase II Report. Prepare and submit reports as required by the EVOS Trustee Council.

Phase III

301. Project Administration- Phase III
Coordinate the operation of nursery research facility. Supervise facility contract maintenance personnel. Project accounting. Monitor progress of the research plan.

302. Purchase of seed and seasonal seeding of the research facility.
Obtain required ADF&G shellstock transport permits. Arrange for the purchase of shellfish seed required for this project from sources certified by ADF&G. Schedule seed shipments as per the project plan. Arrange for transportation of shellfish seed to the research facility. Coordinate with facility maintenance contractor for delivery of shellfish seed.

303. Training - maintenance and data collection.
Provide training for the contract maintenance and data collector in the operation of instruments and equipment necessary to collect and record biological data. Instruct and supervise contract maintenance personnel in cleaning, sorting and general maintenance procedures.

304. Facility Contract Maintenance and Data Collection.
Maintain and operate the nursery research system. Perform routine system maintenance and monitor corrosion control. Clean system upwell bays to provide adequate water flow. Sort shellfish seed to maintain size/class separation in upwell bays. Make volumetric measurements by size/class for bio-mass calculations. Measure water temperature, salinity, and productivity. Collect water and seed samples for analysis. Coordinator shipping of samples to research facility to the University of Alaska Marine Advisory office in

Anchorage.

Maintain rearing records of data collected during the project. Measure, package, and ship shellfish seed to grow-out facilities.

Schedule 1997 - May through October - 3 days per week, 4 hours per day.
Schedule 1998 - May through October - 3 days per week, 4 hours per day.

305. Analysis of data.
Receive seed samples and water for analysis. Monitor spat growth, mortality, bio-mass and quality. Monitor the collection of environmental data. Submit monthly reports summarizing the date collected during the project.

306. Distribution of seed for grow-out study.
Determine a schedule for distribution of shellfish seed upon reaching target size. Coordinate measurement, packaging, and transportation of seed to grow-out facilities.

307. Reporting.
Prepare and submit semi-annual project financial reports for the periods ending June 30, 1997, December 31, 1997, june 30, 1998, December 31, 1998. Prepare and submit yearly progress reports by January 31 summarizing all facets of the nursery research project.

308. Final Report.
Prepare and submit a report describing the performance and operation of the nursery and make it available for general distribution. This report shall include biological analysis, financial information, operating and design information (with drawings), and a practical operations manual.

SCHEDULE

A. Measurable Project Tasks for FY 97 (October 1, 1996 - September 30, 1997)

Oct 1- December 31:	Begin Construction
January 22-25:	Attend Annual Restoration Workshop
March 1 - March 31:	Complete construction, receive permit
April 1 - April 30:	Install and test system, interagency field inspection
May 1 - September 30:	Stock system with shellfish seed, begin operation and data collection
Oct 1 - November 31:	Distribute seed and analyze data
Nov 1 - December 31:	Winterize system
April 1 - September 30:	Stock system with shellfish seed and collect data, submit annual report
Oct 1 - November 31:	Distribute seed and analyze data
Dec 1 - December 31:	Prepare and submit final report

B. Project Milestones and Endpoints

October 1996 to December 1998:

Design and test a floating upwelling nursery system. Conduct research to determine procedures and schedules required to culture hatchery produced bivalves in the Alaskan environment.

February 1997-	Complete construction
March 1997-	Receive operational permits
May 1997-	Install and stock nursery, begin data collection
Dec. 1997-	Winterize system
April 1998-	Stock nursery, begin data collection
Dec. 1998-	Project ends, submit final report

C. Completion Date

This project will be completed on December 31, 1998 (FY99)

PUBLICATIONS AND REPORTS

May 31, 1997	Final Report upon completion of phase II of the project plan.
Dec. 31, 1998	Final Report upon completion of phase III of the project plan. This report will include design, performance, operational and financial information and a practical operation manual.

PROFESSIONAL CONFERENCES

March 1997	Washington State Sea Grant Shellfish Growers Conference.
Oct. 1997	Alaska Shellfish Growers Association Conference

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is conducted as a component of the Mariculture Technical Center in Seward, Ak. The purpose of the nursery upweller system is to facilitate, through increased growth and survival rates, bivalve seed produced by the Mariculture Technical Center. The equipment and information produced by this project will provide the technology and procedures to produce an instate source of accelerated bivalve seed for restoration of wild populations on oil spill impacted beaches. Bivalve seed produced by Alaskan nurseries will also provide a source of high quality seed for stocking on aquatic farms.

