19.07.05 (7 of 8)

98330-BAA

PROJECT TITLE: A MASS-BALANCE MODEL OF TROPHIC FLUXES IN PRINCE WILLIAM SOUND, SUBMITTED UNDER THE BAA.

Project Number:	~~300~~ 98330-BAA
Restoration Category:	
Proposer:	Daniel Pauly, Fisheries Centre, University of British Columbia, Vancouver, and Stuart Pimm, Ecology and Evolutionary Biology, University of Tennessee, Knoxville
Lead Trustee Agency:	
Cooperating Agencies:	
Alaska Sea Life Center:	
Duration:	2 years
Cost FY 98:	$212 168.00
Cost FY 99:	$199 728.60
Geographic Area:	Prince William Sound
Injured Resource/Service:	All injured biological resources and all damaged services

RECEIVED
APR 10 1997
EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL

ABSTRACT

Support is requested for a two-year project devoted to the construction, validation, and dissemination of two models of trophic interactions among the organisms of Prince William Sound (PWS), as required to synthesize the vast amount of information gathered before and after the 1989 *Exxon Valdez* spill, and to evaluate its impact at the ecosystem level. Project components are: 1) an initial workshop devoted to model specification by researchers from the Gulf of Alaska region, 2) an extended study by project staff, and 3) a dissemination phase, in year two, consisting of a training workshop for potential users of the software implementing the model, and the production of a CD-ROM for the public domain, incorporating an interactive graphic version of the software, and an extensive database on the biology and local/traditional knowledge on the fishes of PWS.

INTRODUCTION

The project proposed here is a response to the fact, noted by the Trustee Council, that "the restoration program has reached a stage where it is appropriate to integrate and synthesize what is being learned from different research and monitoring projects" and thus to enable the Trustee Council "to view the effects of the oil spill and the long-term restoration and management of injured resources and services from an ecosystem-level perspective" (EVOS Trustee Council, 1996, p. 53). The approach proposed to achieve this is based on the reasoning that biological production (expressed as energy or carbon) in a given ecosystem must be either exported or consumed locally, and that the biological production of a given group that is not exported must be equal to that which is consumed by the other groups in the system. Such simple mass-balance constraints, when explicitly formulated for each of the major species or functional groups of an ecosystem, can be used to validate (or correct) independent standing stock and flux estimates, and to rapidly construct thermodynamically "possible" trophic models of ecosystems. Models of this sort can then be used to draw numerous inferences on the structure of ecosystems, and the interactions among their components (Christensen and Pauly 1992a, b, 1995, Pauly and Christensen 1993, Pauly and Christensen 1995).

The project proposed here is to construct a trophic model, based on the well-documented ECOPATH software, used from both the above-cited contributions and the models of diverse ecosystems presented by various authors in Christensen and Pauly (1996). The structure of the model will be based on inputs by colleagues studying the various groups in PWS and adjacent areas with EVOS funding, and other experts to be contacted as appropriate. We will formulate two simple, large-scale trophic models of, and uniting, the communities of the APEX, SEA, and NVP projects. Using their published data, data from the literature and the results of a workshop, we seek a broad synthesis of the larger Prince William Sound and Gulf of Alaska ecosystems and the complex changes within them. This broad participation, and the consensus-seeking process used for model specification, should ensure that the product will be perceived as state-of-the-art within the EVOS community.

The general question to be examined with a mass balance model is how effects of the oil spill propagate throughout the food web. When and where else in the food web will the consequences of change in one (or more) species be manifested (Vanni 1987a, 1987b)? Counterintuituve indirect effects may appear several trophic linkages away from their cause (Abrams 1992). In the Bering Sea, for example, the large pollock fishery has caused the decline of pollock-eating sea-lions, murres, and kittiwakes, but more distantly, caused an increase in auklets -species that feed on the plankton on which the pollock feed (Springer 1992). To study such indirect effects, the system of linear equations underlying mass-balance models can be reexpressed as a system of coupled differential equations using a new module (ECOSIM) of the ECOPATH software (Walters et al., in press). This allows, once mass-balance has been established, the rapid construction of a simulation model for any ecosystem. Thus, the proposed project will also generate a simulation model of trophic interactions in PWS and adjacent waters, allowing e.g. "preliminary examination of the potential impacts of large-scale perturbations such as the major decline in the population of Pacific herring." (EVOS Trustee Council, 1996, p.53.)

To ensure the acceptability and wide dissemination of the model , among the public as well as among managers, in year two the product will be released in the context of a training/evaluation workshop, and also made available for distribution by the Trustee Council to interested organizations and institutions, including schools, in form of a CD-ROM that will also contain a database with local /traditional knowledge and scientific information on all fishes of PWS, and of Alaska. This will comprise a locally-enriched, customized version of "FishBase", the global, computerized encyclopedia of fishes. (see MacCall and May 1995).

NEED FOR THE PROJECT

A. Statement of Problem

"Research sponsored by the Trustee Council has produced many data sets on the distribution, abundance and productivity of many species and ecological communities of the northern Gulf of Alaska and Price William Sound. These data need to be integrated in a simple model to benefit long-term resource Management." Also , "the restoration program will increasingly focus on an integrated, ecological approach. To that end, The Trustee Council has identified a possible need for a simple cost-effective ecosystem model" (EVOS Trustee Council, 1996, p.53.)

In a large, multi-faceted research program it is often easy to lose track of the relevance and position of each project in the overall picture that is being created. Several EVOS-funded projects, notably APEX, NVP, and SEA, are devoted to the biology and ecology of distinct groups of organisms, sometimes including their prey, and /or their predators. A straightforward approach to link these organisms, and hence the projects that study them, is through the fact that all organisms, in natural ecosystems, are connected through feeding links. Indeed, trophic interactions are among the most significant links between organisms, especially when considering how to restore a damaged environment and to monitor the potential flows of toxic residues through that environment. Given that indirect effects are important and ubiquitous, we may not fully understand the complex changes occurring in the Prince William Sound and Gulf of Alaska ecosystems unless we recognize their consequences. The complete list of potential questions must come from our working closely with the range of scientist and affected parties. Nonetheless, we can list possibilities where our models might be useful for all the APEX, SEA, and NVP communities.

1. What will be the consequences of loading hatchery raised salmon into the system given the complex interactions between juvenile salmon, large copepods and pollock?
2. What other components of the ecosystem will the decline of Pacific herring stocks affect? What contribution does this make to the declines of marine bird and mammal populations?
3. In what species groups will the consequences of fishing become apparent? Is there likely a strong connection between fishing, marine bird, and marine mammal populations?
4. What are the consequences of changes in harbor seal populations?
5. Should we expect sea-otters, harlequin ducks, guillemots and other oil-affected near-shore species to recover in the near-term, given the observed ecosystem changes?
6. How should the change from an ecosystem dominated by shrimp to one dominated by pollock and cod affect seabirds, marine mammals, and other species groups?
7. How do changes in one ecosystem -- say, the near-shore – affect processes in other ecosystems?

B. Rationale/Link to Restoration

A rapidly achieved overview of the trophic structure of PWS and adjacent waters and the relationships between the different species and groups that inhabit the area will assist both individual EVOS projects and planning future policy. For example, an ECOPATH model of PWS will be able to indicate whether there has been, since the oil spill, a shift in the trophic structure that is hindering the recovery of seabirds and marine mammals. As well, a quantitative analysis of the relationships between seabird foraging and hatchery-released fish will help to identify problems in the restocking program. The versatility of the ECOPATH system allows it to produce a fast and cost-effective overview of any part of the system. The basic idea of this project is that the use of a mass balance model such as ECOPATH will allow easy identification of areas of trophic flux that will be of great interest to all workers involved in the restoration project. The initial workshop will allow the input of data and ideas from a range of people from different projects, while the subsequent analysis of the output from the model will provide feedback and ideas to the researchers in the individual projects.

Further, the outputs from the ECOSIM module of ECOPATH will allow rapid exploration of the predicted consequences of various intervention or events (e.g. restocking, selective harvesting, or changes in some physical forcing functions). In particular, clues discerning which species contribute most to long-term stability of the communities will aid resource managers in making decisions that affect the development of these communities. For example, the successful and sustainable management of the herring and salmon populations depends on a model of the food webs joining the different communities.The final evaluation meeting will provide a forum for validating and teaching the use of this relatively simple model for evaluating management options for PWS.

Production of interactive software displaying temporal changes resulting from the direct or indirect effects of management interventions will allow for novel approaches for explaining basic ecological principles, and species interactions in PWS to the general public, schoolchildren and various special interest groups. The public impact of the proposed project will be strengthened by embedding its main output, the ECOPATH/ECOSIM model of PWS, into a database on the fish of the PWS region, i.e., a version of the computerized encyclopedia of fishes known as FishBase, whose coverage of Alaskan fishes will be enriched by incorporation of as much biological and local/traditional knowledge as can be straightforwardly extracted from published sources.

C. Location

The models to be constructed will refer to PWS in the narrow sense. The proposed workshops, one for model specification, and one, in year two, for product release, (see above) will be held at locations which will minimize participants' travel and other costs, presumably in Anchorage. The biological and local/traditional knowledge to be incorporated into FishBase will pertain to the wider PWS region, i.e., include information from outside PWS proper. Thus, the benefits will accrue across the areas of the Gulf of Alaska and Prince William Sound that harbor APEX, SEA, or NVP communities.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Trophic linkages derived from the experience of fishers and hunters will be considered when specifying the PWS model if citeable sources can be found documenting this experience. Similarly, all local/traditional knowledge on the fishes of the PWS region to be included in FishBase will rely on published sources, as the project does not include a field component. However, care will be taken to enable access to all scientific information on the fishes of the PWS region through local common names, in as many aboriginal languages as possible, using the routines newly incorporated into FishBase for such coverage of common names. A project extension phase to deepen this specific aspect of the database, and which would include a field work component, may eventually be proposed, given an expression of interest by the Trustee Council.

PROJECT DESIGN

A Objectives

The project objectives for FY 97 will be:

1. Prepare and hold a one-week model specification workshop;
2. Build a food web model of the interactions of the APEX community members.
3. Build a food web model of the interactions of the NVP community members.
4. Build a food web model of the interactions of the SEA community members.
5. Integrate the three food webs into two, large-scale models of the interactions of the communities.
6. Interact with experts and modify ECOPATH mass-balance model until consensus on trophic interactions in PWS and adjacent waters is reached;

For FY 98, the project objectives will be:

7. Enter biological information, local names in local languages, and local knowledge (sofar published) on PWS region fishes and other Alaskan fishes into FishBase.
8. Modify ECOPATH such that seasonal changes are explicitly considered when establishing mass balance;
9. Link the ECOSIM module of the PWS model with an existing model of PWS capable of predicting primary production, and thus drive the trophic interactions in ECOSIM;
10. Prepare a CD-ROM with ECOPATH/ECOSIM model(s) of PWS, and a database on the fishes of the PWS region;
11. Prepare and hold a one-week workshop to present and disseminate the final product (in 7), and teach its use.

Additionally, throughout the duration of the project, and beyond, every opportunity will be taken to present the project and its products, especially at conferences and in the primary literature.

B Methods

The models proposed here are extremely simple and yet they account for uncertainties. One approach of past model building has been to build more complex, detailed models, and to demand more data to parameterize them. We are repelled, rather than seduced by this process. As field ecologists we know that the simplest model parameter may be enormously difficult to obtain. As theoreticians, we see a more practicable alternative. Nature is uncertain: a parameter value, here, this week will not be the same as there, next week. Any model that aims to yield insight of use to managers must be robust to these uncertainties (Ludwig et al. 1993). Based on work of Dr. J.J. Polovina (1984), of the US National Marine Fisheries Service, Drs. D. Pauly and Villy Christensen, then both at the International Center for Living Aquatic Resources Management (ICLARM) in Manila, Philippines, developed an approach, implemented as a well-documented software for personal computers, which allows for the rapid construction and verification of mass-balance models of ecosystems (Christensen and Pauly 1992 a, b). The steps involved in the construction of the two models are:

(i) Identification of the area and period(s) for which models are to be constructed;
(ii) Definition of the functional groups (i.e., "boxes") to be included;
(iii) Entry of a diet matrix, expressing the fraction that each "box" in the model represents in the diet of its consumers (with uncertainty being accommodated by wide intervals about the entries);
(iv) Entry of food consumption rate, of production/biomass ratio or of biomass, and of fisheries catches, if any, for each box (with uncertainty again being accommodated by wide intervals about the entries);
(v) Balance the model using either a Monte Carlo approach (i.e., randomly selecting entries from input distributions and selecting model realization based on parameters closest to central values) or modify entries (iii & iv) until input = output for each box;
(vi) Compare model outputs (network characteristics, estimated trophic levels and other features of each box) with estimates for the same area during another period, and or with outputs of the same model type from other, similar areas, etc., and use result of comparison to ensure that inputs are credible;
(vii) Use model balanced in (vi) to generate simulation model via the ECOSIM module of ECOPATH, run same and test its sensitivity to various perturbations;
(viii) Use results in (vii) to refine mass balance model if required, then output different runs

These steps can be implemented easily when basic parameter estimates exist (as in the case of PWS and adjacent waters), and numerous, well-documented examples already exist of ECOPATH applications to aquatic ecosystems, ranging from aquaculture ponds and flooded rice paddies to shelf systems (see Pauly and Christensen 1993, and contributions in Christensen and Pauly 1993), notably the North Sea, and versions of three systems relatively close and similar to PWS, Georgia, Strait, Vancouver Island and the Alaska Gyre, constructed during a one-week workshop similar to the one proposed here, and held in November 1995 (Pauly and Christensen, 1996). Each participant will cover a functional group and its associated fluxes: phytoplankton and primary production, marine bacteria and their consumption of detritus, zooplankton and secondary production, major fish species and their fisheries, marine mammals and birds and their food consumption. Rate and biomass estimates will be standardized for the PWS and adjacent waters and for two different periods (pre spill and post spill). Once parameterized, the problem becomes one of understanding the consequence of the change in density of one species to the change in density of other species in the food web. Technically, the issue is one of resistance (Pimm 1984, 1991): the extent to which different components resist changes elsewhere in the food web. Our simple models allow calculation of simple effects. How will the change in, say, fishing effort affect the abundance of different species of seabird, or which species will be most affected by the change in seal or otter numbers? The technical aspects of this process are familiar (Pimm 1991). For a given parameterization of a particular food web, we can "tweak" the species known to have declined and look where (and, importantly how quickly) the consequent changes will be manifest. The simplicity of our models makes this a rapid and so highly repeatable process. Ongoing analysis of data and model updating will also provide a means of incorporating new information from the various EVOS projects and also a route for identification of possible gaps in current research. Thus, the work of project staff can be tailored to requirements identified during the specification workshop.

C Cooperating Agencies, Contracts and Other Agency Assistance

The PIs and other investigators of all EVOS-funded projects devoted to studying PWS and Gulf of Alaska organisms will be contacted (preferably through the Trustee Council), and invited to participate, along with other experts, in the model specification workshop, and the subsequent validation process. Personal contacts were established during the January 1996 Restoration Workshop which will facilitate this; however commitments were not sought at this stage, as they were assumed to be easy to obtain one the project has been approved..

In year two, the Fisheries Centre, UBC, will subcontract item 4 under "Objectives" (see above) to the FishBase Project of the (non-profit) International Center for Living Aquatic Resources Management (ICLARM), Manila Philippines, both because data encoding in the Philippines is extremely cost-effective, and more importantly, because data entry for FishBase is done only centrally, by FishBase project staff. (Note that creating local alternative to FishBase would not be cost effective, due to the major international investment that has already gone into FishBase). Additionally, in year two, the Fisheries Centre will subcontract item 7 to an off-campus consultant who is an affiliate of the Fisheries Centre and has experience with fisheries related projects. All other items will be handled by Fisheries Center faculty, or affiliates, or project staff to be hired by the Fisheries Centre. The work done by Stuart L. Pimm will be done as a subcontract to him.

SCHEDULE

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

1) Oct. 1 - Dec. 31: We will first conduct an extensive literature search; we need to gain a broad understanding of the naturally occurring marine food webs. We will be gathering data on biomasses, feeding rates, and other parameters from published food webs, so that we have an idea of what ranges of values are acceptable for these models. We will also be investigating the structural patterns of related published food webs.

2) Jan. 22-25: Pauly and Pimm attend the Annual Restoration workshop. In the week before this meeting we will hold the ECOPATH meeting.

3) Mar. - Sep. 30:	Refine model initially specified during workshop, with emphasis on data from EVOS projects, and their uncertainty, and present model at scientific conferences (incl. at the 1998 Restoration Workshop), and in the primary literature.

B Project Milestones and Endpoints

FY 97 Milestones (besides required annual reports):

Jan. 1998:	Presentation of concept at Annual Restoration Workshop;
Feb. 1998:	Holding of PWS Model Specification Workshop;
Apr. 1998:	Publication of workshop report;
Jun. 1998:	Submission of two scientific papers documenting key features and behavior of trophic mass-balance models of PWS and adjacent waters;

FY 98 Milestones (besides required annual reports):

Nov. 1998:	Incorporation into ECOPATH of a routine explicitly accounting for seasonal oscillations, and submission of scientific paper documenting this feature, illustrated through a PWS mass-balance model accounting for seasonal oscillations of all input parameters; .
Jan. 1999:	Presentation at Annual Restoration Workshop of an ECOSIM-based trophic simulation model, with primary production driven by a physical model of PWS.
Mar./Apr. 1999:	Holding of final workshop;
Aug. 1999:	Release of CD-ROM with ECOPATH/ECOSIM models of PWS and adjacent waters and database on scientific and local knowledge of Alaskan fishes, for distribution by Trustee Council.
Aug. 1999:	Submission to Trustee Council of first FishBase CD-ROM enriched with information on PWS fishes.

C Completion Dates

As for "Milestones;" project will be completed on August 1999 (FY 99)

PUBLICATIONS AND REPORTS

The above project milestones identify anticipated publications and reports; more details cannot be provided at present. The publication record of the Principal Investigators (see attached resumes) are invoked here: we will document and publish our work in the primary literature.

PROFESSIONAL CONFERENCES

The principal investigator are often invited to present keynotes at various conferences (see resumes) and will use the opportunities this provides to present the results of the proposed work, and its EVOS science context.

COORDINATION AND INTEGRATION OF RESTORATION EFFORTS

The aim of the proposed work is to synthesize data from projects funded by the Trustee council (see above under "NEED FOR THE PROJECT")

PROPOSED PRINCIPAL INVESTIGATORS

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stuartpimm@aol.com

PRINCIPAL INVESTIGATORS

The key qualifications of Dr. Daniel Pauly are having initiated, while still at ICLARM, Manila, Philippines, the activities which led to the emergence of the ECOPATH approach and software, and of FishBase, and to have authored a large number of primary literature publications documenting these (see references and resume). Further, he has organized several workshops (including one in the Pacific Northwest) and training courses at which the ECOPATH approach was taught and used.

Dr. Stuart L. Pimm is on the editorial boards of Conservation Biology, Evolutionary Ecology, Journal of Animal Ecology, Oecologia, and Science. He has also participated on several major committees such as the National Research Council Committee on Preservation of the 'Alala; the Scientific Advisory Board, the Centre for Conservation Biology, Stanford University; the American Institute of Biological Sciences Task force for the 90s, and the National Research Council Committee on the Value of Biodiversity. He has also given Testimony to the Federal Senate Committee on the Environment; the re-authorization of the Endangered Species Act; July 13th 1995, and the House Committee on Resources; the re-authorization of the Endangered Species Act; September 20th 1995. He is the author of numerous scientific papers in distinguished journals and a book, among others, on food webs.

OTHER KEY PERSONNEL

Other project staff will include: Dr Villy Christensen, Adjunct Professor, Fisheries Centre, who co-initiated the ECOPATH approach and programmed most of its routines, and who will be responsible for item 5 (see above);

Dr Carl Walters, Professor, Fisheries Centre, UBC, who developed the ECOSIM module of ECOPATH, and who will be responsible for item 6;

Dr Tony Pitcher, Director, Fisheries Centre UBC, who will serve as Project Manager, and a staff member to be hired by the project, and to be responsible, together with the P.I.'s for items 1, 2, 3, and 8.

Lisa Manne, Research Assistant, BS in mathematics, magna cum laude, Otterbein College, Westerville, Ohio, 1991. MS in mathematics, University of Tennessee, 1995.

LITERATURE CITED

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Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$112,200.0						
Travel		$37,900.0						
Contractual		$3,200.0						
Commodities		$3,950.0						
Equipment		$20,500.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$177,750.0		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect		$34,418.0						
Project Total	$0.0	$212,168.0		$199,728.6	$0.0	$0.0	$0.0	
Full-time Equivalents (FTE)		35.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: Indirect costs are for UBC Fisheries Centre, standard UBC contract overheads and cover general sevrices, adminsrtation, space and buildings, computer facilities, basic office supplies and communications. They are calculated at the standrad UBC contract rates for ' non-commercial government and NGOs' of 30% of the cost of personnel and 2% or travel costs.

1998

Prepared: 04/07/1997

Project Number: 300
Project Title: A Mass Balance Model of the Trophic Fluxes in PWS
Name: Fisheries Centre UBC, U of Tennessee, Knoxville

FORM 4A
Non-Trustee
SUMMARY

4/7/97

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

Personnel Costs:						
Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
Dr Daniel Pauly	PI - UBC Fisheries Centre		2.0	9000.0		18,000.0
Dr Stuart Pimm	PI		2.0	9000.0		18,000.0
Dr Carl Walters	numerical modeller - UBC Fisheries Centre		0.5	9000.0		4,500.0
Dr Tony Pitcher	ecologist, project manager, UBC -FC		0.5	9000.0		4,500.0
Dr Villy Christensen	ecopath model consultant		0.5	9000.0		4,500.0
Lisa Manne	Graduate student, Pimm		12.0	1775.0		21,300.0
(to be appointed)	Postdoc Research Asst, - UBC-FC		12.0	3200.0		38,400.0
(to be appointed)	part-time secretarial support		6.0	500.0		3,000.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		35.5	50475.0	0.0	
					Personnel Total	$112,200.0

Travel Costs:					
Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
UBC PI, modeller + postdoc to ann'l EVOS mtg + 1st Ecopath wksp	850.0	3	24	130.0	5,670.0
Dr Christensen from Demnark to 1st Ecopath wksp	1700.0	1	8	130.0	2,740.0
5 US participants at model workshop - non-Alaskans	1000.0	5	20	130.0	7,600.0
6 US participants at model workshop - Alaskans	650.0	6	24	130.0	7,020.0
PI Pimm and student Manne to annual EVOS meeting	1100.0	2	16	130.0	4,280.0
PI Pimm and student Manne to Vancouver	1100.0	2	8	130.0	3,240.0
UBC PI, modeller and postdoc to ecopath tech'l review	850.0	3	12	130.0	4,110.0
PI Pimm and student Manne to ecopath tech'l review	1100.0	2	8	130.0	3,240.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$37,900.0

1998

Prepared: 04/07/1997

Project Number: 300
Project Title: A Mass Balance Model of the Trophic Fluxes in PWS
Name: Fisheries Centre UBC, U of Tennessee, Knoxville

FORM 4B
Personnel
& Travel
DETAIL

4/7/97

Contractual Costs: Description	Proposed FY 1998
Report draft, editing, binding and delivery	3,200.0
Contractual Total	$3,200.0

Commodities Costs: Description	Proposed FY 1998
computer supplies	1,200.0
offic and secretarial	900.0
LAN charges	1,100.0
Fax, phone, postage	750.0
Commodities Total	$3,950.0

1998

Prepared: 04/07/1997

Project Number: 300
Project Title: A Mass Balance Model of the Trophic Fluxes in PWS
Name: Fisheries Centre UBC, U of Tennessee, Knoxville

FORM 4B
Contractual &
Commodities
DETAIL

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

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
4 Notebook computers (2 PIs, Postdoc and Grad student) for running ECOPATH	4	4600.0	18,400.0
proprietary software	1	1500.0	1,500.0
ZIP mass-storage drive for data	2	300.0	600.0
			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	$20,500.0

Existing Equipment Usage: Description	Number of Units	

1998

Project Number: 300
Project Title: A Mass Balance Model of the Trophic Fluxes in PWS
Name: Fisheries Centre UBC, U of Tennessee, Knoxville

FORM 4B
Equipment
DETAIL

ohd rate	0.3	
	5400	
	5400	
	1350	
	1350	
	1350	
	6390	
	11520	49920
	900	
	0	
	0	
	33660.3	33660.3
	0.02	
	113.4	
	54.8	
	152	
	140.4	
	85.6	
	64.8	
	82.2	
	64.8	
	758	34418.3

Copper River Inter-Tribal Fisheries Commission/Copper River Salmon Run Data Project

Project Number:	98331
Restoration Category:	Enhance/Replace Subsistence Resources
Proposer:	Native Village of Eyak
Lead Trustee Agency:	DOI
Cooperating Agencies:	
Alaska SeaLife Center:	No
Duration:	1st year, 5 year project
Cost FY 98:	$ 411.4
Cost FY 99:	$ 1013.6
Cost FY 00:	$ 479.1
Cost FY 01:	$ 503.1
Cost FY 02:	$ 528.3
Geographic Area:	Copper River Watershed
Injured Resource/Service:	Subsistence

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APR 15 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Abstract:

Project will assist with the formation of a Copper River Inter-Tribal Fisheries Commission to protect and enhance the Salmon Runs on the Copper to replace the lost subsistence resources on Prince William Sound. The project will also install modern automated run monitoring and data collection equipment on the Copper River tributaries and will develop a Tribal Fisheries Management Plan using data collected over a five year period. The Copper river fishery is at risk because of a shift in resource use from subsistence and commercial fishing to urban sport and personal use fishing. An inter-tribal fisheries commission is needed to protect the Copper River fishery.

Introduction:

The restoration effort being proposed is to replace and prevent further loss of subsistence resources. The Copper River Salmon runs have been used for tens of thousands of years to support our families. These resources are used to replace lost subsistence resources on Prince William Sound. Currently, the use of the Copper River salmon by subsistence and commercial fishermen is threatened by a push in the State for increased allocations for sport fishing and personal use fishing by the growing urban population connected to the Copper Basin by the road system. The Copper River Inter-Tribal Fisheries Commission seeks to provide an organization that can speak with a unified voice for the Native people who live on the Copper River and to provide an organization to develop a management plan that addresses the concerns and interest of the Native people, based on professional scientific methods and the traditional knowledge of our elders.

Need for the Project:

A: Statement of the Problem:

The Copper River Salmon runs have been used for tens of thousands of years to support our families. These resources are used to replace lost subsistence resources on the sound. Currently, the use of the Copper River salmon by subsistence and commercial fishermen is threatened by a push in the State for increased allocations for sport fishing and personal use fishing by the growing urban population connected to the Copper Basin by the road system. If the use of the Copper River salmon runs for subsistence and commercial fishing is impaired either by overfishing in the up river spawning areas or by a shift in allocation because of the increased political power of the urban areas of the state, we will lose a major source of subsistence resources and commercial fishing income that has been used to replace the resources on Prince William Sound that have been damaged by the Exxon Valdez Oil Spill. Fish run data collection systems are weak from a standpoint of breaking out total sonar count fish to their tributaries of origin and distinguishing between Kings and Reds. This lack of data has forced managers to take a very conservative approach to run management and has caused the restriction of early and the most valuable commercial fishing time on the flats. Subsistence fishing at the mouth of the Copper has been restricted to only times when the commercial season is open, so subsistence is being further restricted.

Threat to the loss of the Copper River Run to Sport and Personal Use Fisheries:

The threat to the runs on the Copper and their use as a subsistence resource is very real as demands for the fish on all areas of the river increase from personal use and sport fishermen.

The number of dipnetters in the Chitina area has continued to grow for the past 10 years. The state has illegally bulldozed a road 30 miles across Native Corporation land and has issued permits for people to dipnet in an area that is virtually all private Native land.

The popular dipnet fishery has become more organized and powerful. This year they demanded and received an additional 100,000 fish. The impacts on the adjacent Native lands at Chitina will be more dipnetters crowding onto privately owned land. More trespass, more litter, more garbage and more human waste. The Alaska State court ruled in 1990 that the subsistence fishery was to be opened to all Alaska Residents, previously, it was restricted to Native fishermen and non natives who were local Copper Basin residents. The percent of the total harvest since 1990 has dropped from 100% for residents of the Copper Basin to 59%. The number of subsistence permits on the river went from 300 in 1990 to 700 in 1994. The increase has nearly all been by participants from urban areas outside the Copper Basin who are not traditional and historic users.

The Native voice in the management of the fishery is diminished. There is a continued displacement of traditional subsistence fishermen out of their areas. Elders in the Ahtna Region complained in a meeting November 9, 1996 that their fish wheel camps have been crowded out by non native fishermen. Native fish camps at O'brien creek were outlawed in the 60's. Meanwhile, the state bulldozed access roads to O'brien creek to allow dipnetters from urban areas an easy way to get at the same fishing ground. Thousands of people have crowded this area and in 1991, the state bulldozed another 30 miles of road through Woods Canyon without permits and against a loud public outcry. In addition to wrecking 30 miles of the Copper River Railbed, which is listed on the National Register of Historic Places, the State opened up the Woods Canyon area to vehicle traffic. The area is now overrun by campers, four wheelers, and river boats by the hundreds.

The number of dipnet permits went from 4,500 in 1988 to 8,000 in 1993. The main reason the increased participation was because of the state built access road. This has allowed a large overrun of people on private Native lands and there are not adequate facilities. There is litter, human waste and garbage dumped all over the area.

Sport fishing on the Gulkana river has become widely publicized and the fishery has become more and more crowded. Members of Gulkana Village have complained about large crowds of motorhomes parking at a State developed gravel pit near the river. After a busy July weekend, there is human waste, litter and garbage all over the area. Overfishing on the Kenai and Susitna drainages are causing fishery managers to look for areas to take the pressure off these systems. The Copper River seems an easy target for managers who hope to reduce the pressure on the Kenai and Susitna. The people who traditionally depend on the Copper runs for their livelihood have less and less input to management decisions as the state board of fisheries comes under greater pressure from organized urban fishing groups. The Chitina dipnetters association, largely made up of membership in Fairbanks, is organizing an Anchorage branch. The Gulkana river sport fishermen organized last year. The Copper Basin sport fishing guides are in the process of organizing. The Copper River Inter-Tribal Fisheries Commission is needed for our Native families and fishermen to respond to these organized threats to our access to the fish allocation and management decisions on the Copper.

The sport fishing pressure is increasing at an alarming rate on all tributaries to the Copper that have populations of King Salmon. The Klutina River and Tonsina Rivers are experiencing large increases in fishing pressure on Native Land. Other tributaries are at risk as the urban population becomes more and more mobile and better informed with the advance of technology and transportation improvements, 4 wheelers, jet boats, cellular phones and world wide web sites all add to the ease of gaining information and access to the salmon that run in the Copper River. The interests of the Native people in the management of the river are largely ignored. The considerations are pushed by the majority to give priority to convenience and ease of access to the fish by urban participants. The Tribes that have used the Copper River for the past 10,000 years, need to have a voice in the battle between the State of Alaska and the Federal Government, over who is going to manage this fishery. Our historic and prehistoric use of the Copper River is being ignored by both the State of Alaska and the Federal Government at this time. We need to develop an Inter-Tribal Fisheries commission that will provide recognition and a solid direction for the interest of the Native people on the Copper River.

The Need for Better Management Data on the Copper River System:

The management of the Copper River Salmon Run from is considered a model for success. Its success however, may be one of the biggest problem of the system. With increasing pressure on the upriver areas due to good sport fishing opportunities, there is a great need for better data on the system. The lack of sonar data on the tributaries and data that distinguishes between Kings and Reds has caused the fishery managers to take a very conservative approach to the fishery. Because of increased demands on the up river fishery especially for Kings, this has resulted in even more restrictions on early commercial fishing openings (and subsistence fishing at the mouth of the Copper). This is the most valuable time of the harvest from a commercial standpoint is the early openings. Since subsistence fishing at the mouth of the Copper, has been restricted to only times when the commercial fishery is open, this has restricted the subsistence harvest.

The sonar counting of the fish at Miles Lake and Woods canyon count the main run at its source, the amount of fishing pressure on individual stocks in various tributaries is difficult to manage with our existing data system. Sonar data on the significant tributaries of the Copper is needed over a full run cycle of the Copper or a 5 year period. This will give a baseline to correlate the Miles Lake sonar. This will greatly enhance the ability of managers to estimate run sub-populations. In addition, sonar equipment that can distinguish fish size will be useful in collecting data on not just total run counts, but also on distinguishing Reds from Kings on the tributaries. This data will be very useful in determining the total King run and harvest levels of Kings. The issue of the total King harvest is one that the sport fishermen have used to restrict early commercial fishing at the mouth. Better data on the total run, and how the run is harvested will allow better knowledge on the total escapement to the spawning beds and provide better data to manage the fishery at all points on the system. It may also show how the increased sport harvest of King Salmon is affecting the run and may allow the management of the fishery to better target harvest of particular species thus maintaining the resource sustainability with better targeted fishing efforts.

B. Rationale/Link to Restoration

The work should be done because the Copper River salmon runs are a major subsistence and commercial resource that has been used by people on Prince William Sound to maintain family food supplies and incomes in the wake of the loss of other opportunities in Prince William Sound as a result of the Oil Spill. Access by the Native People to the Copper River runs is now threatened by political change and the need for improved data collection technology. This proposal will protect the access to this resource by addressing both the political and data collection issues. The Copper River Inter-Tribal Fisheries Commission will provide a strong unified voice for the Federally recognized tribes on the river and will provide an organization that can perform professional scientific work that will help better manage the resource. This will help the bargaining position of the subsistence fishermen on the river in allocation negotiations and will provide data needed for better resource management for all users.

C. Location

The project will be undertaken on the Copper River Watershed.

Eight Federally Recognized Tribes are located on the Copper River watershed, beginning at the mouth of the river and moving upstream, these are as follows:

Native Village of Eyak
Chitina Village Council
Native Village of Kluti-Kaah

Tazlina Village Council
Gulkana Village Council
Gakona Village Council
Chistochina Village Council
Mentasta Lake Village Council

These tribal governments serve members who are predominantly Aleut and Ahtna. In addition, there are several adjacent Federally Recognized Tribes that have customarily and traditionally fished or traded for salmon from the Copper River, these are the Native Village of Tetlin, Northway Village Council, Native Village of Tanacross and the Native Village of Dot Lake. At the mouth of the Copper on Prince William Sound is the Native Village of Tatitlek and the Native Village of Chenega.

Community Involvement and Traditional Ecological Knowledge:

Tribal governments will be involved by participating in the set up of the Copper River Inter-Tribal Fisheries Commission through delegates assigned by the Village councils.

Tribal Councils will choose whether to participate in the commission. Those who choose to participate will authorize the participation through resolution of their respective Council's. A periodic newsletter will go out to the Villages informing them of activities of the commission. Periodic board meetings will inform Village delegates of the commission activities and will be given information to take back to their respective Villages.

Research and scientific data will be reported to the Villages through the newsletter and delegates at the board meetings.

Project Design:

A. Objectives:

This project has two objectives:

1: Facilitate the formation of the Copper River Inter-Tribal fisheries commission.

2: Develop a baseline Salmon run data set for Kings and Reds for every major tributary in the Copper River over a full run cycle of five years.

B. Methods:

Specific Hypotheses to be tested:

Sub Populations of Salmon on the Copper River system can be better managed and the total run management can be less conservative if good run data on all major tributaries is available in a real time manner that distinguishes between Kings and Reds.

Methods used:

Research Portion:

Establish automated sonar counters with electronic recording and data transmission capabilities that can distinguish fish count and estimated fish size and shape at the following river systems:

Tasnuna, Bremer, Tiekel, Chitina, Tonsina, Klutina, Tazlina, Gulkana, Gakona, Sanford, Chistochina, Indian, Ahtel Creek, Slana, Tanada Creek (and Copper above).

The data from each sonar will be recorded and transmitted to a central data base. This will be used with other statistical sampling, test fisheries, sport fish creel census, harvest ticket reports, commercial catch data and tag recovery data. This data will be correlated to the Miles canyon sonar and Woods Canyon sonar. This will be used to determine individual drainage run timing and how to read each run at the Miles Canyon sonar counter and on the flats with test fisheries.

Inter Tribal Fisheries Commission Portion:

See schedule section for tasks and dates.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Only one agency is requesting funds for this project.

We are not planning to contract a significant portion of the work to the private sector. We will hire fisheries biologists as employees and consultants.

Schedule:

A. Measurable Project Tasks for FY 98 (10/1/97 to 9/30/98)

Goal 1:	Organize an Inter-Tribal Fisheries Commission made up of the Federally Recognized Tribal Governments on the Copper River.
Tasks:	
October 1 - October 31	Hold an organizational meeting to go over the background of the project and to receive direction from elders and to appoint delegates to draft constitution.
October 1 - December 31	Delegates draft constitution and by laws
January 1 - January 31	Constitution and by laws circulated for review by the Villages
January 1 - January 31	Comments directed to delegate chair
February 1 - February 15	Revisions to constitution made
February 16 - March 10	Final constitution circulated for review by Villages

March 15 - March 31	Second organizational meeting held to approve final version of constitution.
April 1 - April 30	Ratification vote held by Village Councils.

Goal 2: Develop baseline Salmon run data set for Kings and Reds for every major tributary in the Copper River over a full run cycle of five years.

a:	October 1 - October 31	Hold organizational meeting to get direction from elders on fisheries management plan.
b:	October 1 - October 31	Develop list of important issues at elders meeting.
c:	October 1 - October 31	Designate Tribal Fisheries Management Plan work team.
d:	October 1 - October 31	Hire fisheries biologist.
e:	October 1 - December 31	Develop a Tribal fisheries management plan that addresses the list of important issues.
f:	November 1 - December 31	Meet with Alaska Department of Fish and Game fisheries management personnel and the Alaska board of fishery and define maximum benefit/minimum cost data gathering locations and data needs for the fishery. Establish cooperative agreement to coordinate research so efforts of ADFG and Eyak will compement each other and fill in needed data gaps.
g.	November 1 - January 31	Design data gathering sonar system and data system that will capture sonar data for Kings and Reds.
h.	November 1 - January 31	Design data storage and transmission system using store and forward technology to a central data base.
i.	May 1 - September 30	Install test system at one tributary and monitor results.
j.	August 1 - September 30	Design and plan system installation for FY 99 for full implementation on all major tributaries of Copper.
k.	September 1 - September 30	Report results to Tribal members and the Native American Fish and Wildlife Society.

B. Project milestones and Endpoints

Goal 1: Organize an Inter-Tribal Fisheries Commission made up of the Federally Recognized Tribal Governments on the Copper River.

Completed by September 30, 1998

Goal 2: Develop baseline Salmon run data set for Kings and Reds for every major tributary in the Copper River over a full run cycle of five years.
Test data for one tributary completed September 30, 1998

Full Data for all Tributaries Completed each year September 30, 1999, 2000, 2001, 2002. Final report and analysis completed September 30, 2002.

C. Completion Date:

The project will be completed by September 30, 2002

Publications and Reports:

A manuscript will be submitted at the end of fieldwork for FY 98 on the results of the test sonar counts on the tributary selected in the Copper Basin.

Professional Conferences:

The results of the FY 98 field work and project design will be shared at the Native American Fish and Wildlife Society.

Normal Agency Management:

The trustee council should fund this project because there is no resources for this project otherwise. The Copper River is one of the last sources of subsistence resources for people living on Prince William Sound and protecting this resource for use in the absence of lost resources as a result of the oil spill is paramount. Our Tribe is not required to engage in this activity by statute, we are doing this because it is important to the well being and survival of our people.

Coordination and Integration of Restoration Effort:

The project will be coordinated with other restoration projects through the Community Facilitator at the Chugach Regional Resources Commission. We will participate with other projects when possible to share equipment, materials and transportation. We will work with the Alaska Department of Fish and Game to target the most critical data need areas and to focus our efforts to complement the research and management efforts of this agency on the Copper.

Explanation of Changes in Continuing Projects:

Not applicable (New).

Proposed Principal Investigator:

Robert Henrichs, President
Native Village of Eyak
P.O. Box 1388
Cordova, AK 99574
Phone: 907-424-7738
Fax: 907-424-7739
email: rhenrichs@tribalnet.org

Principal Investigator:

Robert Henrichs is a strong leader in his community and understands the need to maintain local control over management of the Copper River and what it will mean to lose local control of the management of the Copper River. He has the ability to insure that qualified personnel will be staffed for the project and will insure that the work of specialists and scientists is closely monitored and reported on.

Other Key Personnel:

Key personnel will be hired to facilitate the formation of the Copper River Inter-Tribal Fisheries Commission and input of the elders and Tribal Council's. There will be fisheries biologists who will design the sonar data gathering system and implement it.

Literature Cited:

Following the budget are graphs that were prepared by the Alaska Department of Fish and Game for presentation at the December 1996 Board of Fisheries meeting in Cordova. These graphs demonstrate the large increase in the fishing pressure placed on the Copper River System.

Native Village of Eyak, Copper River Inter-Tribal Fisheries Commission/Copper River Salmon Run Data Project. Prepared 4/15/97

Native Village of Eyak
Exxon Valdez Oil Spill Trustees Council
Copper River Inter-Tribal Fisheries Commission/Salmon Run Data Project
Budget Summary

Budget Category	Authorized FY 97	Proposed FY 98	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 20002
			Long Range Funding Requirements			
Personnel		185,136.00				
Travel		24,599.00				
Contractual		20,500.00				
Commodities		18,000.00				
Equipment		85,000.00				
Subtotal		333,235.00				
Indirect (UA Method, see Narrative Detail)		78,184.00				
Budget Total	0.00	411,419.00	1,013,608.00	479,110.00	503,126.00	528,347.00
Full-Time Equivalent (FTE)		2.5	4	4	4	4
Other Funds		30,700	32,235	33,847	35,539	37,316

Comments:

Indirect: University method used, see narrative detail for computation	78,184.00
NEPA Compliance categorically excluded	0
Report Writing 1 month project biologist salary, fringe and indirect on the above	9767
Publications (budgeted in commodities, amount allowed per instructions)	1000
Community Involvement: Coordinators salary and fringe, coordinator and council travel, attorney fees, meeting supplies, indirect on the above.	88,333
Professional Conferences:	
Native American Fish and Wildlife Society Anchorage Per Diem 3 days (@165)	495
Workshop Attendance	
Annual Restoration Workshop Air Fare cordova-anchorage, 3 days anchorage winter per diem (@145)	590
Technical Review Session 2 days Anchorage Perdiem (@165)	330

Native Village of Eyak
Exxon Valdez Oil Spill Trustees Council
Copper River Inter-Tribal Fisheries Commission/Salmon Run Data Project
Budget Detail Narrative

Salaries:			Annual Cost	Proposed FY 98	1999	2000	2001	2002
Project Coordinator:	Project Coordinator. The project will require a part time professional coordinator to organize the meetings, take notes, prepare agenda's and draft work products such as constitutions, by-laws and to coordinate the work of volunteers and consultants on the Tribal Fisheries Management Plan. Wages are determined by the Tribes experience in similar projects. The part time coordinator will be required to accomplish goals 1 and 2. (5% inflation factor assumed throughout budget unless otherwised noted)							
	Project Coordinator:	.5 FTE @	59500	29,750.00	31,238	32,800	34,440	36,162
Project Biologist	Project Biologist. The project biologist will work to accomplish the baseline salmon run data set for all major tributaries of the Copper. This individual will work with the council and fisheries management biologists and other professionals to build the data collection model and pilot test it in fy 98. This individual will implement a full data collection project from FY 99 through FY 02.							
	Project Biologist:	1 FTE @	70500	70,500.00	74,025	77,726	81,612	85,693
Fisheries Technicians	3 Fisheries technicians will be needed to assist with building and installing the sonar counter system on a test tributary and exploring and planning for locations of similar systems for FY 99 at proposed major tributary sites. Fish technicians will also collect and summarized electronic data and build meaninful reports from the data with recommendations to the project biologist. Three Fisheries Technicians will be employed for 4 months in FY 98. 6 technicians will operate the full system from 99 through 02.							
	Fisheries Technicians	1 FTE @ (2 fte 99 through 02)	38950	38,950.00	81,795	85,885	90,179	94,688
Total Salaries				139,200.00	187,058.00	196,411.00	206,231.00	216,543.00

Fringe:

			Proposed FY 98	1999	2000	2001	2002
FICA	6.20%						
Medicare	1.45%						
FUTA	0.60%						
Alaska ESC	3.50%						
Workmans Comp.	5.25%						
Medical, Dental Vision benefits	16.00%						
Budgeted Fringe:	33.00%	of salary.	45,936.00	61,729.00	64,816.00	68,056.00	71,459.00
Budgeted Personnel			185,136.00	248,787.00	261,227.00	274,287.00	288,002.00

Native Village of Eyak, Copper River Inter-Tribal Fisheries Commission/Copper River Salmon Run Data Project. Prepared 4/15/97

Travel:

Travel will be needed to gather to discuss the constitution of the inter tribal salmon commission and prepare the Tribal Fisheries Management Plan. There will be three general meetings required for 10 members. In addition, there will be travel necessary by the project coordinator to meet with agencies and coordinate activities. Because of our remote geographic dispersal, travel is a costly, but essential portion of the request we are making. The travel assistance is essential to allow the group the ability to dialog with each other on the significant issues and to generate solid underpinning documents for the Copper River Inter-Tribal Fisheries Commission, and the Tribal Fisheries Data Gathering Plan. Travel is needed to accomplish goals 1 and 2. The project biologist will need to travel to field sites and between communities to monitor the project and accomplish the field work.

	Number of Units (Miles/P-D Days)	Cost per Unit	Proposed FY 98	1999	2000	2001	2002
Project Coordinator Travel, Milage Chitina-Anchorage 6 round trips 504 miles round Trip	3,024	0.31	937.00				
Air Fare RT Anch-Cordova 3 trips at $165	3	165.00	495.00				
Anchorage Per diem, 6 days	6	165.00	990.00				
Council Travel, 3 meetings 10 members, average 475 miles RT	15,120	0.31	4,687.00				
Council Air Fare, 10 members 1 trip, 3 members 2 trips RT Anch-Cordova $165	16	165.00	2,640.00				
Per Diem, 10 members, 3 days for 3 meetings	90	165.00	14,850.00				
Project Biologist Travel, Milage Chitina Anchorage, 6 round trips 504 miles per trip. Basin milage, 100 per day average for four months (includes tech milage)	15,024	0.31	4,657.00				
Budgeted Travel:			**24,599.00**	**25,829.00**	**27,120.00**	**28,476.00**	**29,900.00**

Contractual

	Hours	Cos/Hr.	Proposed FY 98	1999	2000	2001	2002
In Kind work by council members conducting meetings, and drafting constitution and Tribal Fisheries management Plan. 10 members 100 hours each $25 per hour average value. Provided in kind. (Goal 1 and 2) $25,000 in kind/year.	1000	25					
Scientific review and consultation on data gathering system design. to Evaluate fisheries data and provide recomendations on Tribal Fisheries Management Plan: (Goal 2)	200	85	17,000.00	17,850.00	18,743.00	19,680.00	20,664.00
Legal Fees to review constitution and by-laws, and on going consultation regarding commission activities (Goal 1)	20	175	3,500.00	3,675.00	3,859.00	4,052.00	4,255.00
Budgeted Contractual:			**20,500.00**	**21,525.00**	**22,602.00**	**23,732.00**	**24,919.00**

Commodities:

Supplies will be needed to accomplish both goal 1 and 2. For goal 1, general office supplies, filing supplies, and presentation media will be required to summarize group process and present the draft constitution to the Village council's. Goal 2 will require similar office and presentation supplies as well as field camp supplies for scientific data gathering.

Native Village of Eyak, Copper River Inter-Tribal Fisheries Commission/Copper River Salmon Run Data Project. Prepared 4/15/97

	Cost Per Month	Months Needed	Proposed FY 98	1999	2000	2001	2002
Office Supplies and presentation media	250.00	12	3,000.00	3150	3308	3473	3647
Field Camp Food and Supplies	3,750.00	4	15,000.00	15750	16538	17365	18233
Budgeted Commodities:			**18,000.00**	**18,900.00**	**19,846.00**	**20,838.00**	**21,880.00**

__Equipment:__

	Proposed FY 98	1999	2000	2001	2002
We will need Salmon sonar equipment, data storage, data transmission remote power supplies, and other data gathering equipment. FY 98 will require one set up for a test tributary. FY 99 will require tool up for all major tributaries of the Copper. It is estimated that there will be savings in 99 when purchasing equipement for the entire system because of our experience in 98 and volume purchasing capability. 98 equipment estimated at $65,000, FY 99 15 additional sites at 50% of 98 cost with no inflation factor, 00 through 02 estimated at 10% of 98 and 99 cost with a 5% inflation factor.	65,000.00	487500	58013	60914	63960
Field Camp Equipment 1 portable camp set up in 98, 2 portable camp set ups in 99 .	6,500.00	13650			
River Boat with Jet Engine	13,500.00				
Budgeted Equipment:	**85,000.00**	**501,150.00**	**58,013.00**	**60,914.00**	**63,960.00**

__Other:__

	Proposed FY 98	1999	2000	2001	2002
We will need to rent the community Hall for two days for three meetings cost is 250 per day This will be provided in kind by the community $1500 inkind per year.					
Office space 350 per month 12 months This will be provided in kind by the community 4,200 in kind per year					
Budgeted Other:	0.00	0.00	0.00	0.00	0.00
Total Direct Costs:	**333,235.00**	**816,191.00**	**388,808.00**	**408,247.00**	**428,661.00**

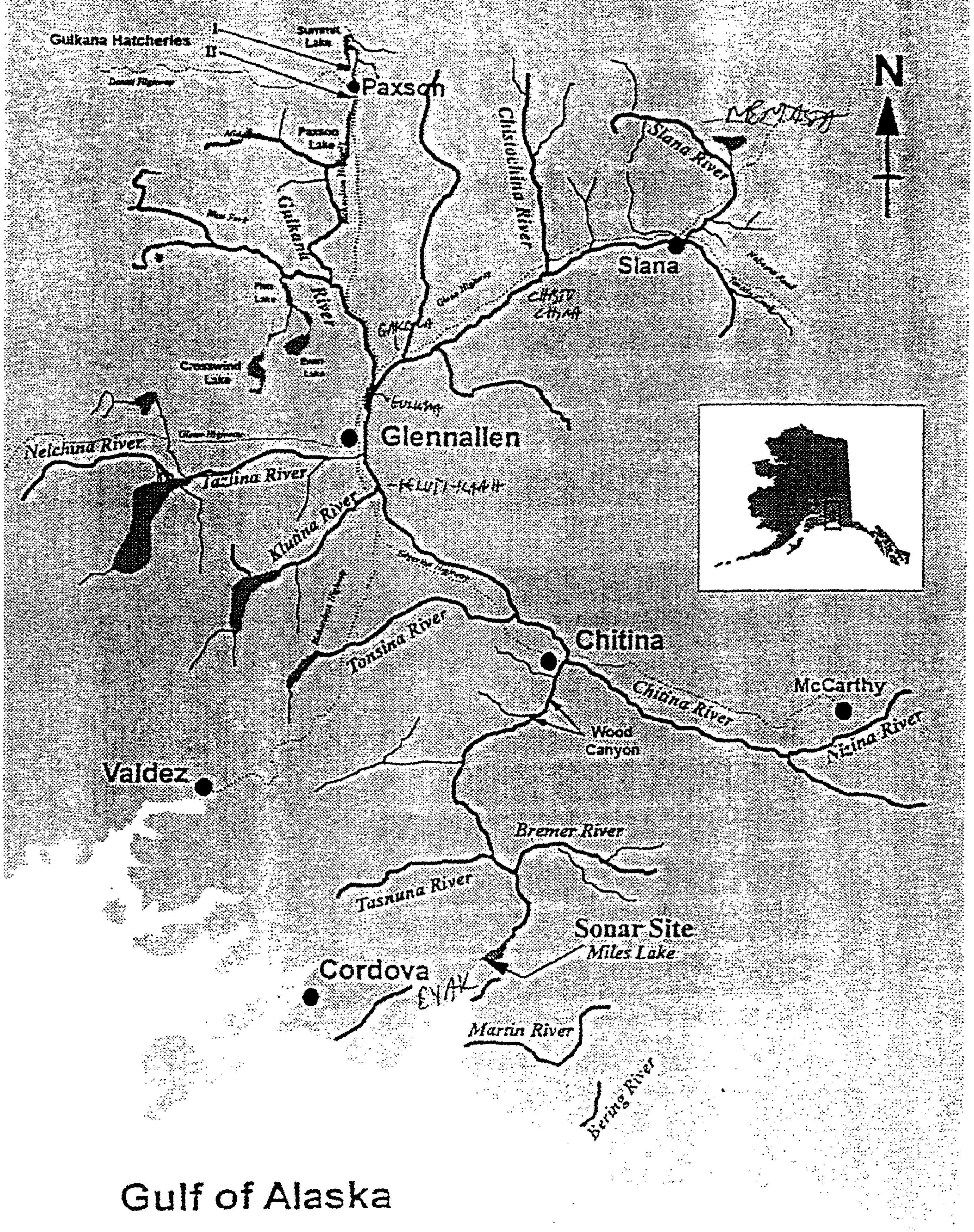
Indirect:

We propose to use the model indirect rate agreed to by the University for Exxpn Valdez oil spill restoration projects. An indirect costs rate of 25% of all costs except equipment for which ownership resides with the Native Village of Eyak or the Copper River Inter-Tribal Fisheries Commission and Subcontract cost in excess of 25,000. Subcontract cost in excess of 25,000 but less than 250,000 shall be subject to an indirct cost charge of 5%. Subcontract costs in excess of $250,000 shall be subject to an indirect cost charge of 2%. The budget assumes the equipment will remain the property of the lead trustee agency as described in the instructions for non trustee organizations.