PROPOSED PRINCIPAL INVESTIGATOR

Mark Bradley
Kachemak Shellfish Mariculture Association
HC01 Box 1595-8
Kenai, Alaska 99611
(907) 776-5498

PERSONNEL

Mark Bradley
Kachemak Shellfish Mariculture Association
HC01 Box 1595-8
Kenai, Alaska 99611
(907) 776-5498

Employment:

Project Coordinator- Kachemak Shellfish Mariculture Association, Commercial Salmon Fisherman, Aquatic Farmer in Kachemak Bay , Alaska

1994- Project Coordinator: "Oyster Spat Feasibility Study for Kachemak Bay"

Ray Ralonde
University of Alaska Fairbanks
School of Fisheries and Ocean Sciences
Marine Advisory Program
222 E. Northern Lights Blvd.
Anchorage, Ak. 99508
(907) 274-9691

KSMA Staff - To be determined

LITERATURE CITED

Horne, Steven. 1993. Shellfish Development in Kachemak Bay. Kenai Peninsula Borough Economic Development District.

Ralonde, Raymond. 1994. Oyster SPat Nursery Feasibility Study for Kachemak Bay. University of Alaska Marine Advisory Program.

Hilde, Christy. 1994. Mariculture in Kachemak Bay. Alaska Science and Technology Foundation.

Bayes, John C. Forced Upwelling Nursery for Oysters and Clams using Impounded Water Systems. Seasalter Shellfish Ltd. Kent, U.K.

1997 EXXON VALDEZ T[illegible]TEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Personnel		$24.0						
Travel		$ 6.4						
Contractual		$15.0						
Commodities		$11.5						
Equipment		$19.8						
Subtotal	$0.0	$76.7						
Indirect								
Project Total	$0.0	$76.7	$27.0	0	0	0	0	
Full-time Equivalents (FTE)								
	Dollar amounts are shown in thousands of dollars.							
Other Resources		$50.0						

Comments:

"Other Resourses" - Initial funding for this project was provided by the Alaska Department of Fish and Game Mariculture Technical Center Project.

1997

Prepared:

Project Number: 97238
Project Title: Kachemak Bay Shellfish Nursery Culture Research
Name: Kachemak Shellfish Mariculture Association

FORM 4A
Non-Trustee
SUMMARY

4/4/96

1997 EXXON VALDE USTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:			Months	Monthly		Propose
Name	Position Description		Budgeted	Costs	Overtime	FFY 199
Mark Bradley	KSMA Project Coordinator		12	1.5		18.0
Vacant	KSMA Staff position		12	.5		6.0
		Subtotal	0.0	0.0	0.0	
					Personnel Total	$24.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
Workshops in Anch. for principle investigator	.1	1	6	.1	0.7
Washington Seagrant Shellfish Conference	.5	2	8	.1	1.8
Ak. Shellfish Growers Association Conference	.1	2	6	.1	.8
Vessel Charter (interagency Facility inspection)	.7	1	1	.1	.8
Project meetings - Anch, U of A	.1	3	6	.1	.9
Staff Travel to project site	0	0	14	.1	1.4
				Travel Total	$6.4

1997

Prepared:

Project Number:

Project Title: Kachemak Bay Shellfish Nursery Culture Research

Name: Kachemak Shellfish Mariculture Association

FORM 4B Personnel & Travel DETAIL

4/4/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1996 - September 30, 1997

Contractual Costs: Description	Proposed FFY 1997
Utilities (elect. energy cost, cell phone, utility instalations)	5.0
Liability Insurance	2.5
Loading Charges (crane charges, shipping nursery system)	.5
Barge Shipping (nursery unit to site)	1.0
Freight (UPS, air freight for shellfish seed, express mail for samples to lab)	1.5
Pile Driving Service	3.5
Freight (steel piling to site)	1.0
Contractual Total	$15.0

Commodities Costs: Description	Proposed FFY 1997
Office (fax,phone,paper, copies, misc.)	2.0
Shipping containers (samples to lab)	.5
Shellfish Seed	9.0
Commodities Total	$11.5

1997

Prepared:

Project Number:
Project Title: Kachemak Bay Shellfish Nursery Culture Research
Name: Kachemak Shellfish Mariculture Association

FORM 4B
Contractual & Commodities DETAIL

4/4/96

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
Kason Vibroscreen (24" seed sorter)	1	7.0	7.0
Water Pump (Honda 1.5" with hoses)	1	1.5	1.5
Pressure Washer (3000 psi for cleaning nursery)	1	1.5	1.5
Seed Handling Equipment (shovels, totes, scoops, screens)	1	1.8	1.8
Fish Totes with lids (for dry storage of equipment)	2	.8	1.6
Galvanic Corrosion Monitor	1	.5	.5
Nursery System Monitor	1	.5	.5
Anchor System	1	2.0	2.0
Water Quality Testing Equip.(DO,PH,Temp,meters)	1	2.0	2.0
Steel Piling	2	.5	1.0
Those purchases associated with replacement equipment should be indicated by placement of an R.	New Equipment Total		$19.8

Existing Equipment Usage: Description	Number of Units	
Prototype FLoating UPwelling SYstem (FLUPSY) designed for operation in the Alaskan environment. (built with ADF&G Funds)	1	[redacted]

1997

Project Number:
Project Title: Kachemak Bay Shellfish Nursery Culture Research
Name: Kachemak Shellfish Mariculture Association

FORM 4B
Equipment
DETAIL

Prepared:

4/4/96