	Proposed FY 98	1999	2000	2001	2002
Total Direct Costs subject to 25% indirect Rate	312,735.00	794,666.00	366,206.00	384,515.00	403,742.00
Exempt Subcontract cost less than $25,000	20,500.00	46,525.00	47,602.00	48,732.00	49,919.00
Subcontract Cost in excess of $25,00 but less than 250,000 subject to 5% indirect rate		-25,000.00	-25,000.00	-25,000.00	-25,000.00
Subcontract Costs in excess of 250,000 subject to 2% indirect rate					
Check Totals (should match total direct costs)	*333,235.00*	*816,191.00*	*388,808.00*	*408,247.00*	*428,661.00*
Budgeted Indirect Costs:	**78,184.00**	**197,417.00**	**90,302.00**	**94,879.00**	**99,686.00**
Total Costs	**411,419.00**	**1,013,608.00**	**479,110.00**	**503,126.00**	**528,347.00**

0

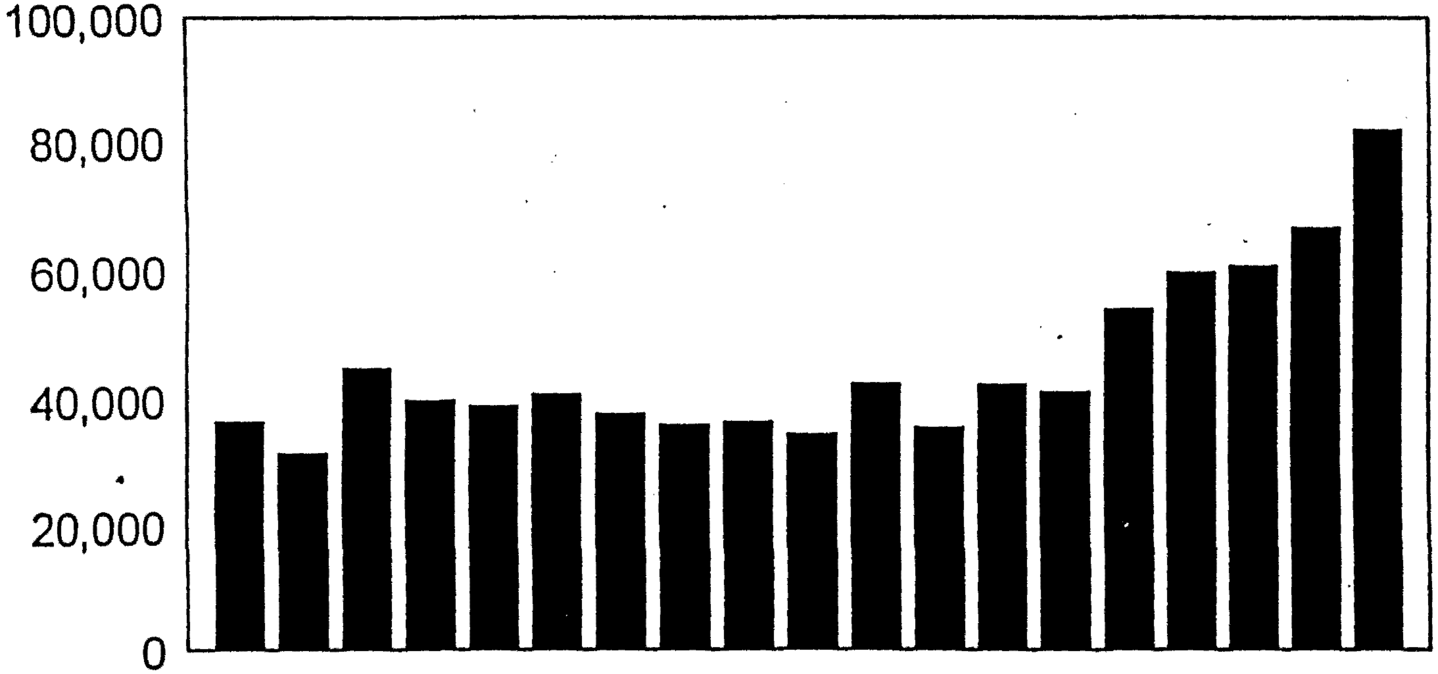
COPPER RIVER DRAINAGE



SOURCE ALASKA DEPT of FISH + GAME

Upper Copper River Sport Fishing Effort

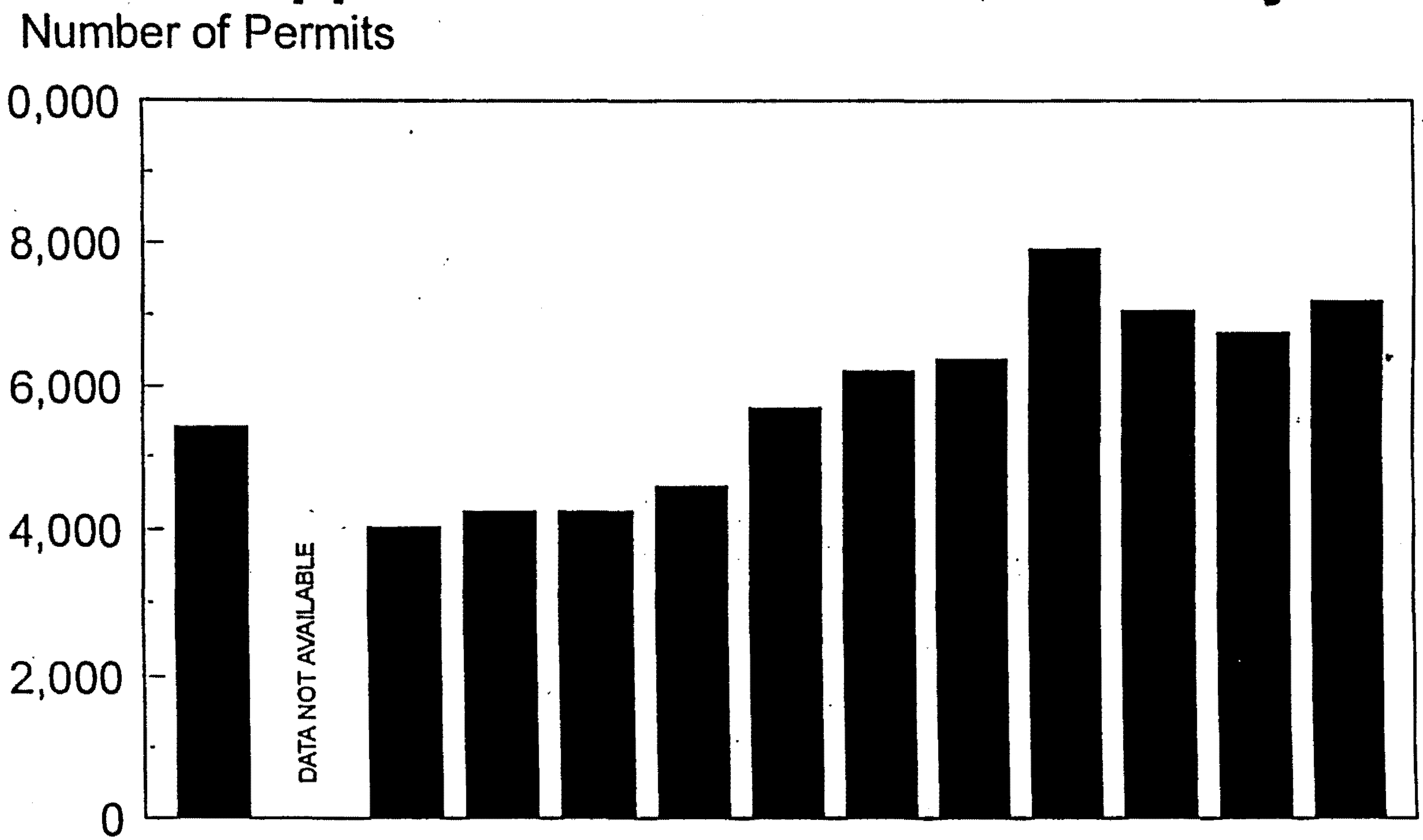
Number of Angler-Days



1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
36,586	31,405	45,067	39,979	39,102	40,929	37,890	36,089	36,604	34,529	42,686	35,645	42,549	41,380	54,455	60,011	61,034	66,913	82,105

Total Sport Fishing Effort in the Upper Copper will continue to increase as urban areas connected by road continue to grow and international promotion of the region continues. Each angler day also represents more than one person camping in the area impacting ~~Native~~ Native Lands. MANAGERS ARE ALSO TARGETING THE COPPER TO TAKE PRESSURE OFF THE KENAI AND SUSITNA.

Copper River Personal Use Fishery



Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
■	5,415		4,031	4,245	4,251	4,582	5,689	6,222	6,385	7,914	7,061	6,760	7,199

START OF PERMIT CHARGING SYSTEM.

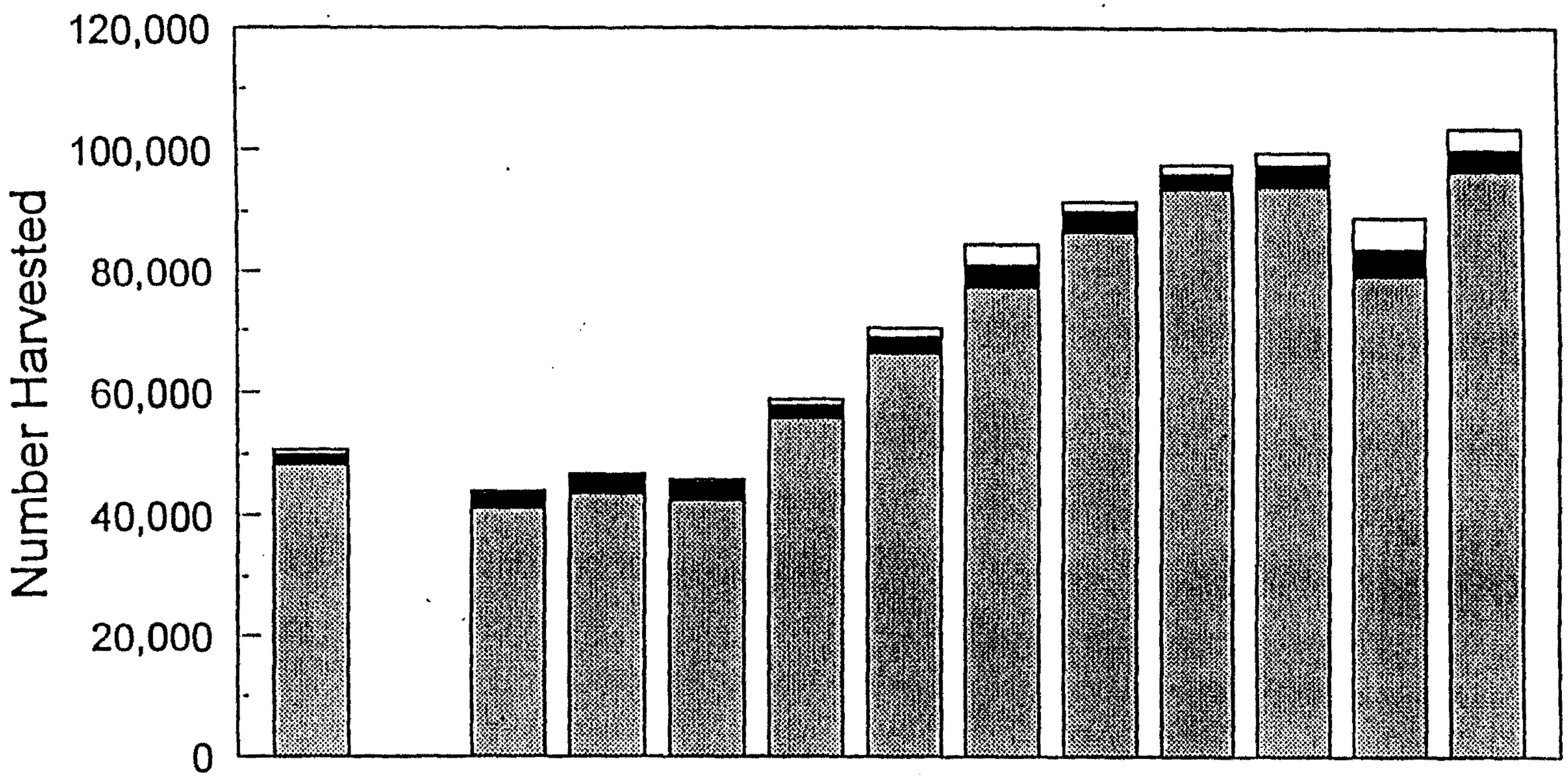
Vehicle Traffic not possible in Woods Canyon

Road Pushed into woods canyon

Road pushed through woods canyon to Tiekel, kept open to Uranita since.

: each permit means 1 to 5 people fishir r

Copper River Personal Use Harvest

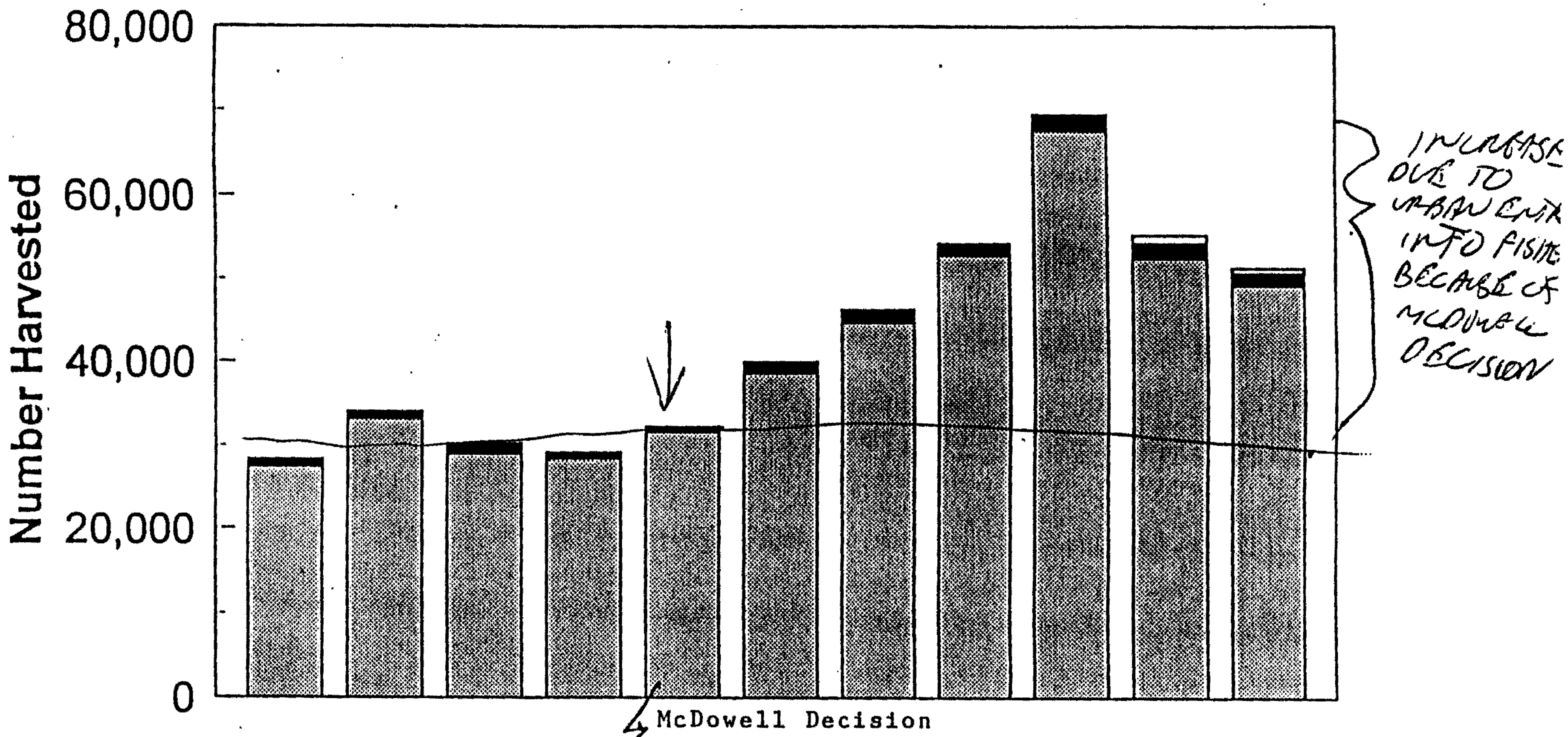


Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Sockeye	48,237	No Data	41,054	43,492	42,403	55,748	66,129	77,245	86,491	93,248	93,725	79,143	96,247
Chinook	1,760	No Data	2,367	2,968	2,997	2,251	2,689	4,038	3,396	2,839	3,731	4,673	3,696
Coho	717	No Data	538	424	495	860	1,499	3,339	1,513	1,413	1,974	4,900	3,400
Total	50,714	0	43,959	46,884	45,895	58,859	70,317	84,622	91,400	97,500	99,430	88,716	103,343

Large Runs and doubling of fishing permits from access road through Woods Canyon has dramatically increased harvest since 1988.

SOURCE: ALASKA DEPT. OF FISH AND GAME.

Copper River Subsistence Salmon Harvest



Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Sockeye	27,441	33,106	28,969	28,366	31,555	38,551	44,620	52,870	67,571	52,516	49,300
Chinook	686	813	985	790	636	1,293	1,430	1,423	1,968	1,892	1,578
Coho	291	161	359	69	92	226	345	76	59	882	561
Total	28,418	34,080	30,313	29,225	32,283	40,070	46,395	54,369	69,598	55,290	51,439

Note, increase since 1990 has come from urban participants allowed into a traditiona fishery as a result of the McDowell Decision. This is crowding traditional native fishermen and camps off the river.

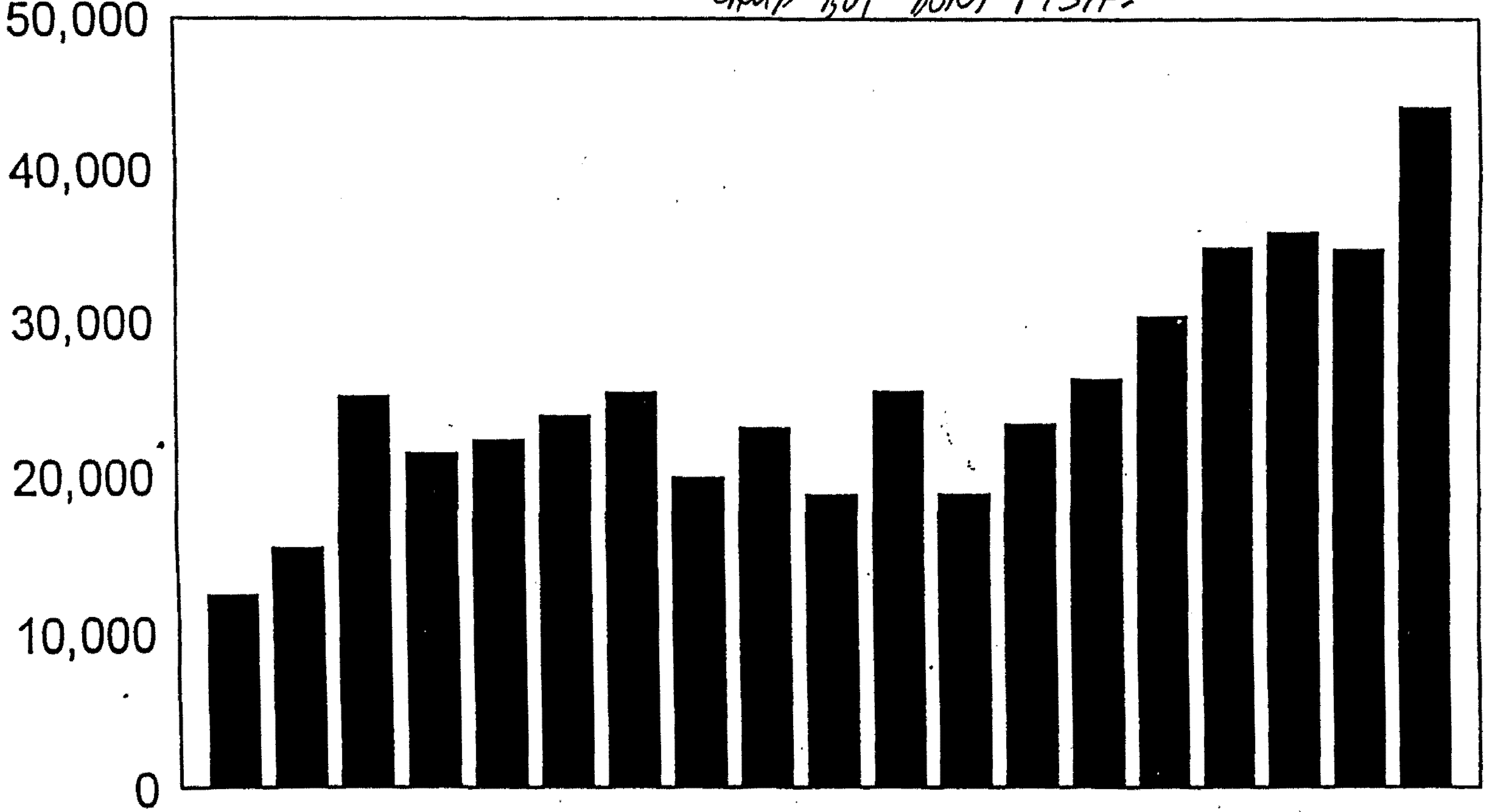
SOURCE: ALASKA DEPT. OF FISH AND GAME

SOURCE ALASKA DEPT OF FISH & GAME

Gulkana River Sport Fishing Effort

Number of Angler-Days

NOTE ANGLER DAYS DO NOT COUNT FAMILY WHO COME AND CAMP BUT DONT FISH.

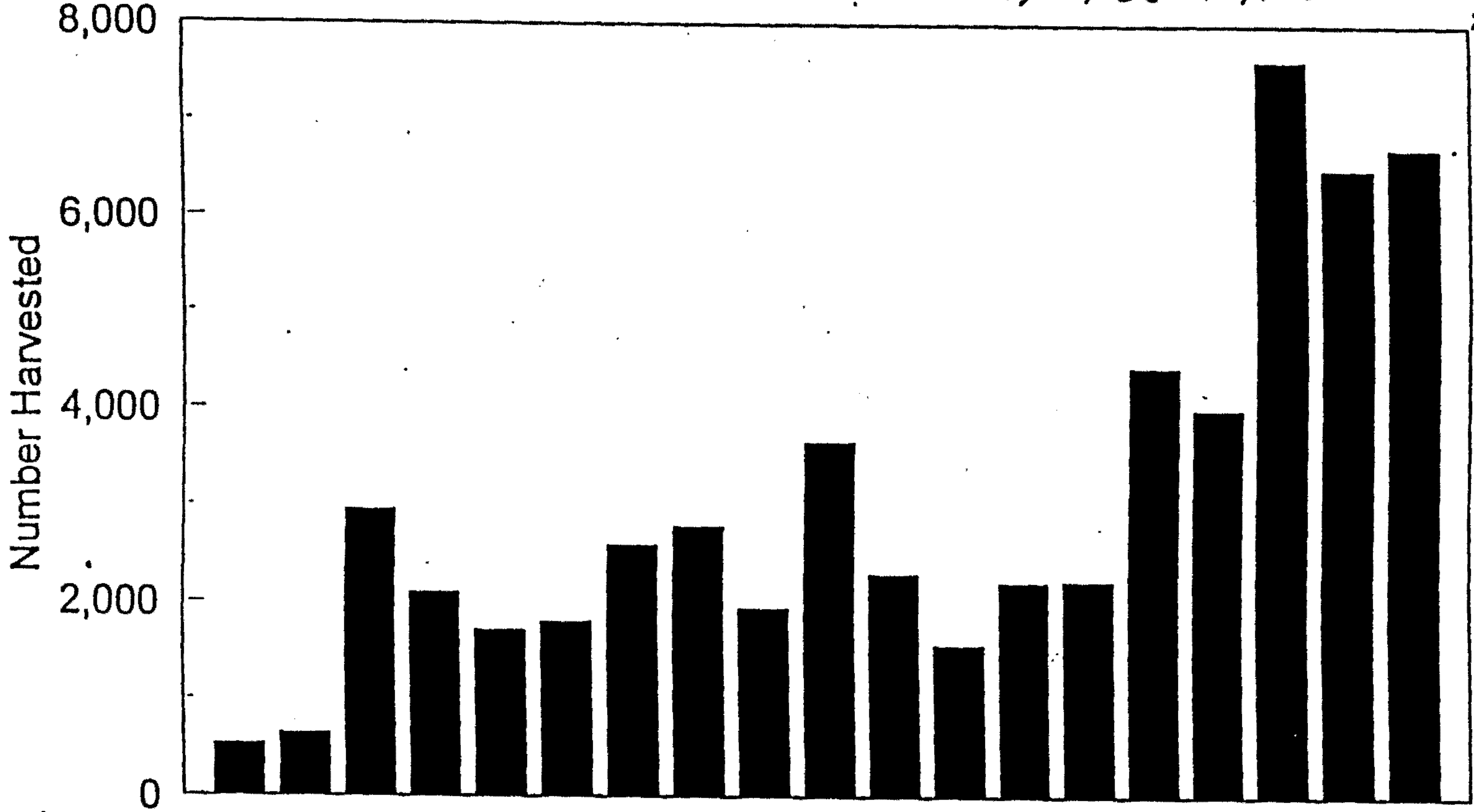


1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
12,446	15,487	25,073	21,477	22,332	23,834	25,342	19,937	23,115	18,894	25,467	18,923	23,405	26,284	30,366	34,855	35,845	34,742	44,077

Gulkana River is the second largest impacted system from Uurban users. large increases in pressure are coming from promotion by commercial guides and the Alaska Dept of fish and game in an attem[...]

Copper River Chinook Salmon
Sport Harvest

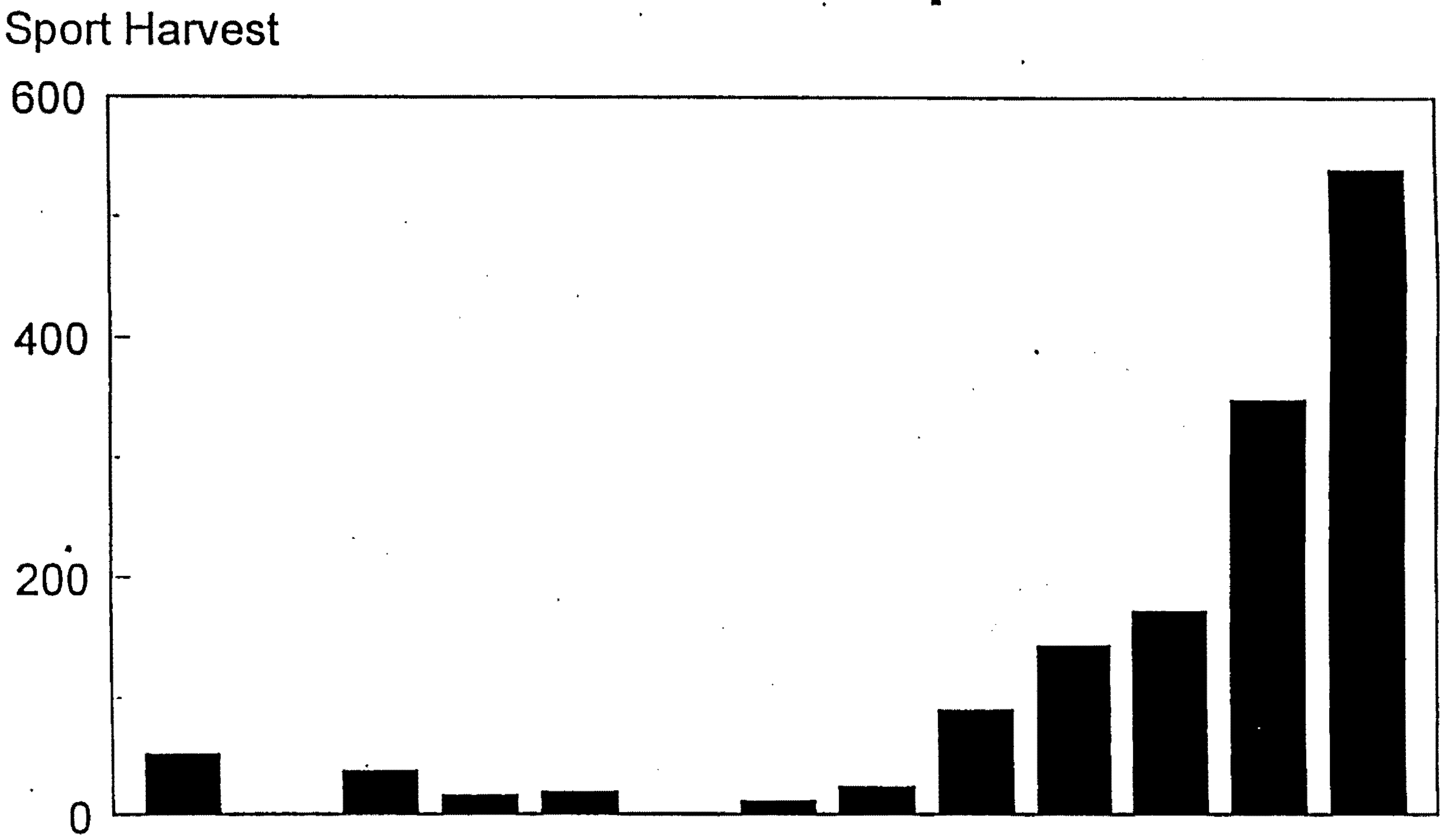
SOURCE ALASKA DEPT OF FISH + GAME



1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
532	641	2,948	2,101	1,717	1,802	2,596	2,787	1,939	3,663	2,301	1,562	2,219	2,232	4,427	3,997	7,620	6,494	6,709

Note, increased Chinook harvest cannot continue in the level that is occurring. Pressure on the fishery has resulted in demans for more fish allocated to sport and personal use at the expense of the Subsistence and 100 year old commercial fishery.

Tonsina River Chinook Sport Harvests



Year	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
■	52	0	37	16	19	0	11	23	89	143	172	349	539

This is a key Chinook spawning tributary, increased usage largely from promotion by sport fishing guides and word of mouth and tourism marketing.

Eyak Subsistence Recovery Camp Planning Project
Submitted to the EVOS Trustee Council

Project Number: 98332

Project Category: General Restoration

Proposer: Native Village of Eyak

Lead Trustee Agency: National Park Service

Cooperating Agency:

Duration: 1 year

Geographic Area: Cordova

Injured Service: Subsistence Services

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APR 1 5 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Abstract

The Native Village of Eyak proposes a planning project to establish a Subsistence Recovery Camp for Alaska Native subsistence users affected by the Exxon Valdez oil spill.
As identified by Picou and Gill (1992) Post-traumatic Stress Syndrome is directly linked to the environmental damage done by the oil spill and the subsistence way of life that Alaska Native people have used for thousands of years With the results of the oil spill still being felt by the communities through lack of or reduced abundance of specific species (i e harbor seal, herring, herring spawns) there has been an upsurge of addictive behaviors exhibited in the oil spill impacted communities As in the case of harbor seal the research scientist have asked for a voluntary~ reduced harvest. This may be warranted from the scientific view point but is extremely frustrating to the subsistence user and increases the emotional and psychological trauma that they have experienced.

Introduction

Fish and marine mammals were not the only species to be injured by the Exxon Valdez oil spill 'We would like to elevate the status of the people in Prince William Sound to the level of sea otters and seal. We know that elevating them to the level of killer whales would be asking too much Such statements are being voiced in our communities as an example of the frustration harbored over the effects of the oil spill affected ecosystem

NEED FOR THE PROJECT

A. Statement of Problem

The Exxon Valdez oil spill created problems for every species living in the Prince William Sound ecosystem. Alaskan Natives have experienced numerous losses throughout many generations. Each loss experienced exacerbates previous losses. The oil spill triggered many addictive behaviors and expanded Post Traumatic Stress Disorder. Native people have always had an inextricable tie to land and water which can only be described as a 'living relationship." This relationship has been severed and manifested in an increase in alcohol and drug abuse. The time for healing has come A place for healing is needed. The Traditional healing and Recovery Camp would uplift our traditional ways of being and help us put this man-made spill into proper perspective.

B. Rationale

Planning for the Eyak Subsistence Recovery Camp is the first step to conducting necessary group activities aimed at combating substance abuse caused by the Exxon Valdez oil spill. In an effort "to efficiently restore the environment injured by the Exxon Valdez oil spill to a healthy, productive world renowned ecosystem, while taking into account the quality of life and the need for viable opportunities to establish and sustain a reasonable standard of living," the Trustee Council must begin to look at the integral part local lives play in this ecosystem.

Local residents have found poor tasting seal meat, declining crab and nonexistent herring in the years that have followed the spill There is little trust in the environment to provide a reasonable quality of human life. These losses has left communities physically, spiritually and emotionally defeated Such problems have manifest themselves in destructive and harmful ways within the communities.

Local residents personally felt the injury of other species There is a human relationship to the environment that must be addressed. The Exxon Valdez oil spill violated the bond between humans &and the environment, a connection that is paramount to subsistence activities

There must be a holistic approach to ecosystem recovery By this. local residents must be enlisted for support in current projects, and assisted in their recovery process.

C. Summary of Major Hypothesis and Objectives

The Eyak Subsistence Recovery Camp study is designed to test traditional healing practices of post-traumatic stress disorder and its symptomatic addictive behaviors. The Native Village of Evak believes that this is an effective means to bring the entire ecosystem back into natural order and to instill respect for natural resources in their recovering state.

D. Completion Date

The planning process for creating the Eyak Subsistence Recovery Camp would take one year, so the planning would be completed by the summer of 1996

COMMUNITY INVOLVEMENT

We envision extensive collaboration with numerous elders. traditional healers, agencies, and professionals involved in the healing sciences The philosophy of the Eyak Subsistence Recovery Camp is both interactive and interdisciplinary The primary therapeutic method would involve all aspects of the community residents of the camp will serve the village as a way to begin the healing process in themselves The residents will undertake the care of the elders, education of the youth, organization of the Sobriety Celebration and Potlatch, development of traditional dance and song groups, the building of a talking circle lodge and a sweat lodge. In return, the village of Eyak will be responsible for the fiscal and philosophical development and planning of the camp

FY 98 BUDGET

Personnel	$26,800
Travel	8,600
Contractual	2,000
Commodities	500
Equipment	300
Subtotal	38,200
Indirect	2,600
Total	40,800

PROJECT DESIGN

A. Objectives

.An in depth analysis of the oil spill effects on local residents in the first step in reaching the human recovery stage. In an effort to deal with the personal struggles that have resulted both by the oil spill and the restoration process the following objectives have been identified

1. Brining the community of Evak and any other surrounding communities together that are interested in communicating the their personal obstacles to recovery

2. Research and develop traditional healing techniques.

3. Set out a plan to work with the exististing environment. involved research agencies and organizations and current restoration activities

4. Produce a final study and report

B. Methods

The Native Village of Eyak will conduct a study on the effects and solutions to the human consequences of the Exxon \'Valdez oil spill. This will be completed through community interaction. consultation with traditional healing centers and practical information on the operation of treatment facilities.

The community of Eyak. Cordova and any other outlying areas will come together to discuss and brainstorm problems and solutions to the current emotional state that the oil spill has put affected communities.

The tribal worker will travel to various traditional healing camps and centers both in Alaska and in Washington state. From this, a basis for effective recovery and be planned out. In addition. professional treatment center personnel will address the Native Village of Eyak's tribal council to address the operation of treatment facilities and camps

A report will be written in conclusion of the activities and information gathered. Both the tribal worker and the project coordinator will be responsible for its completion.

C. Contracts and other Agency Assistance

Various agencies and organizations are actively involved in the emotional recovery of oil spill impacted communities. Such organizations include: Sound Alternatives in Cordova, Alaska Native Health Board, Howard Luke Recovery Camp in Fairbanks, the Native American Children of Alcoholics in Seattle and Mliddleton, Moz & Associates. In addition, Dr. Picou from the university of Alabama is conducting research on the psychological impact of natural resources on the community of Cordova.

D. Location

Mile fifteen of the Copper River highway on an Eyak land holding.

SCHEDULE

A. Measurable Project Tasks for FY 98

October I-October 15, 1998:	Begin coordination of community meeting
November 15 - 19, 1998:	Hold community healing and brainstorming session
November 23 -30, 1998:	Compile conclusions from community meeting
December 1-15, 1998:	Contact various treatment centers for information
January 15 - February 28, 1999:	Travel to various treatment centers
March 1 - 15, 1999:	Compile information on treatment center visits
March 21-24, 1999:	Treatment center professional meets with Tribal Council
April -May 1, 1999:	Draft report is written
May 7-15, 1999:	Draft report goes out for review
June 1-July 1, 1999:	Final report is written
July 15-21, 1999;	Tribal Council accepts report
August 1-7, 1999:	Council forwards report to Trustee Council
September 1-30, 1999:	Eyak begins report implementation process

B. Project Milestones and Endpoints

November 19, 1998:	Community meeting held
February 28, 1998:	Various treatment centers visited
March 14, 1998:	Treatment Center professional meets with Tribe Council
May 1, 1998:	Draft report written
July 1, 1998:	Final report written
August 7, 1998:	Report forwarded to Trustee Council

C. Project Reports

All Trustee Council reporting requirements will be complied with. In addition, a final report will be completed by the end of the award period

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The Eyak Subsistence Recovery Camp Planning Project will complement the current community involvement activities. as well as the work that the Principal Investigators are beginning within the local communities

ENVIRONMENTAL COMPLIANCE

The Native Village of Eyak will comply with any and all environmental regulations.

PERSONNEL

Robert Henrichs, President of the Native Village of Eyak. will oversee and administration of the project. He will be ultimately responsible for all fiscal and reporting requirements associated with an awarded grant.

Harold Napoleon of the Alaska Federation of Natives will serve as a project consultant.

Mark Potvin MSW. has worked with the community of Cordova as an alcohol counselor He is currently a Ph D candidate and is expected to participate in the planning and reporting process

Jane Middleton Moz Ph.D and Anna Latimer, MS from the Seattle area are noted academics and authors in traditional Native healing practices They will serve as consultants to the project.

Bob Henrichs

Bob Henrichs, President and Project Coordinator
Native Village of Eyak Tribal Council
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Phone (907) 424-7738
Fax: (907) 424-7739

Don Callaway
National Park Service
2525 Gambell
Anchorage. AK 99503
Phone (907) 257-2646
Fax: (907) 257-2410

Date submitted:

SEA OTTER POPULATION MONITORING
Submitted Under the BAA

Project Number:	98333
Restoration Category	General Restoration
Proposer:	Native Village of Eyak
Lead Trustee Agency:	
Cooperating Agency:	USFWS
Duration:	5 Years
Cost FY 98:	$269,611
Cost FY 99:	$137,092
Cost FY 00:	$137,092
Cost FY 01:	$137,092
Cost FY 02:	$137,092
Total Cost:	$817,979
Geographic Area:	Prince William Sound (PWS)

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APR 1 5 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT:

The overall goal of this project is to involve Alaska Natives, specifically the Native village of Eyak, in monitoring the sea otter population in the Prince William Sound region. Prince William Sound has been occupied by sea otters since the 1970s, and according to some estimates the population has been growing at approximately 9% per year. Because sea otters moved into areas long unoccupied by sea otters, they initially thrived on the the abundant food resources. Prior to the Exxon Yaldez Oil Spill, the sea otter population in Prince William Sound was estimated to be between 10,000-16,000 animals. While the number of animals killed in the oil spill area is not certain, estimates account for the loss of roughly 2,500 — 4,000 animals. While sea otters appear to have been recovering, region wide, in the oil spill area, localized populations appear to be experiencing trouble. During the past two years, and likely due to reduced food resources, in combination with uncharacteristically harsh winters, the sea otter population in the Cordova area has experienced reduced population viability. Initial inquiries by the United States Fish and Wildlife service indicated that Native hunting may be a cause for increased sea otter mortality in the area. However the Native hunters in the region believe that the sea otter population is likely experiencing problems because of reduced resource availability. Therefore, Native hunters are interested in becoming involved in local monitoring of the population. They propose to do so through, regular boat surveys, to access population distribution and abundance. In addition, hunters are organizing a local permitting system to monitor harvests in the local area. In combination, these two activities will help access the status of the sea otter population in Prince William Sound.

INTRODUCTION

Sea otters began reoccupying Orca Inlet, near Cordova, in significant numbers during 1980. Initially the population thrived on rich food resources such as Dungeness Crab and Gaper (horse clams). As more Sea Otters moved into the area, food resources have become reduced. During the winter of 1995-96, which was uncharacteristically harsh, sea otters began to die off in alarming numbers. Intital inquiries by the USF&W Service, suggested that increased human harvests and poor struck and loss ratios may be responsible for the increased mortality. Subsequent investigation points to the cause of death as starvation. Also, the few animals necropsied showed emphysema and heavy parasite loads. The deaths were not only the young and old, but the prime age class.

The Marine Mammal Protection Act (MMPA) requires that marine mammal populations be managed in such a way as to "maintain the health and stability of the marine ecosystem", and, when possible,to maintain them within their optimum sustainable population range. Under the MMPA, the USF&WS cannot regulate Native harvest unless it is wasteful or the population is depleted. The Native Village of Eyak realizes, that that to be most effective management actions should be initiated if and when a population is experiencing problems. It is the belief of the Native Village of Eyak, that the population is experiencing problems that may lead to local depletion. The Native Village of Eyak proposes, consistent with provisions of the MMPA, to monitor the health and status of the sea otter population in PWS through local monitoring efforts and development of local guidelines for hunting, including a permitting system.

NEED FOR THE PROJECT

Because the sea otter population in the Cordova area is currently experiencing problems, there is a dire need for the project. The members of the Native Village of Eyak need to closely monitor the health of the sea otter population in the area because of their direct dependence on a healthy marine ecosystem. The problem with sea otters may extend to other resources. Also, because many sea otter populations across the state may experience the same developmental process as sea otters in Cordova are currently experiencing, there is a need to develop an approach to monitor the population before it crashes. This model may work in other areas. Also, the Native Village of Eyak is in a unique situation to conduct this project because of long term, local residence by our members, which provides for a long term and in depth knowledge of the area, as well as a direct and fundamental dependence on a healthy environment.

A. Statement of Problem

The sea otter population in Cordova is experiencing difficulties which appear to be related to reduced food resources and starvation, as well as heavy parasite loads. Many of these symptoms also appeared during the Exxon Valdez Oil Spill

B. Rationale

Overall, the status of sea otters across the state is good. However, in the Cordova area there has been increased mortality during the past two winters, due largely to starvation and related effects. To date, scientists are unsure of why the mortality is occurring, although initially it was blamed on Native hunters. It is essential for Native hunters and users of the resource, to become involved in monitoring the population and accessing its abundance and distribution and to develop local mechanisms for monitoring Native harvests.

C. Summary of Major Hypothesis and Objectives

The immediate goal of this project is to encourage local involvement in accessing the distribution and abundance of the resource.

The long term objectives are to ensure healthy sea otter populations in the Cordova area, PWS, and statewide, consistent with the MMPA. Additionally, and also consistent with the MMPA, a goals is to develop an approach to be used locally, to ensure local control over the resource.

D. Completion Date

This project will be completed in 2002

COMMUNITY INVOLVEMENT

This project will involve all members of the Native Village of Eyak. In addition, the tribe will receive assistance and support from Chugach Regional Resources Commission and the Alaska Sea Otter Commission. Also, we expect to work with the National Biological Survey and the USF&WS, and the National Marine Fisheries Service.

FY 98 BUDGET

1/4 time Program Monitor 5 hr x 52 x 15	$ 3,900
Fringe Benefits @ 30%	1,170
2 vessels 3 x 52 x 300	93,600
2 deckhands 3 x 8 x 52 x 12	29,952
Fringe Benefits @ 30%	8,986
2 skippers 3 x 8 x 52 x 20	49,920
Benefits @ 30%	14,976
Fuel 5 gal/hr x 8 hours x 3 x 52 x 2 @ $1.40	17,472
Gloves & gear 4 x 500	2,000
travel:	
1 trips 5 SOC 300	1,500
Perdiem 5 x 120 x 2	1,200
Subtotal ($224,676)	
Indirect Costs: @20%	44,935
Total for FY 1998	269,611

BUDGET FOR SUBSEQUENT YEARS

	FY1999	FY2000	FY 2001	FY2002
Program Monitor				
5 Hrs x 52 x $15	$ 3,900	3,900	3,900	3,900
Fringe Benefits @30%	1,170	1,170	1,170	1,170
Vessels				
3 x 52 x $300	46,800	46,800	46,800	46,800
Deckhands				
3 x 8 x 52 x $12	4,493	4,493	4,493	4,493
Skippers				
3 x 8 x 52 x $20	24,960	24,960	24,960	24,960
Fringe Benefits @ 30%	7,488	7,488	7,488	7,488
Fuel				
5 gal/hr x 8hr x 3 x 52 x $1.40	8,736	8,736	8,736	8,736
Gloves & Gear 3 x 333.33	1,000	1,000	1,000	1,000
Travel				
1 Trips x 3 SOC x 300	900	900	900	900
Per Diem 3x 120 x 2	720	720	720	720
Subtotal	114,243	114,243	114,243	114,243
Indirect Cost @20%	22,849	22,849	22,849	22,849
Totals	137,092	137,092	137,092	137,092

FY 1998 BUDGET	269,611
FY 1999 BUDGET	137,092
FY 2000 BUDGET	137,092
FY 2001 BUDGET	137,092

TOTAL FOR PROJECT 817,979

PROJECT DESIGN

A. Objectives

1. Native hunters will develop guidelines to ensure that all sea otter harvests are reported.
2. Native hunters will survey the Orca Inlet area for population presently in the area.
3. Native hunters will conduct a monitoring program for accounting for natural deaths, not by hunters through a routine year round program.

B. Methods

1. The method used to develop guidelines for reporting will be to establish a Sea Otter Commission within the Native village of Eyak consisting of all sea otter hunters. The SOC will meet on a monthly basis throughout. the year to update the hunters on the progress of the sea otter~r population. The local SOC will gather local knowledge data to establish basic guidelines for the harvesting of the sea otters and depend on self reporting on a voluntary basis for the first year to establish the guidelines for the harvesting of the sea otters.

After the first year's data is analyzed via the vessel survey process, changes in the established guidelines will reflect the changes necessary for a sustained population. Working with the statewide Sea Otter Commission will provide a forum in which to report the results and receive other areas data on the health of the population.

The focus on the local Sea Otter Commission will be to maintain a t£balanced population and to establish the harvest frequency as well as the amounts to maintain a viable sea otter population. The local management plan will focus on ensuring that the proper proportion of males/females is harvested and the area is not over harvested. A process by which the hunters are licensed ~and monitored for want and waste.

2. The method used to survey the Orca Inlet area will be via vessels on a three day a week basis throughout the year on a calendar schedule. A deck hand to assist with the recording and surveying. A program monitor will do the report summaries and data summaries on a quarter time basis. The use of a fishing bowpicker/sternpicker will be the vessel of choice for better access to the beach and shallow areas. The survey~y will include counting the population of live and dead ~sea otters for the first year to establish a baseline for the population.

Subsequent years (FY 99 through 2002) will be on a single vessel monitoring process as known areas of haulout and feeding will be established and tri-weekly survey and monitoring will provide sufficient data sampling for the hunting and harvesting guidelines.

The area that the vessels will survey and monitor the sea otters will be on the eastern side of Prince William Sound and Orca inlet along the islands of Hawkins, Hinchenbrook and Montague as well as the Copper River Delta.

C. Contracts and Agency Assistance

As mentioned, the Native Village of Eyak will receive technical assistance from the Alaska Sea Otter Commission, and the Chugach Regional Resources Commission.

The Sea Otter Commission will be asked to provide any previous data that would assist in establishing the management plan and baseline data. The USF&WS will be asked to cooperate in the reporting of any infractions of the MMPA and hunting regulations.

Most importantly the Elders of the Chugach Region will be consulted at all times.

D. Location

The range of sea otters within the Cordova area

SCHEDULE

A. Measurable Tasks for FY 98

1st month	NVE Sea Otter Commission, appointed (meets monthly)
45 days	Vessel survey begins
2nd month	Tasks defined for SOC
3rd month	Hunters meeting
	Preliminary Management Proposed with Data
4th month	Management Plan
6th month	Data for first six months
	presented to hunters, SOC & Tribe
9th month	Data for quarter reported
12th month	Baseline survey completed

B. Project Milestones and Endpoints

The milestone for the first year will be to establish the management program through the local Sea Otter Commission. The monthly meetings with hunters and users to establish guidelines for the harvesting of the sea otters. The adjustment of the guidelines after six months and one year and then adoption of the review of the harvest amounts for later regulation will be two important milestones.

The endpoint of the harvest guidelines adjustment will be after the first and second year data is analyzed for error in any survey observations.

The local Sea Otter Commission will continue. The milestone for it's establishment will be at the sixth month, when all the previous data from all agencies has been accessed and management plan is submitted to the Native Village of Eyak for adoption. There is no endpoint for the Commission.

The milestones for the monitoring through vessels will be after the first quarter of data. The success of the data gathering will be reviewed by the SOC and local Sea Otter Commission, and any adjustments to this monitoring will be after the five year project. The adjustment for weather, number of hunters, amount of harvest, and compliance by hunters will be analyzed for the management plan.

C. Project Reports

ENVIRONMENTAL COMPLIANCE - - NA

PERSONNEL

The quarter time clerk will compile the data in a report form manner. The clerk will work with the Sea Otter Commission and gather the previously published/gathered data for the Commission. The clerk will also attend the annual Alaska Sea Otter Commission meeting for reporting the findings for the Cordova area. The clerk will be paid $15 per hour.

The skippers on the vessels will be two for the first year. The baseline data can be gathered in a more rapid manner since the baseline data for a full year has not been established. The skippers will be paid a charter rate for the vessel of $300 per day for three days a week and $20 per hour on an eight hour day for their work on the project. The deckhands, one per vessel, will assist in the physical count of sea otters. The deckhands will be paid $12 per hour on an eight hour day for their work on the project.

Robert J. Henrichs
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907-424-7738
907-424-7739 Fax

98334-BAA

Restoration of Prince William Sound Pink Salmon through Test Fishery Project

Broad Agency Announcement

Project Number:	New Project 98334-BAA
Restoration Category:	General Restoration
Proposer:	Native Village of Yak
Lead Trustee Agency	U.S. Department of Interior- Bureau of Indian Affairs
Cooperating Agencies:	Prince William Sound Aquaculture Corporation Department of Fish and Game University of Alaska Prince William Sound Science Center
Start -up /Completion date:	October 1, 1997-September 30, 2001
Expected Project Duration:	3 years
Cost FY 98:	$500,000
Cost FY 1999:	$500,000
Cost FY 2000:	$500,000
Geographic Area:	Prince William Sound (PWS)
Injured Resource/Service:	Pink salmon, commercial fishing, subsistence

ABSTRACT:

Pink salmon egg mortality attributed to oiling of anadromous streams from the *Exxon Valdez* oil spill has contributed to a reduction in adult pink salmon returns. Natural populations of pink salmon are harvested with large numbers of hatchery pink salmon in mixed stock fisheries, which may limit escapement to damaged streams and thereby delay recovery. This project will evaluate the feasibility of changes in hatchery production to reduce exploitation of injured wild stocks. Specific projects will focus on changing the location and timing of hatchery returns in western PWS. Funding for FY 98-FY01 will be for Inventory and Assessment of Pink Salmon.

INTRODUCTION

Natural spawning populations of pink salmon in western PWS were among the resources injured by oil from the *Exxon Valdez* oil spill (EVOS). These populations are harvested with large numbers of hatchery pink salmon in mixed stock fisheries, which may limit their ability to recover from the effects of the spill. To reduce harvest pressure on injured wild stocks, hatchery salmon targeted by commercial fishermen can be isolated spatially or temporally from the injured wild populations. Restoration of injured pink salmon populations through spatial or temporal separation from hatchery fish is centered on the idea that more specific stock management will lead to higher escapement into oil impacted stream and facilitate recovery through increased egg deposition. Hatchery pink salmon, for example could be released in the Esther, Northern, or Montague Districts, thereby distributing the commercial fleet away from injured stocks in the Eshamy, Northwestern and Southwestern Districts. Hatchery pink salmon can also be replaced with species or populations that have different return timing from wild pink salmon populations currently harvested in fisheries targeting hatchery salmon. By modifying hatchery production to separate hatchery and wild salmon returns, fisheries can be managed to minimize pressure on injured populations.

The extent to which the hatchery contribution to the pink salmon fishery in western PWS should be reduced to effectively aid the recovery of the injured populations, however, is unknown. Evidence has shown that oil impacted streams experienced higher embryo mortality than non-oiled streams, but that differences between oiled and no-oiled streams are declining. If the high embryo mortality in injured streams does not persist, the escapement needed to achieve pre=spill levels of abundance would change accordingly. Moreover, differences in survival between hatchery and wild fish will complicate the assessment of changes that result from remote releasing or altering run timing of hatchery fish. Consequently, this project is designed to achieve a measurable reduction in hatchery contribution to the mixed stock fishery, rather than a demonstrable increase in escapement to injured streams.

Equally important is the need to determine whether clanging the existing hatchery program will genetically impact wild populations. For example, the remote release of hatchery fish may result in local straying if the fisheries do not harvest all of the adult return. Similarly, developing new hatchery returns from species or populations outside the local area could lead to straying if migration patterns and homing are under rigid genetic control. Temporal or apatial overlap of characteristics such as spawning time and habitat also increase the potential for hybridization and gene flow between hatchery and wild populations. The implications of these alternatives are not well known, and will be considered in evaluation restoration alternatives.

Efforts by PWSAC to restore injured pink salmon populations to pre-spill conditions will be direct toward:

* **relocating hatchery runs in area or time by remote releasing current or anticipated hatchery runs away from areas which create fishing pressure on injured wild stocks.**

* **replacing current late run pink salmon production with species or stocks of earlier run timing.**

A. Statement of Problem

Egg mortality attributed to oiling of the anadromous streams has persisted through several generations, which has contributed to a reduction in adult pink salmon returns. This has reduced the escapement of natural spawning populations and economic benefits of users and communities that derive income from the resource. In addition, commercial fishing harvests in Western Prince William Sound that target mixed wild stock and hatchery stocks of salmon may expose injured wild stocks to levels of exploitation which limit wild stock escapement to oil damaged streams, thereby further suppressing recovery.

B. Rationale

Without steps to reduce harvest pressure on the injured wild populations, it may take many generations before these recover to pre-spill levels. If not action is taken, injured populations will remain subject to pressures that prevent their full contribution to the biodiversity of the PWS ecosystem. Moreover, services related to salmon harvesting such as fishing, processing and economies of the PWS communities will continue to suffer economic distress. curtailment of fishing to protect pink salmon (*EVOS* Restoration Plan, 1994).and to allow injured stocks to achieve higher spawning escapement will only further injure associated services. Diversion of fishing effort to reduce harvest pressure on injured stocks can provide for better management of stocks to achieve spawning escapement while maintaining fishing services and economies based on fishing at the highest degree possible until injured stocks return to pre-spill levels of abundance. Information from this project will increase the options available to fisher managers to maximize the economic benefits from enhancement programs while ensuring wild stock protection.

C. Summary of Major Objectives

This project will assist the restoration of naturally spawning populations of pink salmon in PWS by providing field =data that would enable the management agencies to determine if a modification of the existing hatchery and wild management programs is necessary to meet the objectives of a mixed stock fishery in PWS. In it's Record of Decision (October, 1994), the Trustee Council stated "restoration will take an ecosystem approach to better understand what factors control the populations of injured resources." Therefore, this project supports an integrated approach involving the application of salmon life history, genetics, disease and culture methods including the inventory and assessment of wild and hatchery populations, investigations at proposed remote release sites, and the evaluation of project impact and success factors such as predation, and hatchery fry interactions with other species. This study will provide the field data which can be used to evaluate the feasibility of releasing hatchery fish into new ares. or changing hatchery production to species or stocks with timing characteristics different from local pink and chum salmon populations.

Inventory and assessment will examine phenotypic characteristics in wild salmon stocks with particular focus on spawning time and spawning and spawning habitat distribution. Characteristics such as population abundance, stream life, adult size, egg size and fecundity will be needed to evaluate the appropriateness of specific stocks for hatchery culture or wild stock enhancement. In addition, water conditions (i.e. temperature, chemistry) of natal streams should be assayed and compared to hatchery water supplies to evaluate whether any particular species or population can be successfully cultured. These studies are not incorporated into this test fishery proposal.

Concurrent with the inventory and assessment, we would recommend that a sampling program also be conducted designed to evaluate potential sites as locations for remote releasing hatchery cultured salmon. This project could be directly integrated with other investigations as part of an ongoing effort to study physical and biological relationships between salmon land herring productivity in the PWS ecosystem.

Finally, the test fishery results will be available for study by the agencies such as the University of Alaska to examine responses in genetic and life history characteristics resulting from hatchery practices, and the potential impacts to population fitness from hybridization between wild and hatchery fish. Specific investigations could compare the magnitude of the effects that hatchery stocks have on wild pink salmon populations with similar and different spawning times (i.e. opportunity for hybridization).

As a results of these activities, specific remote release and stock development objectives will probably be recognized that will help achieve a reduction in the mixed wild/hatchery stock ratio in the Western PWS commercial salmon fishery. More specifically, species, stocks, numbers of fry and release locations will be defined, and direct action proposed to accomplish remote release or replacement of current production with species or stocks that possess different run time characteristics.

D. Completion Date

The inventory and assessment of natural spawning populations will be completed in the FY 98 and FY 99. Investigations related to genetic impact evaluations will be completed if and agency comes forward to cooperate with the activities of the test fishery.

COMMUNITY INVOLVEMENT

The Native Village of Yak, Traditional Council is made of up of over 550 members and as such will have a direct access to community members to encourage their involvement in the project. This project will be closely coordinated with 97052 Community Involvement. PWSAC, as one of the cooperative agencies, is comprised of representatives from all interested user groups and possess a board of directors "which includes no less than one representative of each user group that belongs to the association". The concept of a regional association is intended to allow active public participation in the salmon rehabilitation program. The PWSAC board of directors is comprised of: commercial / sport / subsistence / personal use fisherman, native representatives from villages in PWS and the Copper River region, representatives of the fish processing industry and representatives of the communities in PWS.

The Native Village of Yak Traditional Council will help provide vessels and crews to support field work necessary for proposed test fishing, inventory and assessment of salmon stocks at specified locations.

FY 98 Budget

Personnel	$120.0
Travel	5.0
Contractual Services	300.0
Commodities	5.0
Equipment	15.0
sub total	445.0
Gene. Admin.	44.5
Total	489.5

PROJECT DESIGN

A. Objectives

The purpose of this project is to reduce the interception of oil impacted wild pink salmon stocks by changing the location and timing of hatchery returns in Western Prince William Sound. The specific objectives are to:

1. Identify and evaluate potential remote release sites that will produce spatial separation between hatchery fish and wild pink salmon populations in the oil impacted areas.

2. Determine the feasibility of developing hatchery species and stocks that are temporally distinct in return time from wild pink salmon populations in the oil impacted area.

B. Methods

This project is a multi-year program to achieve a reduction of hatchery fish returning in the mixed stock fisheries in Western PWS. The program is sequential approach to evaluate the potential for remote release of hatchery salmon or change the present hatchery species or stock composition. It includes projects to inventory and assess wild stocks, evaluate the feasibility of matching the conditions of hatchery water supplies to specific requirements of new species or stocks, and investigate the genetic impacts that might result from wild-hatchery stock interactions. Most wild stocks of pink salmon returning to western PWS enter the Sound through several corridors situated between Montague and Bainbridge islands return in mid-to late summer, therefore evaluation studies will focus on identifying remote release areas that shift the migration of hatchery fish away from southwest corridor, or change hatchery production to species or stocks with earlier run timing.

1. Inventory and Assessment

The application of remote release projects or development of new hatchery stocks to help restore injured pink salmon stocks in PWS will require detailed baseline information of conditions in the near shore marine environment including currents, salinity and temperature, and the abundance and composition of plankton, predators and competitors. The biology of individual spawning populations, and the physical and biological characteristics of their spawning and rearing habitats must also be assessed to determine the potential for introducing new species or stocks into hatchery environments. Life history traits such as the timing, distribution and abundance of spawners and genetic population structure will be needed to identify possible brood sources and conduct studies to examine the impacts related to restoration alternatives. Finally, the thermal and chemical characteristics of natal streams will be examined to match brood sources to hatchery water supplies. Collection of these data will be the focus of the initial phase of project and will be used to refine and direct the implementation of the restoration methods.

a. Wild salmon population surveys: This phase of the project will provide baseline information on naturally spawning populations of pink and chum. The purposes are to: 1) identify potential sources for early run hatchery stock (Eastern, Northern and Coghill subdistricts), 2) obtain more specific data to establish the run timing and spawning schedules of populations in the study areas (Southwest and Montague subdistricts), 3) collect information on spawning habitat distribution, population abundance, life history characteristics (adult size, fecundity, egg size), and 4) genetic population structure (allozyme frequencies).

Information on return and spawning schedules of potential donor populations and populations in the vicinity of hatchery and remote release sites is needed to ensure that spatial and temporal separation is adequate to minimize the potential for hybridization. Data indicating differences in spawning habitat preference will provide additional protection for wild populations from introgression by hatchery fish. Population abundance, adult size, and the size and number of eggs produce are essential data for evaluating the biotic feasibility of a population for hatchery stock. The genetic sampling will supplement the EVOS funded PWS Pink Salmon Genetics Project (95320D) conducted by the AD&G.

AD&G records indicate that early pink salmon populations are present in at least twenty-eight streams within PWS (17 in the Eastern District, 1 in the Northern District,10, in the Coghill subdistrict). In the Southwest District, 28 streams are known to support later spawning pink salmon populations (12 in the vicinity of Armin F. Koenig Hatchery), but only 2 support chum salmon populations with mean annual escapements > 100. Based on escapement levels and proximity to hatcheries, 11 streams have been identified as potential sites for genetic evaluation studies (2 in the Southwest District, 2 in the Southeast District and 7 in the Montague District). The stream numbers by district, the purpose of the survey and sample schedule are:

District	Stream Number	Purpose	Schedule
Eastern	11,35,36,48,51,52, 115,116,117,127,129, 131,133,152,153	Potential brood source	Late June-early Sept
Northern	234	Potential brood source	Late June-early Sept
Coghill	303,307,310,314,322 414,421,422,430,432	Potential brood source	Late June-early Sept
Montague	741,744,745,746,749 770, 775	Genetic evaluation and remote release	Early July-mid Sept
Southeast	850,851	Genetic evaluation	Early July-mid Sept
Southwest	603,604,613,630,665 667	Genetic evaluation	Early July-mid Sept

Sampling Data Collection

1. Ground survey steams on a weekly basis throughout the period of adult return and spawning. Count number of live and dead fish.

2.Collect adult size (length) samples from 100 fish (50 each sex) during each survey.

3. Collect fecundity and egg size samples at or near the peak of spawning from -50 females.

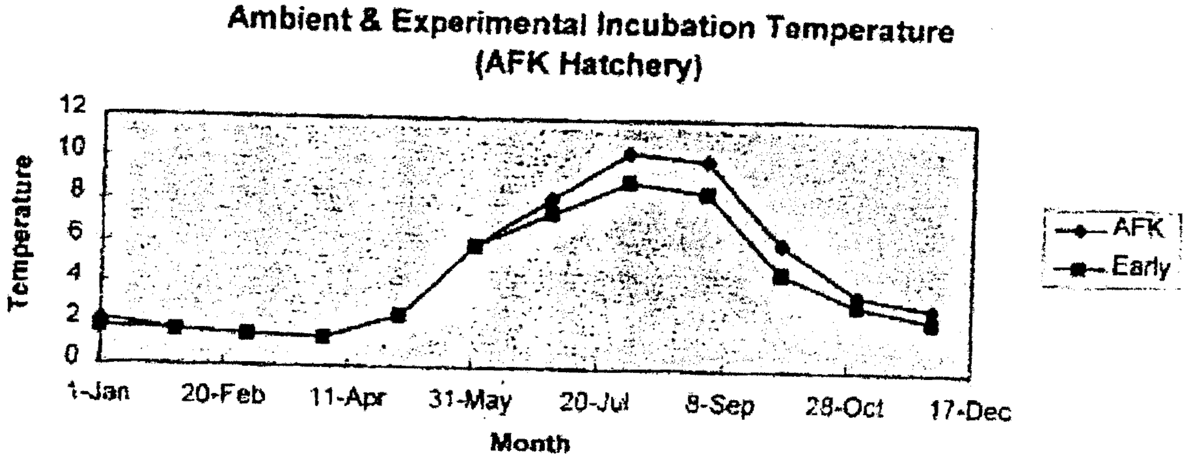
4. Collect genetic samples (muscle tissue) from a subset of the streams in each district (see Population Genetic Assessment of Gene Flow Study).

5. Install continuous recording thermograph (intergravel probe) on 7 streams identified for gene flow studies during initial survey.

Surveys will require two support vessels with 3 person crews. Support vessels will be equipped with a skiff or inflatable for transport to and from shore. Data collected from continuous recording thermographs will be utilized in the experimental gene flow studies (i.e. hatchery introductions). These data are needed to control the development rate of hatchery stock eggs before out planting to ensure that fry emergence occurs within the normal window of timing for the experimental stream.

b. Assessment of facility water supplies: Successful incubation of hatchery stocks requires matching the inherent biological characteristic of the donor population to the water supply of the facility. Characteristics such as the time of spawning and rate of embryonic development have evolved in response to the thermal environment of the natal stream (Brabb in 1987), and may not be suited to the conditions present in the hatchery water supply. For example, the embryos produced by early spawning populations found in cold water streams are less likely to tolerate the elevated incubation temperatures (i.e. > 12 C) often experienced by later spawning stocks. Moreover, the fry of such transplants are likely to emerge far earlier than the optimum time for their new environment. Similarly, embryos produced by late spawning populations introduced into cold water environment may not achieve the degree of development needed to emerge at the proper time.

The effect of differing water regimes on development are show below. The upper figure shows the average monthly water temperature for ASK hatchery (1977-1994) and simulated temperature regime for an early spawning pink salmon stock. The lower figure illustrates the cumulative temperature units that would be acquired during development under these conditions. A stocks that spawns in early July would accumulate ~ 1200 temperature units in its natal stream by the time of normal fry emigration in early to mid-April. In contrast, the same stock incubated under ambient temperature conditions at ASK would accumulate ~ 1200 temperature units by early January. Although it is likely that some temperature compensation would occur (i.e. rate of development increases at higher temperatures but the increase is not proportional to temperature), emergence in February to March would be much earlier than optimum.



The response of the donor population to the hatchery environment must be determined prior to any decision to develop it as a hatchery stock or for post-eyed incubation and remote release. This project will examine the feasibility of incubating eggs from an early spawning pink salmon stock (VFDA) and early spawning chum salmon stock (WINNIE) in a hatchery (ASK) that now supports a late spawning pink salmon stock.

Gametes to produce twenty-five mating pairs from an early spawning pink salmon stock (VFDA) and an early spawning chum stock (WINNIE) will be transferred to AK hatchery, fertilized on site, and incubated in vertical flow trays (Heath-Technica) to complete yolk absorption. Each pair will be divided into four lots (two treatments with replicates) to determine the the rate of embryonic development and approximate timing of spring emergence under ambient (control) and chilled (experimental) temperature regimes. The experimental temperature regime will be designed to simulate conditions in the natal stream of the donor population (figures above). Water temperature will be monitored daily, and egg and fry mortality at weekly intervals. Samples will be collected and preserved in 5% buffered fomalin from each lot at fertilization, hatching, and yolk absorption to measure size (wet weight) and yolk absorption efficiency, and periodically through incubation to monitor the rate of yolk absorption. Treatment effects on each variable will be compared to Analysis of Variance.

c. Near shore marine habitat evaluation: Growth and survival of salmon fry in near shore marine environment are closely related to temperature, food availability, and predation. Information obtained from EVOS funded SEA Investigations indicate that these conditions vary annually and regionally within PWS, and that much of this variations driven by physical oceanographic conditions in the Gulf of Alaska. More specifically, evidence suggests that surface and deep water circulation patterns provide a link between temperature and plankton abundance in the two regions, and that plankton abundance influences the intensity of predation through a prey switching mechanism. In years of low planton abundance, predator species such as walleye pollok appear to switch from feeding primarily on macrozooplanton to juvenile salmon, and that smaller salmon (>60 mm) experience higher rates of mortality. Moreover, data suggest that interannual variability in planton abundance may be greater in southern part of the Sound than in the north. Establishing the relationships among broad scale oceanographic processes and the near shore conditions that affect juvenile pink salmon productions a major objective of the DEW research, and will contribute important information for identifying release sites that will provide favorable conditions for growth and survival of hatchery fry.

This project will integrate with the sampling outlined in other investigations to assess physical and biological features of potential remote release sites, and identify salmon predator populations. Monitoring will focus on the temperature and salinity conditions, and zoo plankton abundance during the period of spring rearing (mid -March to mid-June), and abundance, composition and distribution of predators and wild juvenile salmon. Additional monoriting will be conducted to assess the timing, abundance and composition of adult migrations (early June to early September).

Three areas have been identified by the Prince William Sound Regional Planning Team that have practical potential for remote release of hatchery produced early pink or early chum fry: Naked Island and Montague Island (both species), Nelson Bay (early chum only). PWSAC has established a remote release site in Chalmers Harbor on Montague Island and has been conducting test fishing in the area since 19094. SEA Investigations 95320 are scheduled to sample each site 4 times per season (2 pre- and 2 post fry emigration samples). This project will be directed primarily toward evaluating marine conditions for juvenile salmon in the areas surrounding Naked Island and Nelson Bay.

Zoo plankton sampling will be conducted twice weekly from mid-March to mid-June. Samples will be collected with0.5 meter plankton net (0.25mm). Replicate 20 meter vertical tows will be taken at two locations at each site, preserved in 10 percent formalin and shipped to UAF for analysis. Temperature and salinity data will be recorded hourly using remote continuous recorder./ logger installed on site. Data will be downloaded to a laptop computer during each site visit.

Release strategies for hatchery salmon are directed toward timing the release to accretion of the zoo plankton forage base in the near shore environment. Releases are typically concentrated to 1-2 large events or spread across a period of 2-3 weeks. In addition to zoo plankton abundance, the outcome and impact of either strategy is affected by the concentration of wild salmon fry and predators at the time of release. Juvenile salmon sampling will occur weekly at each site during the period corresponding to the estimated optimated time of release based on increasing zoo plankton abundance. Sampling will be conducted using a beach seine at 6 hour intervals and at two locations at each study site. The number and species of salmon fry will be counted and recorded.

Predator abundance will be estimated following procedures outlined by SEA Investigation 96320E (Juvenile Salmon and Herring Integration). Two purse seine vessels will sample near shore habitat at each site in conjunction with beach seine sampling for juvenile salmon (i.e. weekly intervals corresponding to the period of fry release). Each vessel will sample with a small mesh purse seine (250 m x 30 m x 1.5 cm stretch mesh) in the upper 20 m in waters deeper than the beach seine sampling, and with a paired mid-water trawl (30m x 30m x 1.5 cm stretch mesh cod end) in the water column deeper than 20 m outside the beach seine area. A variable mesh gill net (150m x 1.5 -10cm stretch mesh) will also be fished in the near shore area with water depth < 20 m. Sampling will be conducted at 6 hour intervals. Processing will occur on board to determine species composition and abundance.

Test fishing for adult salmon Will be conducted from mid-June to late July, which will approximate the return timing of early pink and chum returns to PWS. Two purse seine vessels will sample eight survey locations at each site for two 12-hour periods per week. Nets will be 150 fathoms, 3 strip seines set on a right-handed hook haul and fished for 10 minutes. Each vessel will have one technician to record catch by species.

Methods, particularly the research and monoriting aspects, follow in concept a model for monitoring interactions of wild and hatchery salmon recently set forth by a international pane of salmon geneticist and conservation scientist convened by NINA (Norweg. Instit. Nature Res.0. They emphasize the necessity of monitoring a baseline of genetic and fitness (phenotypic) data, of understanding the extent of gene flow between stocks, and of studying the biological effect of gene flow through quantitative genetic analysis. The ADF&G recognizes that much of Genetics Policy is based on extrapolation of knowledge from other disciplines and encourages cooperative research efforts among governmental, university and private sectors (McGee 1995). Areas recommended for research include the potential for genetic improvement, such as timing parameters, assessment of the effect of introgression of genes from hatchery fish into wild populations, and establishing the impacts that result from introgression. This project will address some of these issues and contribute to improved management of pink salmon populations.

6. References

Brannon, E>L> 1987. Mechanisms stabilizing salmonoid fry emergence timing. Pup 120-124 In H.D. Smith L. Margolis, and C.C. Wood, Sockeye Salmon (Oncorhynchus Newark) Population Biology and Future Management. Can. J. Fish. Aq. Sci. 96.

McGee, S.G. 1995. The hatchery program and protection of wild salmon in Alasks: Policies and regulations. AK Dept. of Fish and Game. CFMDD.

Cooney, R.T. 1995. Sound Ecosystem Assessment (SEA)-An integrated science plan for the restoration of injured species in Prince William Sound. Draft 1994 final

report to the Exxon Valdez Oil Spill Trustee Council.

C. Contracts and other Agency Assistance

Technical support will include the services of:

- ~ PWSAC project management & fish culture staff
- ~ ADF&G biologist and technicians
- ~ University of Alaska geneticists
- ~ ADF&G pathologist
- ~ permitting agencies including ADF&G, Department of Army, Corps of Engineers, Department of Natural Resources
- ~ ADF&G otolith mark analysis lab

Contracts will be established for vessel charter to inventory and assess salmon stocks. Contracts will also be required or vessels chartered test fish potential remote release locations recommended for evaluations.

D. Location

This project will take place in Prince William Sound. Location of activities will vary dependent on the project phase. Early run time salmon stock inventory and assessment will occur principally in the Southeastern and Eastern districts. Wild stock assessment and test fishing will occur at Montague Island, Nelson Bay and Naked Island, as may future remote releases. Other activities including possible hatchery incubation and fry rearing will take place at hatcheries in PWS potentially including the Arim F. Koerning Harchery, on Evans Island in the Southwest District, and Wally Norenberg Hatchery on Esther Island near Port Wells.

Schedule

A. Measurable Project Tasks for FY98.

I & A

May 1-May 20:	Contract vessels and organize crews (I&A; Test Fish)
May 15-June 1:	Hire field technicians (6)
June 1-June 10:	Train field technicians
June 10-October 1:	Inventory stock baselines (census, phenotypes)

Test Fish

June 5- October 1: Test fish proposed remote release sites

Logistical Support

May 10-June 10:	Establish university support facilities at Evans Island
June 15-Sept 15:	Collect GFE and EEE stream samples
Junly 15-Sept 1:	Spawn and incubate BY97 eggs fir QG study
Oct 1-Dec 1:	Report

B. Project Milestones

Report of second year I&A results	December, 1998
Report of second year test fishing results.	February, 1999

C. Project Reports

April, 1999:	Annual report for FY98
Quarterly:	Quarterly reports as required.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Project 95093 is a multi-component program of research, restoration, monitoring and integration with more extensive programs already activated by the Trustee Council. In conjunction with 95093 program components to inventory wild salmon stocks, evaluate stocks for hatchery utilization, test fish remote release locations for presence of local or migrating wild stocks, and implement genetic studies to identify interactions between wild and hatchery fish, the program will draw directly on work being conducted by SEA Investigations. In this regard, oceanographic conditions will be evaluated at proposed remote release sites to assess physical (95320M Observation Physical Oceanography in Prince William Sound and the Gulf of Alaska) and biological (95320G SEA : Phytoplankton and Nutrients, 95320N SEA ZOO: The role of Zooplankton in the Prince William Sound Ecosystem,95320N Nekton-Plankton Acoustics)features of the environment that may affect salmon fry survival. Sampling will be conducted to identify salmon predator populations (95320E Juvenile Salmon and Herring Integration), and potential remote releases will be guided by results obtained from both 95320A Juvenile Salmon Growth and Mortality and 95320K Experimental Fry Release studies. Temporally and spatially directed SEA sampling will aid evaluating sites for selection of appropriate stocks and run timing that could be designated for release by the hatchery program.

In conjunction with the program to reduce harvest pressure on injured stocks, the otolith marking project (95320C) funded by the *EVOS* Trustee Council will aid both in season management of the fishery through detection, evaluation and more specific management of mixed stocks harvested in the fishery The Technology will also be utilized to support the evaluation programs related to straying, hybridization and genetic interactions between hatchery and wild stock pink salmon.

ENVIRONMENTAL COMPLIANCE / PERMITTING

Ak. Dept. of Fish and Game will conduct NEPA review. It is likely a categorical exclusion (CE) will be required for most field work which includes inventory and assessment, and test fishing.

Additionally, should shore based field camps be required to support genetic research, special use permits may be required if selected sites are within the Chugach National Forest.

PERSONNEL

Dr. Tim Linley, Project Leader
Vacant, Project Manager
Vacant, Project management assistant
Vacant, Field Biologists / technicians (6)
Vacant, Test fish technician
Vacant, Fish culturist II

Robert J. Henrichs

Robert J. Henrichs, President
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EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

PROPOSAL FOR THE NANWALEK HATCHERY

The Nanwalek IRA Council would like to submit a proposal for funds to build a hatchery in the village of Nanwalek. This hatchery would be able to hatch and care for up to 1.5 million Sockeye Salmon eggs taken from local stock.

The English Bay River Sockeye Salmon was depleted from approximately 45,000 return adult salmon to a low of about 3,500.

The hatchery would enhance an ongoing successful Nanwalek Salmon Enhancement Project since 1991. The goal of the project is to raise 1 million eggs in the local lake system in a net pen rearing system and release then into the lake in late fall and to have a return of the Sockeye salmon of 100,000 adults returning to the English Bay River System. In 1997 the expected return of 44,000 adults. At the present time the project is having the eggs hatched at a hatchery in the nearby village of Port Graham, Alaska. After the eggs are taken they are flown over to the village of Port Graham and transferred into the hatchery.

The village already has a large building that is used for storage and is willing to used this for a hatchery for the incubation of the local Sockeye Salmon eggs to be used in the current salmon enhancement project. The building is high enough for a loft office space and already has a concrete slab install as the flooring. The work that would need to be performed would be to renovate the current building in Nanwalek and to purchase and install all of the hatchery equipment, utilities, and inside plumbing and electricity. The building of the hatchery would employee local residents and then the operation of the hatchery would also add additional employment.

The Native Village of Nanwalek has been working very hard to enhance the Sockeye Salmon run for subsistence and commercial fisheries to be reopened since they had been closed since 1989. As of 1995, when a short season was opened late in the sockeye run and in 1996 when the fishery opened with a regular opening in June the village has experience growth with the adult sockeye salmon coming back in larger numbers.

The following is an estimate of what the installation and start up cost complied by the Nanwalek Salmon Enhancement Project Biologist, Paul McCollum.

Start Up:

Incubators and layout	$10,000.	
Water line labor and materials	20,000.	(8" PVC or polyethylene w/ insulation and intake)
In building plumbing	5,000	
Electrical Service	5,000	
Computer Alarm System	15,000	
Set up construction	10,000	
Automatic generator system (20kw)	12,000	
Furnace system	2,000	
Barge and shipping	2,000	
Sub Total	$81,000	

Annual Operational Costs:	
Building and Property Lease	
Staff and Crew estimate	$50,000
Materials and upkeep	20,000
	$70,000

The staff would consist of one full time manager and two seasonal culturists (May 1 to Nov 1, then as needed, probably 2 months equivalent).

A hatchery in the village to incubate the local sockeye stock would be a great benefit towards the village and the salmon project as well as adding pride within the community to be taking care of the local stock. In the village there has also been interest within the young people in the fishery field and someday the youth of the community will take over the running of the hatchery and their natural resources.

Prepared by: Carol Kvasnikoff; Nanwalek Salmon Enhancement Coordinator on behalf of the Nanwalek IRA Council

NANWALEK SALMON HATCHERY

NANWALEK IRA COUNCIL
P.O. Box 8028
Nanwalek, AK 99603
907-281-2274

Nanwalek IRA Council

____
Vincent Kvasnikoff, Nanwalek IRA Council President

ABSENT
____
Emilee Swenning Vice President

____
Sally Ash, Secretary/Treasurer

____
Nancy Radtke, member

____
Nancy Yeaton, member

____
Lisa Moonin, member

ABSENT
____
Priscilla Evans, member

Date 15 April 1997

98336

FROM : L PHONE NO. : 907 486 3361 APR. 15. 1997 12:51PM P 2

KODIAK TRIBAL COUNCIL

98336

P.O. BOX 1974
Kodiak, Alaska 99615

PHONE (907) 486-4449
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April 14, 1997

RECEIVED
APR 15 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Molly McCammon, Executive Director
Exxon Valdez Trustee Council
645 G Street, Suite 401
Anchorage, AK 99501-3451

Dear Molly,

Enclosed is a brief outline of a four-phase proposal that the Kodiak Tribal Council is submitting for consideration of funding for the 1997-1998 Restoration project proposal year. We are calling our project "Subsistence Restoration" through community participation.

Overview

As a result of the Exxon Valdez Oil Spill in 1989, the disruption of the commercial fishing industry is well documented. The Kodiak island area implemented a "zero-tolerance" policy which was defined as no fishing, and no selling of product. The documented decrease in subsistence activities has also been well documented through the Alaska Department of Fish and Game Subsistence Division. The disruption in subsistence activities actually resulted in more than a one year interference. In fact, for several years after the oil spill the coastal subsistence users in and around Kodiak were fearful that their subsistence foods were still contaminated with toxic chemicals that were released from the oil. We are aware of the many genetic studies that are being funded by the Trustee Council to determine whether oil does in fact have long-term implications for many of our subsistence foods and resources.

During the spill and for several years after EXXON employed many of the local residents to assist in clean-up efforts. People worked long hours cleaning up oiled debris. Most people were unable to participate in normal subsistence activities for many years which includes hunting and harvesting natural resources, but more importantly, passing those traditions and skills on to their children or other children in the community who may be without a male role to teach them the proper care of the resource. Proper care includes humane methods of taking the resource, skinning of the resource, care of the hide, and preservation and storage of the food item.

The Kodiak Tribal Council is noticing that as a result of the many years of disruption surrounding the subsistence resources, that the children who would have normally been engaged in subsistence activities lack many of the proper knowledge and skills surrounding harvesting subsistence resources.

Proposal

The Kodiak Tribal Council is requesting that the Trustee Council fund a four-phase project. The underlying objective of the project is to promote restoration of injured resources that were injured by the oil spill. This will be accomplished through instruction in responsible resource use and developing local management plans to protect and manage injured resources.

An important component of this project will be to encourage traditional uses of the subsistence resource by promoting responsible animal usage for first subsistence foods, and secondly promoting traditional customs of using by-products for clothing and/or arts and craft projects. Our goals include protection of resources by instruction in fully utilizing all parts of subsistence resources. We believe this will lead to protecting subsistence resources through traditional means of resource management.

Not only will this proposal provide a vehicle for encouraging local awareness and management plans, it will also unify the communities and assist in restoring the human aspects of practicing subsistence gathering methods which were obviously hampered during and after the spill. Dr. Kai N. Lee in his address at the 1997 Restoration Workshop clearly pointed out that restoration is taking place now through research and land acquisition. He did note that after the "money runs out" that people will continue to live and subsist in coastal communities in Alaska. Dr. Lee pointed out that the Trustee Council might be able to address some human concerns and restore some human injustices through funding activities which affected people. We also agree that one of Alaska's greatest resources are its people, it's traditions and customs. Our project encompasses the human aspect and proposes to address restoring not only subsistence resources but also the restoration of our people's traditional lifestyles.

Each phase has been summarized and then more specific goals and objectives are identified and listed.

Phase 1 Village regionalized hunting classes in each community. Students will participate in a traditional subsistence hunt and then learn proper skinning techniques. Local traditional hunting experts will be utilized.

A. Proper hunting tools suitable for humane take of varying species.
B. Seasons and time of year for taking species which will identify mating seasons, age of animals, prime of year for hides.
C. Hide skinning, care and preservation tools and techniques.
D. Meat cutting, cleaning and aging techniques.

Phase 2 Safe food preservation techniques will be taught through hands on learning experiences which may include a broad range of techniques from jelly-making to canning and/or smoking fish.

A. Health benefits of specific foods.
B. Size and proportion according to RDA.
C. Hands on canning instruction for proper preservation of meats and/or berries. Canning vs. Bottling, venting, sterilization, storage. Smoking techniques.
D. Smoking techniques, brines, animal avoidance.

Phase 3 Local traditional artists will be utilized to instruct in the use of subsistence resource by-products. For example, furs from marine mammal hunts will be utilized to instruct in traditional skin sewing of garments. Other subsistence by-product will be utilized in order to instruct in the full utilization of animal take. Traditional ornamentation will also be a topic of instruction. Beading has long been a traditional method of identifying the Alutiiq culture.

A. Skin preservation and storage techniques.
B. Skin cutting and traditional sewing techniques. A garment will be produced at the end of this instructional class which may be displayed at the Alutiiq Museum.
C. Practical uses of by-products of subsistence resources.
D. Traditional beading and ornamentation on hides and/or skins.

Phase 4 A regional subsistence round table meeting will be held in Kodiak to discuss co-management issues affecting subsistence resources. Two representatives from each community will meet in Kodiak for a two day meeting to discuss how to develop village-specific management plans in order to ensure that the restoration of subsistence resources is consistently being practiced. A framework for these local-based management plans exist so community leaders will not have to invent the wheel but will be able to discuss local subsistence issues and adopt the management plan to reflect the individual needs of each community.

A. Resource management and regulations State v. Federal
B. Co-management of marine mammals for local communities.
C. The product will include a co-management plan for one or more resources that each community uses on a regular basis.

Subsistence Restoration
Budget

Kodiak Tribal Council Project Coordinator for proposal	$24,000
Hunters Contract for two-day excursion for each of 7 villages (including Kodiak)	16,000
Sewers Contract with local traditional skin sewers for week-long instruction in each village(includes travel)	10,000
Beaders Contract with local traditional beaders or artisans for week-long instruction in each village (includes travel)	10,000
Food preservation specialists Contract with instruction for instruction in traditional food preservation techniques (no travel because local food techniques will come from within villages)	8,000
Materials and supplies Includes cost of tanning hides, arts and crafts supplies.	10,000
Travel and related expenses 2-day Subsistence meeting. Includes travel & meals for two reps from each village.	15 ,000
Administrative expenses Phone, fax, paper, long distance, shipping, other office supplies. Video tapes for recording. (Under 10%)	7,290
Total	$100,290

Time line

August - February	Hunting skills
July - November	Food preservation skills
January - April	Skin sewing and arts/crafts projects
January - April	Subsistence Round table

Summary

The benefit of funding a proposal as outlined above would be numerous. Communities would join in re-learning skills lost during the oil spill which may not otherwise be learned. Proper take and preservation of the subsistence resources could be reinforced so as to ensure that each animal was used to the fullest extent possible. The Kodiak Tribal Council would select respected and experienced hunters, food preservation specialists and skin sewers to pass on traditional skills. The Kodiak Tribal Council will work with the Alutiiq Museum to offer historical information as well as culturally relevant material in combination with the curriculum that will be taught. Skills and traditions that might have been otherwise lost as a result of the oil spill will be restored to individuals who were prohibited from gathering the resources, teaching the skills, and/or engaging in natural subsistence practices during the spill. Traditional sewn clothing and/or foods will be on display at the Alutiiq museum for all people in Kodiak and tourists to learn from. Special traditional clothing produced as a result of this project will be donated to the Kodiak Alutiiq dancers that will be worn during traditional dance performances for public and tribal members.

We hope that you will seriously consider our proposal as a way of restoring and enhancing subsistence knowledge, skills and activities that were directly and negatively impacted by the oil spill and continuing public perceptions that the resources were and still are damaged due to toxic substances. This project will be a method of once again encouraging the use of subsistence resources, and teaching the proper use and skills surrounding the take of the resources. Our project will be directed at those individuals who feel they missed out on these skill-building activities during the oil spill.

If you need additional information or would like us to go into more specific detail on this proposal please feel free to contact me at (907) 486-4449. Thank you.

Sincerely,

Margaret Roberts
Kodiak Tribal Council President

98337

Project Title: Archaeological Forage Fish

Project Number:	~~98007D~~ 98337
Restoration Category:	Restoration management actions; archaeology/forage fish
Proposer:	Chugach National Forest
Lead Trustee Agency:	USFS
Duration:	11.5 months
Cost FY 98:	$143,100
Geographic area:	Prince William Sound
Injured Resource/Service:	Forage fish and related prey species

RECEIVED
APR 15 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT

Funding is requested for processing bulk samples from archaeology site SEW-430 on Eleanor Island to separate, identify, and quantify forage fish skeletal remains. Preliminary processing of one such sample from this rock shelter has yielded over 150 well-preserved skeletal elements of sand lance, small greenling and small sculpin. More forage fish remains are expected to be found during processing of the other bulk samples from the 4000 years of human occupation represented by the deposits at the site. The identification process will include preparing modern comparative skeletal specimens, to reduce the need to travel to other locations to use comparative collections. The project goal is to provide identified, dated skeletal specimens of a variety of forage fish, representing populations from 500 to 4000 years old, to biologists seeking baseline ecological and climatic data for Prince William Sound.

INTRODUCTION

The proposed project addresses the potential availability of biological specimens in dated archaeological samples. Archaeologists working in 1993 at a rock shelter midden on Eleanor Island, within the oil spill area, collected 93 bulk samples which range in age from 500 to 4000 years old. The one sample which has been partially processed has yielded over 150 skeletal pieces of sand lance, small greenling and small sculpin, species of interest to biologists studying forage fish to learn more about birds and animals in higher trophic levels. Given the good faunal preservation at the site, from which cormorant, scoter, loon, canada goose, several Anatidae, butter clam, Pacific little neck, cockle, mussel, Oregon triton, limpet, chiton, seal, sea lion, porpoise, and mink have been identified, it is likely that additional fish remains are present in other bulk samples. The proposed work is the processing, identification, and preliminary analysis of the other bulk samples to provide data for biologists interested in pursuing genetic,morphologic and biogeographical baseline studies of forage fish, as well as climate changes, during the late Holocene.

NEED FOR THE PROJECT

A. Statement of the Problem

Since 1989 biologists have been studying modern populations of Marbled murrelet, Pigeon guillemot, Kittlitz's murrelet, herring, and forage fish with respect to injuries resulting from the *Exxon Valdez* Oil Spill, and restoration measures for injured species. At the January 1997 EVOS workshop, a need was expressed by a number of biologists to study the larger ecological picture in Prince William Sound, incorporating information from previous centuries or millennia where available. Forage fish and herring skeletal remains are known to be present in several archaeological sites within and just east of the oil spill area. The archaeological sites vary in age, but all include late Holocene fauna from some portion of the past 4000 years. As-yet unanalysed bulk samples, collected during recent excavations, exist for four sites, and are likely to contain additional remains.

First discovered by a biologist working for the state of Alaska on land otter studies, archaeological site SEW-430 is located on the west side of Eleanor Island in Prince William Sound, about 10 meters above the high tide line on the edge of a steep eroding bluff. It is somewhat protected by a rock overhang. The site depth varies from less than one meter to close to two meters deep, depending on the portion of the site, and is about 30 meters long and 4 to 5 meters wide. The site is believed to represent about 4000 years of intermittent human use. It may have also been used from time to time as a scat site by land otters. Charcoal samples have yielded uncalibrated dates of 3970$\pm$150, 3770$\pm$70, 2880$\pm$160, and 700$\pm$80 radiocarbon years Before Present (BP). Over 100 additional charcoal samples were collected during the course of an excavation by a Forest Service crew in 1993. They remain unanalysed, and offer the possibility of more specifically dating the various remains in the site.

Bulk samples from the site were recovered during the 1993 excavation of five 1 x 1 meter test units. The work was conducted by natural strata where possible, and by 5 cm thick arbitrary layers where natural stratigraphy was not distinguishable. The deposits varied from five distinguishable layers within 1 meter depth in the northwest part of the site, to well over a meter of midden with less easily distinguished strata in the northeast and central portions of the site. During the course of the excavations, bulk samples of 3,125 cm^3 were collected from each unit. A 25 x 25 cm sq. corner of each unit was designated for bulk sampling. To obtain each bulk sample, the designated corner was manually excavated 5 cm, during the course of which large artifacts and fauna were removed. The rest of the sample was bagged and labeled with its provenience for later examination.

Close to 100 bulk samples were collected, a total of about 300,000 cm^3 of material. Laboratory processing of a portion of one bulk sample has yielded over 150 sand lance and sculpin skeletal elements. While it is suspected that the other samples contain the remains of these and other species, the samples must be processed to recover any forage fish skeletal elements that may be present.

Identification of recovered elements will be necessary to render the remains useful to other researchers. A fairly complete range of comparative specimens are available at the University of Victoria, British Columbia. The Anchorage Consortium of Zooarchaeologists and University of Alaska-Anchorage comparative collection is limited. However, it should be possible to process comparative skeletal specimens in Anchorage, to use for identification of the bulk of the expected remains.

B. Rationale/Link to Restoration

Restoration projects to date have studied modern biological populations injured by the oil spill. Recent research trends emphasize understanding modern populations in light of their Holocene history, particularly in relation to known periods of climatic change. Dated biological material from archaeological sites can be related to current climate research, such as NOAA's oxygen isotope studies for sea surface temperature changes. A variety of relevant studies, including genetic, biometric, and biogeographical, will be possible with the archaeological specimens.

C. Location

The project will be undertaken in Anchorage. The project's benefits will be realized in Prince William Sound.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Community members may be contacted for assistance in procuring fish to process for comparative specimens. The poster at the annual EVOS Restoration Workshop and the annual report for this project will make information available to the public. Public presentations of the recovered information will be arranged through the community involvement facilitator if is determined that there is interest in the results at this identification stage.

PROJECT DESIGN

A. Objectives

The project objectives are to process 93 archaeological bulk samples for skeletal remains of forage fish, identify the remains to the lowest possible taxa, and enter the results in a computerized database to be made available to researchers working on restoration of injured biological resources.

B. Methods

The samples will be processed by hand in a laboratory situation. Each will be divided into thirds, with one portion being dry-sorted, the second being floated or water-screened, and the third being curated for possible later examination.

Fish to process into comparative specimens will be obtained from ADF&G or local fishermen and prepared in the lab facility concurrently with sample sorting.

Skeletal elements recovered during the process will be identified using prepared comparative skeletons and the Anchorage Consortium of Zooarchaeologists comparative collection. The identifications will be recorded in a computerized faunal database.

After completion of the project, comparative specimens will be donated to the Anchorage Consortium of Zooarchaeologists comparative collection, housed at UAA. Specimens in this collection are for research and educational use.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

No contracts are anticipated as necessary to accomplish this project. ADF&G will be contacted regarding obtaining specimens, however Forest Service will be the only agency involved in completing the proposed work.

SCHEDULE

Because the remains present in each sample may vary, processing time may also vary. The following schedule is only an estimate.

A. Measurable Project Tasks for FY 98

October 1, 1997-June 30:	Sort samples and prepare comparative skeletal specimens
January 15-24 (3 of these days):	Attend Annual Restoration Workshop; poster describing project and progress
July 1-August 20:	Identify remains, compile computerized database

B. Project Milestones and Endpoints

January 1:	31 bulk samples sorted, preparation of 10 comparative specimens
March 1:	62 bulk samples sorted, preparation of 20 comparative specimens
July 1:	all bulk samples sorted, preparation of 30 comparative specimens
August 20:	completion of identifications and finalization of computerized database

C. Completion Date

The project will be completed in FY98.

PUBLICATIONS AND REPORTS

The resulting information may result in publication of a paper in FY99.

PROFESSIONAL CONFERENCES

The resulting information may result in presentation of project results at a professional conference in FY99.

NORMAL AGENCY MANAGEMENT

The entire scope of this project is outside the Forest Service's normal management activities. The Forest is only involved in research as it may pertain to management obligations. The biological interest in this project has been generated by the need to understand more about past populations of forage fish and related species which were injured in the Oil Spill. The data expected to be generated from this project will assist biologists in further understanding the progress of the restoration effort for several injured species.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Although SEW-430 was first recorded and dated during the Exxon Cultural Resource Program following the Oil Spill, the subsequent excavations which resulted in the recovery of the SEW-430 bulk samples were funded through a Forest Service management project to determine the nature and significance of the site, and assess its state of erosion. That project resulted in the curated bulk samples, which account for a significant amount of excavation work. The existing Forest Service heritage program does not dovetail with this project. The Forest archaeologists and biologists perform fieldwork and related analysis and report writing on a project funded basis.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Not applicable.

PROPOSED PRINCIPAL INVESTIGATOR

Linda Finn Yarborough
Assistant Forest Archaeologist
Chugach National Forest
3301 C St., Suite 300
Anchorage, AK 99507

PRINCIPAL INVESTIGATOR

The Principal Investigator for the project is a zooarchaeologist with degrees from SUNY Binghamton, University of Toronto and University of Wisconsin-Madison. She has experience in species identification of skeletal remains of north Pacific fish, and preparation of comparative specimens. She has been responsible for the excavation and curation of the samples, and will be responsible for analysis of archaeological, zoological, botanical and soil information present in the samples. Ms. Yarborough has been a Principal Investigator on past EVOS archaeological sites restoration projects. She meets the professional qualifications standards specified under the Secretary of the Interior's Guidelines for Archaeology and Historic Preservation. She will be responsible for supervising bulk sample sorting, comparative specimen preparation, and identification of specimens.

1998 EXXON VALDEZ TRUS OUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$68.0						
Travel		$0.0						
Contractual		$58.0						
Commodities		$2.8						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$128.8		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$14.3						
Project Total	$0.0	$143.1						
Full-time Equivalents (FTE)		1.4						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998

Prepared:4/15, K.Holbrook of 4

Project Number: ~~98007D~~ 98337
Project Title: Archaeological Forage Fish
Agency: US Forest Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/15/97

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

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1998
L.Yarborough	Archaeologist	GS-11	5.7	5.2		29.6
Vacant	Arch Tech	GS-5	11.3	3.4		38.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		17.0	8.6	0.0	
					Personnel Total	$68.0

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

1998

Project Number: 98007D
Project Title: Archaeological Forage Fish
Agency: US Forest Service

FORM 3B
Personnel
& Travel
DETAIL

Prepared:

4/15/97

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

Contractual Costs:		Proposed
Description		FY 1998
Wet lab	9 months (140 sq ft)	50.4
Dry lab	2 months (140 sq ft)	7.6
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$58.0

Commodities Costs:		Proposed
Description		FY 1998
lab equip, (petri dishes, plastic bags, specimen boxes, 2 microscope, chemicals, small freezer, gloves, misc		2.6
Shipping		0.2
	Commodities Total	$2.8

1998

Project Number: 98007D
Project Title: Archaeological Forage Fish
Agency: US Forest Service

FORM 3B
Contractual &
Commodities
DETAIL

Prepared:

4/15/97

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

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

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1998

Project Number: 98007D
Project Title: Archaeological Forage Fish
Agency: US Forest Service

FORM 3B
Equipment
DETAIL

Prepared:

98338

Survival of Adult Murres and Kittiwakes in Relation to Forage Fish Abundance

Project Number:	98 338
Restoration Category:	Research (new)
Proposed By:	U.S. Geological Survey (PI- John F. Piatt)
Lead Trustee Agency:	DOI-BRD
Cooperating Agencies:	DOI-FWS
Duration:	3 years
Cost FY 98:	$76,000
Cost FY 99:	$124,000
Cost FY 00:	$45,000 (data analysis, reporting)
Cost FY 01	$0
Cost FY 02	$0
Geographic Area:	Cook Inlet, Gulf of Alaska
Injured Resource:	Multiple resources

RECEIVED
APR 1 5 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT

Some seabird populations damaged by the *Exxon Valdez* oil spill continue to decline or are not recovering. In order to understand the ultimate cause of seabird population fluctuations, we must measure productivity, recruitment, and adult survival. Current APEX studies are focused on measuring productivity only. Recruitment measurement demands an unrealistic study duration. We propose to augment current studies in lower Cook Inlet that relate breeding success and foraging effort to fluctuations in forage fish density by using radio telemetry (contingent on pilot work) and banding to quantify the survival of adult common murres and black-legged kittiwakes.

INTRODUCTION

Some seabird populations in the Gulf of Alaska have undergone marked fluctuations during the past few decades (Hatch and Piatt 1995; Piatt and Anderson 1996), including periods of decline or non-recovery. Ultimately, the ability of injured or declining seabird populations to recover depends on: 1) breeding success, or productivity; 2) fledgling survival and subsequent recruitment; and 3) overwinter survival of adults (Harris and Wanless 1988). Without concurrent measurement of at least two of these three parameters, it is difficult to determine which factor is limiting a population's recovery.

Mechanisms that regulate seabird populations by influencing productivity, recruitment, and adult survival are poorly understood, but food supply is clearly important (Cairns 1992). Studies sponsored by the *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) in 1995 and 1996 (APEX, project no. 98163) have shown linkages between food supply and population fluctuations. Exactly which parameters of reproductive strategy are driven by food supply, and so drive population fluctuations, remains unclear. To date, APEX has focused work on forage fish availability and its relationship to productivity.

We propose to determine the overwinter survival of adult common murres (*Uria aalge*) and black-legged kittiwakes (*Rissa tridactyla*), using a combination of radio telemetry and banding at two of the colonies (Fig. 1) currently being investigated by APEX (Project 98163M). Results of 1996 work show clear differences in prey availability between the two colonies, with forage fish scarce around Chisik Island and rich around Gull Island. Both species must work significantly harder at Chisik to provide food to their chicks (Fig. 2). This difference appears to be dramatically expressed in sharply reduced kittiwake production at Chisik Island (Fig. 2). Realizing that kittiwake populations have been steadily declining at Chisik while increasing at Gull (Fig. 3), one might be tempted to conclude that weak productivity and recruitment are driving the Chisik kittiwake population declines. However, while murres have had equal productivity at Chisik and Gull (Fig. 2), the Chisik Island murre population has declined at an even greater rate than the kittiwake population.

From these data we conclude that the murre population decline at Chisik Island and concurrent increase at Gull Island may be attributable to differences in adult survival rates. Measurement of survival rates, in coordination with APEX's focus on food supply and colony productivity, should help to more completely resolve the mechanisms underlying seabird population fluctuations, particularly for those species such as murres that are able to buffer against periods of food shortage by increasing foraging effort (Burger and Piatt 1990; Irons 1992).

Our proposed research will measure adult survival of both murres and kittiwakes at Chisik and Gull Islands. We will use a combination of radio telemetry (contingent on successful pilot work-see Methods) and conventional banding/resighting methods to establish indices of survival for each species and island. Working in collaboration with the CISeaFFS component of the APEX project, we will compare survival between colonies in relation to breeding success and forage fish abundance. The proposed work will enhance our understanding of the relationships among survival, reproduction, and foraging in kittiwakes and murres in lower Cook Inlet. In a broader context, our research will clarify the mechanisms and limiting parameters underlying natural population declines or the failure of injured populations to recover.

NEED FOR THE PROJECT

A. Statement of the Problem

Research has provided few clear examples of how seabird population biology is affected by changes in prey availability (Hunt et al. 1991). Consequently, it has been difficult to understand the non-recovery of some EVOS-damaged seabird populations because natural changes in forage fish stocks may have also contributed to their decline. The picture is further complicated by our inability to pinpoint which aspect of population biology ultimately drives population fluctuations. To determine the cause of population declines or non-recovery, the population's productivity, recruitment, and adult survival should be measured concurrent with evaluation of available food supply (Cairns 1992).

Current EVOSTC-funded work (APEX, project no. 96163M) is measuring productivity and foraging differences of seabirds in response to fluctuating prey availability. Preliminary results from research conducted in lower Cook Inlet show correspondence in some species between productivity and forage fish abundance available to breeders. There is no correspondence, however, in species such as the murre which are able to increase foraging effort in response to decrease in forage fish abundance (Burger and Piatt 1990). Differences in recruitment and/or adult survival are thus implicated as important determinants of some population fluctuations. Yet their relative importance has not yet been established by EVOSTC researchers, despite past work which has shown that variation in either recruitment or adult survival could obscure or even offset population fluctuations apparently driven by productivity differences (Hudson 1985).

Since murres and kittiwakes do not commence breeding until they are several years old (Hudson 1985; Aebischer and Coulson 1990), it is not feasible to measure recruitment in seabird populations within the time frame required by EVOSTC funding. Measurement of adult overwinter survival has not yet been studied within a complete ecological framework, and has been identified by APEX reviewers as an important topic for expanded research in pursuit of understanding population fluctuations and recovery.

B. Rationale

Population changes are continually being driven by natural ecosystem changes, and are occasionally driven by anthropogenic perturbations such as the *Exxon Valdez* oil spill. In order to separate natural population fluctuations from anthropogenic population changes, we must have a complete understanding not only of the factors which drive population changes (e.g. change in prey availability) but also of the population biology parameter which is most altered by those driving forces. Chick productivity in relation to varying prey availability is currently being studied, but cannot explain all observed population trends. It is not feasible to measure chick survival and recruitment. Therefore, to assess the potential for recovery of seabirds affected by the *Exxon Valdez* oil spill by pinpointing the cause of population trends, a comprehensive study of adult survival and its relationship to prey availability is required.

In collaboration with the ecosystem-based study of seabird foraging conditions and breeding biology currently being conducted by APEX in lower Cook Inlet (project no. 98163M), we have a unique opportunity to assess not only the role of adult survival in seabird population fluctuations, but also the suspected linkage between foraging effort during the breeding season and adult survival. By choosing species with different long-term breeding strategies (kittiwakes maintain investment in reproduction at relatively constant level despite variation in food supply; murres strongly adjust reproductive effort in relation to prey availability) we will address questions raised by ongoing APEX work that shows linkage between prey availability and population fluctuation in some species (kittiwake) but not in others (murre).

Our proposed research has important foraging and time-budget components ancillary to measurements of survival. Refined understanding of foraging effort in relation to food supply will further our understanding of the costs of breeding in murres and kittiwakes. Stress induced by increased foraging effort in response to poor foraging conditions may explain variation in adult survival.

C. Location

The proposed research will be undertaken in lower Cook Inlet, Alaska. The project's benefits will be realized throughout the EVOS area, in the form of enhanced understanding of seabird population trends and recovery mechanisms. Homer, Alaska is the only community that may be directly affected by the proposed research (as detailed below).

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Gull Island in Kachemak Bay is owned by the Seldovia Native Association (SNA). Limited subsistence use occurs during summer, with occasional egging and harvesting of juvenile birds (Fred Elvsaas, pers. comm.). It is also a major tourist attraction for visitors to Homer. Permission to work on and around the island has been obtained under the provision that annual reports of findings be made available to the SNA. We also plan to inform the local tour boat operators about our activities so that our presence at the island can be explained to visiting tourists. Chisik Island is managed by the Alaska Maritime National Wildlife Refuge, and we will employ tourist charter vessels from Homer to support field work there. Chisik Island supports a small, seasonal fishing community and we will inform the summer residents about the purpose of our activities. Every attempt will be made to include local residents in the pool of applicants considered for volunteer positions related to the project. Whenever possible, equipment and other resources will be acquired locally in the Homer area. Traditional and local knowledge will be sought from fishermen and other residents, particularly on the topic of seabird foraging patterns.

PROJECT DESIGN

A. Objectives

Survival Component

1. To establish indices of adult common murre overwinter survival at Gull and Chisik Islands using radio telemetry.

2. To determine adult common murre and black-legged kittiwake overwinter survival rates, using conventional banding and resighting methods.

3. To relate differences in common murre and black-legged kittiwake overwinter survival to differences in prey availability and foraging effort during the breeding season.

4. To evaluate and compare the cost-effectiveness and precision of banding and radio telemetry as tools to measure adult common murre overwinter survival.

Control Component

5. To assess the impact of radio transmitter attachment on breeding and foraging performance of common murres.

Foraging Component

6. To characterize the foraging patterns and ranges of breeding common murres using radio telemetry, and examine their relationship to prey availability.

7. To determine the daily activity budgets of common murres using radio telemetry, and investigate their relationship to prey availability.

B. Background

To test our primary hypothesis- that adult common murre and black-legged kittiwake overwinter survival is related to prey availability and foraging stress during summer- we need to obtain measures or indices of overwinter survival concurrent with measures of prey abundance and distribution. Data on prey (forage fish) abundance and distribution will be obtained via coordinated efforts with EVOSTC-funded projects 96163M (APEX) and 97306 (Sand Lance Ecology). We will collaborate with Dr. Alexander Kitaysky (University of Washington, Dept. of Zoology, FY 98 proposal submitted to EVOSTC) to further investigate the relationships among stress, reproduction, and survival.

We will conduct the proposed research at Chisik and Gull Islands, lower Cook Inlet (Fig. 1). Chisik Island has relatively low prey availability within typical murre/kittiwake foraging, while Gull Island has high prey availability (Piatt unpubl. data). The Chisik Island populations of both murres and kittiwakes have shown steady declines over the past two decades, in contrast to the

Gull Island populations which are expanding (Fig. 3). Ongoing APEX work has shown a significant relationship between breeding success and foraging effort for kittiwakes, but not for murres (Fig. 2). Both species show increased foraging effort with decreased prey availability, but it appears that murres have a greater range of foraging effort within which they can still successfully produce chicks, as indicated by past studies (Burger and Piatt 1990). This raises the question: Is there a delayed or hidden cost to successful breeders that have had to "work harder" to raise their chicks? One way such a cost may be expressed is in decreased annual adult survival.

Measurement of survival:

Adult overwinter survival in seabirds has typically been measured by intensive banding and resighting programs (Harris and Wanless 1988; Aebischer and Coulson 1990; Hatchwell and Birkhead 1991; Hatch et al. 1993; Sydeman 1993). A suite of potential confounding factors (loss of bands, emigration, intracolony movement, observer failure to see marked birds) complicate survival estimates based solely on banding (Harris and Wanless 1988). Models have been developed which account for some of these problems (Pollock et al. 1990), but uncertainties remain. Adult common murre survival is particularly difficult to measure with bands, due to the murre's compact body posture while at the nest site. Bare rock nest sites and the relatively chaotic colony structure typical of murres further hamper individual and nest monitoring. Reliance on a banding study may introduce sources of error (e.g., more intracolony movement and consequent missed birds at Gull Island, with its denser aggregations of murres compared to Chisik Island) that would obscure actual differences in survival rates. Furthermore, precise survival estimates based on banding are ideally generated by multi-year studies, due to evidence that adult murres sometimes skip one or more years of attempts at breeding (Hudson 1985)

Why use telemetry?

Contingent on successful FY 97 pilot work (using support from outside the EVOSTC), we propose to use VHF radio telemetry as a tool to measure adult murre survival, while simultaneously using conventional banding methods to measure adult survival of both common murres and black-legged kittiwakes. We propose to use telemetry on murres but not kittiwakes because 1) using telemetry on both species would require unrealistic funding, personnel, and effort, and 2) banded murres are more difficult to resight than kittiwakes. Radio telemetry has several important advantages:

1. An index (to show relative difference) of survival will be generated in 1-2 years of study
2. Birds moving within the colony will not be missed.
3. Birds attending the colony but not attempting to breed are more likely to be relocated.
4. Birds emigrating to nearby colonies are more likely to be discovered.
5. Ancillary data on foraging and activity budgets.

Radio telemetry does have disadvantages:

1. High initial cost for transmitters, and high costs for aerial relocation surveys.
2. Possible adverse effects on birds resulting from transmitter attachment.
3. Radio failure may result in underestimated survival rates.

We believe that the advantages of using radio telemetry as a survival measurement tool outweigh its disadvantages. Indices of survival will be rapidly generated, precise, and without between-colony bias, facilitating accurate between-colony comparison with which to test our primary hypothesis.

Banding and resighting will be an equally important part of our proposed research. We will be able to directly address the question of differences between survival measurement methods by carrying out the proposed radio telemetry study at the same colony and the same time as a conventional banding study. Given successful telemetry work, we will have a high-precision data set which will justify or disprove the survival estimates generated by the longer-term banding work (pers. comm. D Esler, NVP project no. 98025). Combining the results of both methods will strengthen our interpretive ability, and increase the likelihood of accurately determining between-colony variation.

B. Methods

Pilot Work:

We recognize that a radio telemetry survival study presents significant technical obstacles. Of primary importance is the transmitter attachment method. The minimum year-long duration required for the transmitter precludes externally-mounted transmitters, since even transmitters glued and sutured to avian skin tend to be sloughed off within a few months (pers. comm., Fred Anderka, Holohill Systems). Abdominal implants have been used on murres, but with an unacceptably high mortality rate.

Prior to using EVOSTC funds for a murre telemetry study, we will establish the feasibility of transmitter deployment.

Using base funding from the USGS/BRD, we plan a small pilot program to test the feasibility of various transmitter deployment techniques for common murres. During the summer of FY 97, we will work together with Dr. Dan Mulcahy (Alaska Science Center veterinarian; has successfully implanted over 300 radio and satellite transmitters into seaducks and other birds) and Fred Anderka of Holohill Systems (provider of the implantable radio transmitters used successfully on Prince William Sound harlequin ducks in 1996/97 [EVOSTC-funded NVP project, number 97025]), we will design and evaluate a subcutaneously-implanted transmitter, similar to one used successfully on black ducks (Harms et al. 1997). We will also re-evaluate the possibility of abdominal implants, capitalizing on experience gained from Mulcahy's previous surgeries. Smaller transmitters, refined surgery and handling protocol, shallower water surrounding the study colonies, and VHF instead of microwave signals may combine to make abdominal implantation a viable method for murres, as it is for a variety of other diving bird species (Petersen et al. 1995; D. Esler unpubl. data).

As a critical component of the proposed study, both instrumented and control murres will be visually monitored throughout the breeding season, to assess the impact of transmitter attachment on breeding and foraging performance (Wilson et al. 1986; Wanless et al. 1988a;Wanless et al.

1989; Croll et al. 1992). Visual monitoring will be carried out by cooperators in the CISeaFFS component of APEX.

Technical telemetry guidance and advice on study design will be provided by research collaborator Dr. David Irons in coordination with the kittiwake component of the APEX project. Vessel use for bird capture and surgeries will be provided by USGS cooperators (31' Uniflite twin diesel; 25' Boston Whaler; 4.8 meter Naiad; other inflatables).

We will also begin a banding program in the summer of FY 97, using base USGS funds. We will attempt to band a minimum of 200 adults of each species (murre and kittiwake) at each colony (Chisik and Gull Islands). Birds will be noosed and taken from their nest sites, then fitted with a USFWS metal band and a unique combination of color bands per USFWS protocol.

Proposed FY 98 Work

Survival Component: Contingent on positive results from our pilot work in 1997, beginning in FY 98 we will deploy 50 transmitters on common murres at each colony. (Radio specifications and deployment technique will be determined based on 1997 results, and will be reported to EVOSTC when confirmed.). Breeding birds will be noosed, and their position in the colony will be noted on plot photos. Captured birds will then be individually transported to a processing station (yet to be determined; either in a tent at the colony or on a vessel anchored offshore). Birds will be individually banded as per USFWS protocol. All birds will be weighed, and culmen, tarsus, and wing length (flattened, straightened, to longest primary) will be measured. After transmitter attachment, birds will be held for an equilibration period (time contingent on deployment method) then released on the water near the colony (Cairns et al. 1987).

CISeaFFS personnel will assist in establishing and monitoring control pairs of breeding murres to continue study of the effect of transmitter attachment. They will also resight kittiwakes and murres banded in FY 97, and will continue banding adult kittiwakes and murres. To allow calculation of resighting probabilities, our goal will be to have a minimum of 200 individually marked birds of each species at each colony.

To determine overwinter survival of radioed birds, telemetry flights will be conducted intensively during colony departure and arrival (ca. September and late April/May). Aerial surveys are necessary in order to relocate emigrants, nonbreeders, or failed breeders that may not regularly attend the colony.

Sample Size and Survival Statistics: Assuming a binomial distribution (sample unit being an individual murre, with survival being a yes or no), a power analysis of sample size in a two by two table (Steel and Torrie, 1980) predicts that a sample size of 47 radioed murres per island would resolve a 6% difference in survival between colonies with acceptable statistical power and confidence (Table 1). To double the resolution (3%) would require a sample size nearly five times greater. A sample size of 125 is predicted to resolve a 5% difference with strong power and significance at the 0.05 level. Previous studies have reported murre survival rates ranging from 87% to 98%, measured at stable colonies (Hudson 1985, Sydeman 1993). Given that our study colonies represent relative extremes of population expansion and decline, it is not unreasonable to expect their survival rates to also be at the extreme ends of the normal range. Therefore, detection of a 5% difference with statistical significance should adequately address our primary hypothesis.

We propose to attach 50 transmitters to murres per colony in FY 98, and 75 more in FY 99, for a total of 125. Assuming that between-year effects on survival do not vary between colonies, we will pool both years of data if necessary to achieve a sufficient sample size to show significant differences in between-colony survival. The number of transmitters we deploy in FY 99 will be contingent on FY 98 results and statistical analysis, and may be reduced.

Foraging Component: An important corollary benefit to using radio transmitters for survival measurement is the ability to simultaneously collect data on foraging patterns, ranges, and effort (Wanless et al. 1988; Wanless et al. 1990; Monaghan et al. 1994; Uttley et al. 1984). Aerial surveys will be used to locate foraging birds, and Data Collection Computers will be used to automatically log presence/absence data at the colony. Foraging data obtained concurrently with APEX forage fish abundance and distribution data will give insight into the mechanisms that reduce or influence adult survival and productivity, elucidating the forces that drive population fluctuations.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The proposed research will be conducted by a research student, under the PI's supervision. A Research Work Order will be used to provide funding for one MSc. student at a university yet to be determined. Personal Services contracts may be used for statistical consultation and programming assistance to aid in interpreting the large data sets generated by telemetry work. Aerial surveys will be contracted to the private sector.

SCHEDULE

A. Measurable Project Tasks for FY 98

Oct. 1-Jan. 31:	Evaluate results of pilot FY 97 work; continue design of implantable radio transmitter; refine surgery protocol
Jan. 15-24:	Attend Restoration Workshop
Feb. 1-April 15:	Arrange logistics (capture events, nest monitoring, survey flights, etc.)
April 16-Sept. 10:	Conduct field work
Sept. 11-Sept. 30:	Begin data analysis

B. Project Milestones and Endpoints

April 15:	Transmitter attachment, survey, banding, and nest monitoring protocols will be finalized
Sept. 10:	Field work designed to address all project objectives (listed under PROJECT DESIGN, Part A above) will be completed
Dec. 31, FY 99:	Preliminary data analysis will be completed

April 14, FY 99:	Project design modifications (based on FY 98 results) will be completed
April 15, FY 99:	Submit annual report (FY 98 findings)
Sept. 10, FY 99:	Field work, as necessary based on FY 98 results, will be completed
April 15, FY 00:	Submit annual report (FY 99 findings)
Sept. 30, FY 00:	Preparation of research results for publication in peer-reviewed journals will be completed

C. Completion Date

Our proposed research takes advantage of a natural comparative system (failing vs. thriving colonies) to reduce the time required to test the hypothesis that increased foraging effort will decrease adult survival. We propose two field seasons (FY98 and FY99) to ensure an adequate sample size and to allow for modification of project design based on initial results. The project will be completed by the end of FY 00, which is planned as a close-out year during which no new research will be undertaken. Efforts in FY 00 will focus on the graduate student's thesis completion and defense, and on publication of research results in peer-reviewed journals.

PUBLICATIONS AND REPORTS

The first planned product of the proposed research will be the annual report detailing FY 98 findings, due on April 15, 1999. Publication of project results in peer-reviewed journals will be pursued as soon as scientifically appropriate and logistically possible.

PROFESSIONAL CONFERENCES

Results of this project will be presented at the Annual Meeting of the Pacific Seabird Group, and at local professional meetings where appropriate.

NORMAL AGENCY MANAGEMENT

This research would not be conducted as a normal part of USGS research on seabirds.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The proposed research issues are related to management and conservation of seabirds in Alaska as addressed by the U.S. Fish and Wildlife Service (USFWS) 'Seabird Management Plan' (USFWS Region 7, Migratory Bird Management). The proposed work will complement and be coordinated with: i) long-term studies conducted by the Alaska Maritime National Wildlife Refuge (AMNWR, USFWS Region 7), which includes annual monitoring of seabird productivity at 9 major seabird colonies throughout Alaska; ii) related studies (APEX) of seabird-forage fish interactions being supported by EVOSTC in Prince William Sound; iii) EVOSTC-funded research on the Pacific sand lance; iv) ongoing studies of seabird populations in areas of oil and gas development conducted by the Minerals Management Service (MMS) in Alaska and the Biological Resources Division of the USGS and, v) ongoing studies of marine fish and oceanography conducted by the University of Alaska, Fairbanks out of the Kasitsna Bay Marine Lab in Kachemak Bay.

Logistic support from the USFWS and AMNWR will include vessel use, storage facilities, laboratory space, computer usage, and communications. Field sites and research platforms will be shared with the EVOSTC-funded APEX and sand lance projects. Telemetry equipment will be borrowed where possible, saving a minimum of $25K in the first year of funding for the proposed research.

PRINCIPAL INVESTIGATOR

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fax (907) 786-3636
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PRINCIPAL INVESTIGATOR

Dr. John F. Piatt, Research Biologist (GS-13) with the Alaska Science Center, Biological Resources Division, USGS in Anchorage. Obtained a Ph.D. in Marine Biology from Memorial University of Newfoundland in 1987 (dissertation on seabird-forage fish interactions). Since 1987, studied seabirds at colonies and at sea in Gulf of Alaska, Aleutians, Bering and Chukchi Seas. Author on 45 peer-reviewed scientific publications about seabirds, fish, marine mammals, and effects of oil pollution on marine birds. Responsible for coordination and oversight of the proposed research.

PROJECT LEADER

Thomas Van Pelt, proposed MSc. student. Over five years of experience working in Gulf of Alaska and Aleutian marine ecosystems. Responsible for project design, logistics, implementation, data analysis, and preparation of manuscripts and reports.

COLLABORATORS

Dr. David B. Irons, Migratory Bird Management, USFWS. Extensive experience with radio telemetry and seabird survival studies in Prince William Sound. Will collaborate on project design, and provide technical guidance.

Dr. Alexander S. Kitaysky, University of Washington, Dept. of Zoology. Will collaborate on study design and field work.

Daniel M. Mulcahy Ph.D., D.V.M. Responsible for consultation on transmitter deployment and design, and for performing surgeries (contingent on pilot work).

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Table 1. Power analysis of sample size (in a two by two table). One minus beta is power; a power of <0.50 is typical in survival estimations. One minus alpha is the confidence interval. Ps and Pe are estimated survival fractions at two hypothetical colonies. Thus, with a sample size of 47 (transmitters per colony), we would expect to resolve a 6% difference (Ps minus Pe) with a power of 0.51 and 90% confidence intervals. With a sample size of 125, we would expect to resolve a 5% difference with a power of 0.75 and 95% confidence intervals In general, as sample size doubles, variance is halved (Heisey and Fuller, 1985). Resolution of differences <5% demands unacceptably large sample sizes.

alpha	Zalpha	beta	Zbeta	Ps	Pe	n =
0.10	1.18	0.25	0.68	0.92	0.89	352.32
0.10	1.18	0.49	0.01	0.92	0.89	226.01
0.05	1.65	0.25	0.68	0.95	0.90	125.25
0.10	1.18	0.25	0.68	0.95	0.90	100.14
0.10	1.18	0.49	0.01	0.94	0.89	72.49
0.10	1.18	0.49	0.01	0.95	0.89	46.97

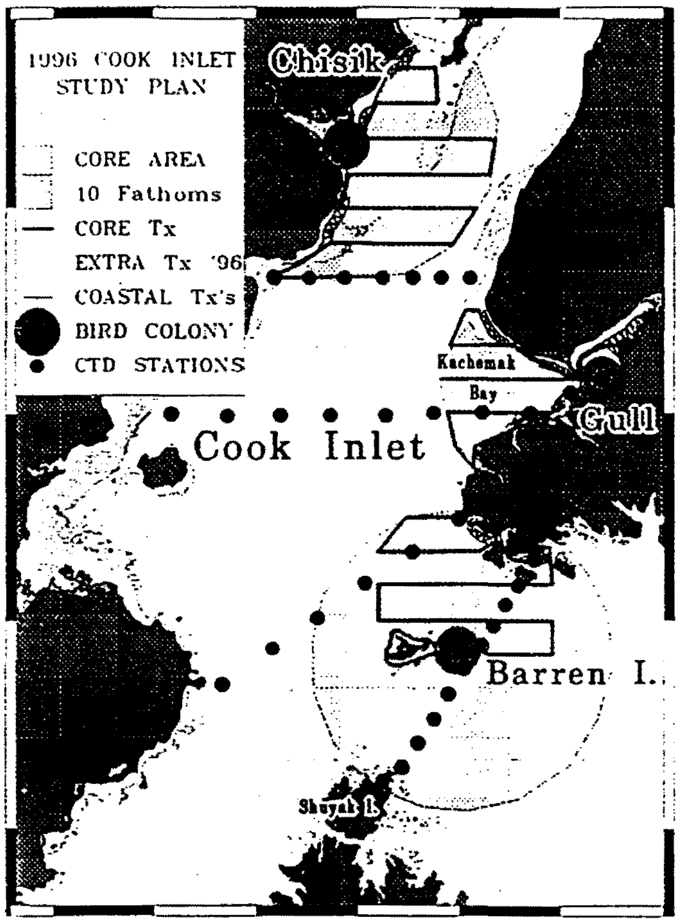
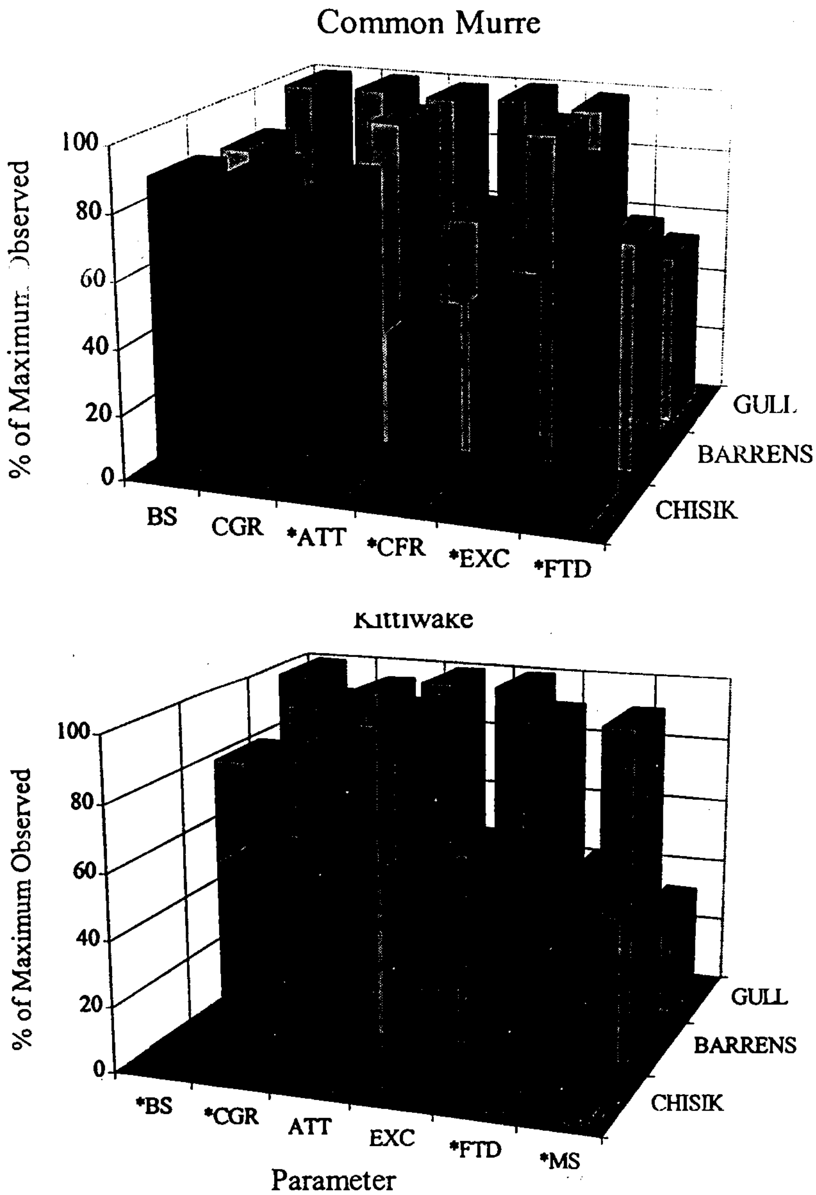


Figure 1. Study area in lower Cook Inlet. Colonies proposed for study of adult survival are Chisik and Gull islands. Core marine study areas around each colony will be surveyed for birds with radio-transmitters attached for survival study.



Parameters: BS- Breeding Success, CGR- Chick Growth Rate, ATT- Attendance by Adults, CFR- Chick Feeding rate, EXC- Exchange Rate of Brooding Adults, FTD- Foraging Time Duration, MS- Mean Meal Size. Asterisk (*) indicates significant difference in parameter values between colonies.

Figure 2. Variation in Reproductive and Behavorial Parameters of Seabirds at Chisik, Gull, and Barren Islands, 1996. Note high and similar breeding success of murres at Gull and Chisik made possible by increased foraging effort of Chisik birds; but kittiwakes could not compensate at Chisik, and therefore failed to produce chicks.

Population Trends of Common Murres (CM) and Black-legged Kittiwakes (BK) at Chisik, Gull, and Barren Islands

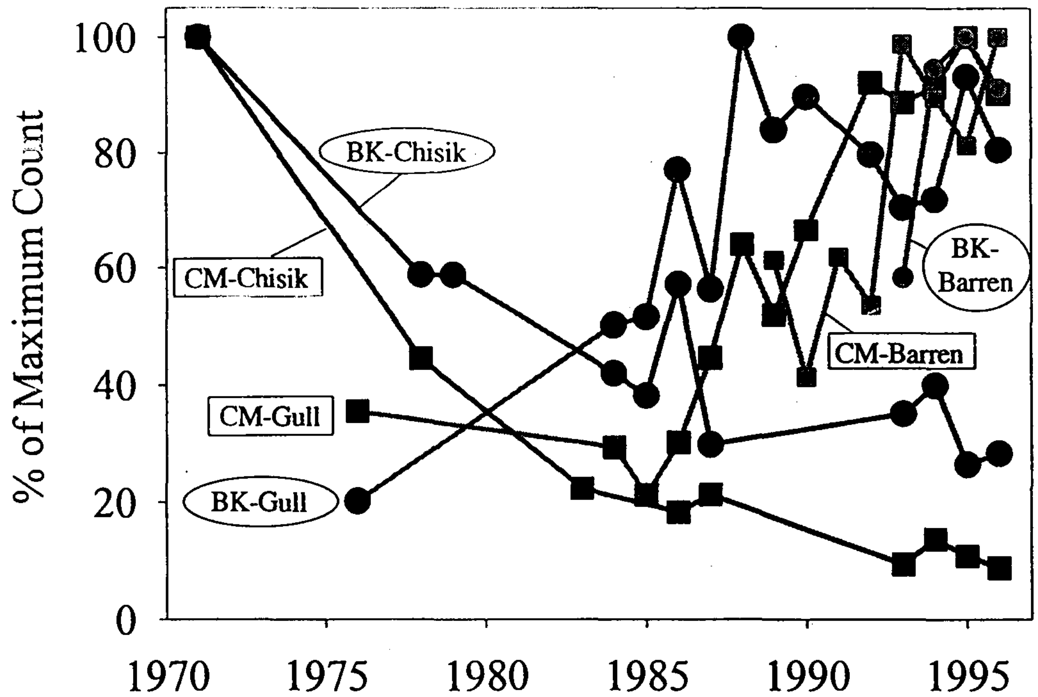


Figure 3. Population trends of murres and kittiwakes showing declines at Chisik Island and increases at Gull Island.

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$9.0						
Travel		$1.0						
Contractual		$40.2						
Commodities		$21.0						
Equipment		$0.7	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$71.9		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$4.2						
Project Total	$0.0	$76.1		$124.0	$45.0	$0.0		
Full-time Equivalents (FTE)		0.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998

Project Number: 98338
Project Title: Survival of Adult Murres and Kittiwakes in Relation to Food
Agency: U.S. Geological Survey

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:

4/16/97

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

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1998
Vacant	Biotech	GS-5	3.0	2.1		6.3
Dr. D. Mulcahy	Veterinarian	GS-13	0.3	5.0		1.5
vacant	Anesthetist		0.3	4.0		1.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal	[redacted]	3.6	11.1	0.0	[redacted]
					Personnel Total	$9.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
Anc/Hom/Anc	0.2	5		0.0	1.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.0

1998

Project Number: 98______
Project Title: Survival of Adult Murres and Kittiwakes in Relation to Food
Agency: U.S. Geological Survey

FORM 3B
Personnel
& Travel
DETAIL

Prepared:

4/16/97

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

Contractual Costs:	Proposed
Description	FY 1998
Air Charter (7d @ 3h/d @ 225.00/h)	5.0
Boat Charter (5 @ 500/d)	5.0
Safety training	0.2
Research Work Order with University (to be determined)	
RWO Includes:	
Grad Student Stipend and Tuition (30 K)	28.0
Benefits	2.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$40.2

Commodities Costs:	Proposed
Description	FY 1998
Fuel (15d @ 20gal/day @ 3.00/gal)	1.0
Vet supplies (estimated $50.00/surgery)	4.0
Misc. Equip.	1.0
Radio Transmitters (100 @ $150.00)	15.0
Commodities Total	$21.0

1998

Project Number: 98______
Project Title: Survival of Adult Murres and Kittiwakes in Relation to Food
Agency: U.S. Geological Survey

FORM 3B
Contractual &
Commodities
DETAIL

Prepared:

4/16/97

1998 EXXON VALDEZ TRUS. __ COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
GPS Unit			0.7
			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**	$0.7

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Data Collection Computer -	2	FWS
Receiver and Antennae	2	USGS
Boston Whaler	1	FWS
Laptop Computer	1	USGS

1998

Project Number: 98______
Project Title: Survival of Adult Murres and Kittiwakes in Relation to Food
Agency: U.S. Geological Survey

FORM 3B
Equipment
DETAIL

Prepared:

4/16/97

Prince William Sound Human Use and Wildlife Disturbance Model

Project Number:	98~~xxx~~ 339
Restoration Category:	General Restoration & Habitat Protection
Proposer:	Chugach National Forest
Lead Trustee Agency:	USFS
Cooperating Agencies:	ADNR
Alaska SeaLife Center:	
Duration:	1st year; 1.5 year project
Cost FY98:	$144.2
Cost FY99:	$ 53.1
Geographic Area:	Western Prince William Sound
Injured Resources/Service:	ALL (emphasis on: harbor seal, pigeon guillemot and cutthroat trout)

RECEIVED
APR 15 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT

This project will use geographic information system (GIS) techniques to describe current human-use patterns in western Prince William Sound and to model potential changes in those use patterns as a result of additional development (e.g., increased access). GIS generated maps of present and projected human-use patterns will be incorporated with GIS maps of the distribution of resources injured as a result of the *Exxon Valdez* oil spill. This will provide a basis to identify areas where there may be existing and potential conflicts between human use and wildlife concentrations resulting in disturbance. Disturbance of injured wildlife may result in decreased productivity exacerbating the effects of the oil spill and prolonging the time to recovery. Identification of potential areas of disturbance will allow development of recommended management practices that may eliminate or minimize the negative effects of increasing human use. All injured resources and subsistence species will be addressed in a general approach but specific management recommendations will be developed for harbor seal, pigeon guillemot and cutthroat trout. The model of projected human-use patterns and resulting management recommendations are expected to be useful to Federal, State, and private land managers in their land management planning efforts.

INTRODUCTION

The Prince William Sound (PWS) ecosystem has experienced many changes in the last decade. The most notable of these are related to the Exxon Valdez oil spill (EVOS) of 1989. The EVOS caused direct and indirect effects on many resources throughout the oil spill area (EVOS Restoration Plan). Some of the oil spill effects have resulted in changes in human use patterns in PWS and other areas. For example, subsistence harvest patterns changed after EVOS (Seitz and Fall 1995), and commercial harvest of herring was closed in PWS for several years due to pathological problems believed to be caused by the spill. Land acquisition through the EVOS restoration program has made more land available for public use and habitat protection.

In addition to changes which are directly linked to EVOS, other changes in human use of PWS are occurring. Tourism patterns in PWS have changed as cruise ships altered their routes and new glacier tour cruises have been added. While the extensive commercial salmon fishery is expected to remain at about the same level, recreational boating and kayaking has increased dramatically in the last decade and is expected to continue to increase (ADOT 1995). Development in Chenega Bay and Tatitlek have made these communities more accessible. Additional changes in human use are expected as projects such as the Whittier access road or the proposed Bering River road are completed. The Whittier access road will make western PWS much more accessible to Alaska's largest population base. This improved access is expected to result in increased human use in PWS (ADOT 1995) and anticipated ecotourism development by Chenega Corp. will allow for greater dispersion of traffic throughout western PWS.

The State of Alaska Department of Transportation (ADOT) predicted increases in recreation and tourism boat traffic in PWS due to the installation of the Whittier access road (ADOT 1995). Using a baseline of 662 boats/day in 1994, ADOT predicted recreation and tourism boat traffic to increase to 1,621-2,408 boats/day by the year 2015. The majority of this increase is expected to occur in western PWS where a 600% or greater increase in recreation and tourism boat traffic is predicted. According to their analysis, this translates into an increase from 1-2 boats for every 4.8 km of shoreline to 1 boat for every 0.5-0.8 km of shoreline for areas closest to Whittier (i.e. Culross Island to Whittier). The ADOT analysis showed the greatest increase will occur in recreational sport fishing activities, but increases in hunting and hiking are also expected. With angler days predicted to increase from an average of 9,800 days to 81,750 days in the year 2015 the greatest potential for direct impact is likely to occur on fishery resources (ADOT 1995). Harvested wildlife species such as black-tailed deer and black bear will also be affected. Use is predicted to diminish with distance from Whittier, unless additional fueling stations are made available in PWS.

Increased human activity in PWS may affect the recovery of species injured by EVOS. Human-caused disturbance has been shown to have negative effects on a wide variety of species (e.g. York 1994; Boyle and Samson 1983). Some types of boat-based disturbance have been shown to reduce productivity in many species of birds (e.g. Sowls and Bartonek 1974) and in some seal species (e.g. Pitcher 1998). The potential effect of human disturbance varies with species, frequency and type of disturbance, season, and other factors (Knight and Cole 1991). As human use increases in PWS the potential for disturbance-related effects on resources also increases.

Human disturbance to marine mammals, seabirds, and shorebirds often occurs as people approach for viewing or photos or when beach activities such as camping and hiking disturb nesting birds.

Managing human use in large geographic areas is often very complex; management of PWS is the responsibility of numerous State and Federal Agencies, and private land owners. Presently, there is no single source of information on human use in PWS. This may create difficulties in resource management if human use increases as predicted and populations of injured resources are affected by human disturbance.

This project provides a foundation for displaying and understanding existing and future human use patterns in PWS, the potential disturbances on injured resources, and would make recommendations for management actions to minimize adverse effects of increased human use on injured resources. This proposal describes a pilot project which would focus on western PWS in FY98. If results provide meaningful information to the restoration program and to land managers, the project may be expanded to include all of PWS in future years. The project consists of three components:

1. Develop and evaluate a spatial computer model of existing human use patterns in PWS,
2. Use the model to project changes in human use patterns as a result of development and management actions in western PWS, and
3. Recommend management actions for public lands, and identify research needed to minimize potential future disturbance on injured resources.

The final product of this pilot project would be a report with management recommendations for State and Federal agencies and a geographic computer database. The report and computer model would be available to all agencies and to Chenega Bay to assist land owners and managers to better understand the potential human use of an area and make appropriate management decisions. While the project would generally take a broad-spectrum approach in describing potential disturbance patterns on injured resources and on subsistence species, we also propose a more in-depth analysis of three injured species: harbor seal, pigeon guillemot and cutthroat trout.

This project would provide a useful tool in many aspects of the EVOS restoration program. The model would help in the identification of appropriate research and monitoring sites to understand the effects of human disturbance on specific injured resources or services. It would help in identifying areas where subsistence harvests may be affected by increased recreation and other uses. In addition to benefitting restoration activities, the model and recommendations would benefit State and Federal agencies, and the Chenega Corporation, in land management planning and in the protection of resources.

NEED FOR PROJECT

A. Statement of Problem

Human activity in PWS is expected to increase significantly in the next decade (ADOT 1995). This project provides a management tool that would increase the effectiveness of management of resources and human use in PWS. The project has direct application under Habitat Protection and General Restoration as described in the EVOS restoration plan (EVOS Trustee Council 1994), and has the potential to aid in the restoration of most of the identified injured resources and services. The pilot phase of this project places emphasis on describing potential disturbance effects and developing management recommendations for harbor seals, pigeon guillemots and cutthroat trout on public lands in PWS.

B. Rationale/Link to Restoration

The Trustee Council has made significant progress in understanding the effects of the EVOS and in restoring and protecting the resources and services injured by the spill. However, the recovery of these resources and services may be affected by a dramatic increase in human use in PWS. The ADOT has predicted that the Whittier access road will result in an increase of over 600% in recreational and tourism boat traffic in parts of western PWS by the year 2015 (ADOT 1995). However, the Whittier road is one of several changes that will affect human use in PWS. For example, in the last 5 years new glacier cruise tours have been established in Whittier, more State and Federal lands have been acquired in western PWS, and the number of recreational boaters in western PWS has increased. As more people recreate and work in PWS, there will be higher levels of interactions between people and injured resources. Research has shown that human disturbance can cause a wide range of problems for wildlife and fish populations. At its most severe levels, disturbance can cause mortality or reduced productivity (Knight and Cole 1991). As human use increases in PWS, the potential for problems related to human disturbance to delay recovery of injured species also increases. By identifying existing and potential human use patterns in western PWS, the Trustee Council would be providing a tool that would assist in habitat protection, general restoration, and would also provide valuable information for research and monitoring projects.

This pilot project would take a broad-spectrum approach in describing potential disturbance patterns on injured resources and on subsistence species. We also propose a more in-depth analysis associated with three injured species: harbor seal, pigeon guillemot and cutthroat trout. This analysis would compare known distribution patterns of these species with the predicted disturbance patterns to provide more specific management recommendations. Harbor seals were selected because their haulout sites are often approached by tourism and recreational boats. Pitcher (1988) provides a summary of effects of disturbance at haulout sites; such disturbance can result in site abandonment, shifts to nighttime haulout schedules, or injury and increased pup mortality. Pigeon guillemots are susceptible to human disturbance during nesting because they nest on or near beaches that may also provide good campsites and fishing areas for people. Of sportfish species, cutthroat trout may be at the greatest risk. PWS is the northern-most extent of the range for this species. Populations in western PWS are generally small and poorly understood. Increased harvest of this species could further reduce the population (Gillikin, D. pers. com.).

C. Location

The proposed pilot project would focus on western PWS; however, the project may be expanded to include the rest of PWS in future years. The project would benefit all State and Federal agencies with management responsibilities in PWS. The project would also benefit other land owners, especially the Chenega Corporation and the community of Chenega Bay.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Involvement from the community of Chenega Bay and from the Chenega Corporation is an important component of this project. In order to fully understand human-use patterns in western PWS, the human use patterns to and from Chenega Bay must also be incorporated into the model. More importantly, development plans from Chenega Bay and the Chenega Corporation could be incorporated into this model as they become available to provide a valid predictive model of future human use. The Chenega Corporation has agreed to cooperate on this project by supplying information on historical and current use patterns, and to comment on the predicted human use patterns identified by the model. Residents of Chenega Bay would be asked to participate in identifying activity patterns near the village and in southwestern PWS.

PROJECT DESIGN

A. Objectives

There are three objectives associated with this pilot project:

1. Describe existing and potential human-use patterns in western PWS

2. Identify areas where human disturbance has a high potential to affect injured resources.

3. Develop management recommendations for public agencies to minimize or eliminate the effects of disturbance on injured resources.

B. Methods

Model Construction

Only water-based transportation will be considered in the description of human-use patterns in PWS. Vessel classes will be established to more accurately describe use patterns. Classes will be based primarily on size and function (e.g., personal pleasure craft, charter, tour, commercial fishing). Current number, locations, and trips of vessels by class in western PWS will be determined through registration records, fuel records, and harbor master information on slip rental, moorage and launches. Additional information will be provided through a user survey.

The extent of human use in western PWS will be described through an analysis of accessibility of the area by water craft in association with preferred destinations (e.g., recreational and commercial fishing areas, mooring buoys, camping sites, recreation cabins). Accessibility will be defined as a function of the travel range of each vessel class. Average travel ranges will be assigned to vessel classes based primarily on fuel capacity. "Preferred" destinations will be described from existing information such as recreation sites maintained by land management agencies (e.g., U.S. Forest Service, Alaska Department of Natural Resources), commercial fishing areas (e.g., Alaska Department of Fish and Game, Prince William Sound Aquaculture Association), sport fishing areas (e.g., Alaska Department of Fish and Game), tour destinations (e.g., tour operators associations). Potential use levels of these sites will be determined from existing survey information collected at the Whittier harbor (USDA Forest Service, unpublished data) and from a mail survey of the patrons of the Whittier harbor. The survey will be distributed to individuals and groups known to work and recreate in PWS. This survey will help to refine model parameters on frequency and duration of trips associated with different vessel classes.

Cell-based modeling using the GRID feature of the ARC/INFO geographic information system (GIS) will form the basis of our approach to evaluate human-use patterns in western PWS (Environmental Systems Research Institute, Inc. 1994). Weighted distance functions will be used to describe areas that are available to and may be used by vessel operators. Separate grids of the water portion of western PWS will be created for the analysis of dispersion of vessels in each class. For each vessel class a source grid will be created which will represent trip initiation points (e.g., marinas, launch sites). Corresponding cost grids will also be established for each vessel class. A cost grid will assign an impedance value to each cell that depicts the cost involved in moving through any particular cell. The value of each cell in the cost grid will represent the cost-per-unit distance of passing through the cell, where a unit distance corresponds to the cell width (Environmental Systems Research Institute, Inc. 1994:253). A grid will be established that represents attraction zones associated with preferred destinations.

ARC/INFO GRID functions will be used to create additional grids in which each cell is assigned the accumulative cost to the nearest source cell. Additional functions will be used to combine the accumulative cost grids and the attraction zone grids to develop grids that represent dispersion of water craft by vessel class in western PWS. These dispersion grids will be combined to describe areas of western PWS by use class (e.g., low, medium, high vessel densities).

Model Evaluation

The model will provide predictions of movements and concentrations of water vessels in the pilot study area. This information will be used to characterize areas of western PWS as having high, medium, and low densities of vessels by vessel class and total vessels on a monthly basis. Separate runs of the model will be made for each month from May through September. Actual vessel densities in representative areas will be determined, by month, through field surveys.

Three areas of western PWS within each of the high, medium, and low density classes (as predicted by the model) will be randomly selected. Counts of vessels present in each of the sample areas will be made each month from May through September during high-use (e.g., weekends) and low-use (e.g., mid-week) periods. Counts will be conducted from fixed-wing aircraft along line transects using the approach described by Anderson et al. (1979) and applied by Gasaway et al. (1986). Transects will be located 0.4 km apart and will traverse the sample areas. All vessels observed from transects during flights within the sample areas will be recorded by vessel class. Most vessels within sample areas are anticipated to have high sightability. However, small, nonmotorized vessels (e.g., kayaks) may not be obvious to the observers, especially if they are near the shoreline. A Sightability Correction Factor will be calculated for all vessel classes by conducting one intensive survey (e.g., following shorelines) each month in each density class while a standard survey is being conducted. The Sightability Correction Factors will be applied to the results of all transect surveys to provide an estimate of total number of vessels, by class, in the sample areas. The survey technique may be modified as experience in its application is gained.

Results of the field surveys will be used to determine if ranges of actual vessel densities in the sample areas correspond to the vessel density classes predicted by the model under current conditions. If model predictions are not corroborated by the results of the field counts, model parameters will be examined and modified to bring the model into compliance with field counts.

Model Application

Upon completion of the evaluation, the model will be used to estimate future use of western PWS under potential management changes (e.g., improved Whittier access, additional fuel sources provided). Analyses will be completed which will incorporate projections of increased use of western PWS to demonstrate expected temporal and spatial changes in use patterns. ARC/INFO grids of potential human-use patterns will be combined with existing GIS maps of the distribution and areas of essential habitat for injured wildlife and fish resources. Areas of potential conflict (e.g., high density human-use areas coinciding with essential habitat) will be identified.

Recommendations for management actions designed to minimize or eliminate potential conflict on public lands will be developed for all injured wildlife and fish resources based on information available in the published literature. More specific management recommendations will be developed to reduce potential risk to harbor seals, pigeon guillemot, and cutthroat trout. These recommendations will incorporate published literature and site-specific information available from ongoing studies in PWS.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Forest Service personnel will be responsible for the development and evaluation of the human use dispersion model and its attributes. Evaluation of the model will be based on the results of aerial surveys. The Forest Service will conduct the literature search on human disturbance effects on injured resources, and develop management recommendations. Forest Service personnel will incorporate the model with known information for three injured species. Coordination with other agencies will be the responsibility of the Forest Service.

The State of Alaska, Department of Natural Resources (ADNR) is a partner on this project. The Chugach National Forest, ADNR, and Chenega Corporation are responsible for most land management within the study area. An ADNR Natural Resources Manager will provide input and coordination with the Division of State Parks and Outdoor Recreation, and the Division of Lands. This partnership would ensure that relevant State activities are included in the model, and that the management recommendations are compatible with State management responsibilities. ADNR will also provide information on other activities related to State management, these will include, but are not limited to, human use patterns related to the State Marine Parks, Alaska Marine Highway System, and commercial fishing industry. The State will also conduct the user survey, and incorporate results of previous surveys, to refine the information about existing use patterns.

Contracts for this proposal include airplane costs associated with conducting the aerial surveys. Chenega Corporation will collaborate on this project by working with the principal investigators to ensure that the human use model accurately displays existing and potential activities on Corporation lands and activities associated with the community of Chenega Bay.

SCHEDULE

A. Measurable Project Tasks for FY98

Oct. 1 - April 30:	Model development and literature review
Nov. 1 - 30:	Coordinate with Chenega Corporation
Jan. 15-24:	Attend annual restoration workshop (3 days)
May 1 - Sept. 30:	Conduct aerial surveys and user surveys
June 1 - Aug. 30:	Preliminary test of model based on initial aerial survey results
Sept. 15 - Sept. 30:	Begin analysis of survey results and evaluation of model

B. Project Milestones and Endpoints

All three of the objectives described in this proposal will be fully completed at the end of the pilot project in April 1999. Project milestones are described in the following schedule.

FY98	
Oct. 1 - April 30:	Model development, Literature search
May 1 - Sept. 30:	Conduct aerial surveys and user surveys
FY99	
Oct. 1 - Dec 15:	Analyze survey data; evaluate, adjust and apply model with future projections of use
Jan. 1 - Feb. 28:	Develop management recommendations
March 1 - April 15:	Prepare final report and model
May:	Contract to have model prepared for distribution, if desired

C. Completion Date

This pilot project will be completed by April 15th, 1999. This includes a final computer model and management recommendations. This does not include development of a user-based version of the dispersion model for direct use by land managers.

PUBLICATIONS AND REPORTS

The first, and final, report for this project will be submitted in April 1999. There are no plans for publication during FY98; however, opportunities will be explored for FY99.

PROFESSIONAL CONFERENCES

No conferences are anticipated for FY98; however, the principal investigators will request support to present the model at annual GIS and The Wildlife Society conferences in FY99.

NORMAL AGENCY MANAGEMENT

This project is outside the scope of normal management for the Chugach National Forest. Development of human dispersion models similar to the proposed project has not been done previously in the context of National Forest management. The Forest Service has conducted public use surveys in 1992 and 1995 on the Chugach National Forest to provide information for the Forest Plan Revision process. Additional surveys are not planned for PWS. This project is also outside of normal agency management because of the combination of species being addressed. Populations of species injured by the EVOS are potentially some of the most vulnerable to disturbance associated with increased human use. Many of these species, such as harbor seals, rarely occur on National Forest land; however, activities and management associated with National Forest land can affect these marine species.

Ultimately, managing human use in PWS will be an interagency responsibility which will require coordination between multiple agencies. This project will provide useful information for all of these agencies.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Opportunity exists to integrate this project with many of the other restoration projects. During the development of this proposal, three of the principal investigators who work with harbor seals, pigeon guillemots and cutthroat trout were contacted. All three have agreed to cooperate with this project to facilitate the emphasis on management of these species. The primary principal investigator for the APEX project also identified opportunities to link the dispersion model to GIS data layers on forage fish densities, and seabird foraging and nesting areas. The combination of the dispersion model and the model developed through APEX would provide important insights into managing seabird populations.

The project would also be integrated into State and Federal agency management and would provide useful information to the Chenega Corporation and Chenega Bay in their ecotourism development plans for PWS. The Chugach National Forest will be continuing the revision of the 10 year Forest Plan during FY98. The information gathered for this project would be incorporated into the Forest planning process. Although the Forest Plan revision effort is anticipated to be completed before this project would be finalized, the principal investigators would work with the planning team to provide relevant information as it becomes available. The model and recommendations would also benefit biologists and recreation specialists who make project-level decisions for the Chugach National Forest. Many of these individuals would be involved in the development of this project and would have the opportunity to apply the information to other aspects of forest management. It is anticipated that other Federal agencies, such as National Marine Fisheries Service, would benefit from this project in their management activities.

The Alaska Department of Natural Resources is a partner on this project. This partnership will ensure that activities undertaken by State agencies are incorporated into the model and that the product would be beneficial to the State of Alaska.

PROPOSED PRINCIPAL INVESTIGATORS

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PRINCIPAL INVESTIGATORS

Lowell H. Suring received his M.S. in wildlife science from Oregon State University in 1974. His thesis involved assessing habitat use and activity patterns of the endangered Columbian white-tailed deer. This work lead to co-authorship of two major scientific publications. Lowell was leader of the Endangered Species and Wildlife Biometrics units in New York State from 1974 through 1977. In 1977 and 1978 he conducted research on secondary succession patterns in pinyon-juniper woodlands in northwest Colorado. From 1978 to 1984 Lowell held biologist positions with the Fish and Wildlife Service and Forest Service in New Mexico and Minnesota where he was involved with determining wildlife habitat relationships and the assessment of effects of management actions on wildlife habitats and populations. Since 1984, Lowell has been a primary participant in the development of GIS-based wildlife habitat relationships and cumulative effects models in the Alaska Region of the Forest Service. Lowell's professional expertise and interests focus on analyzing habitat-use patterns of wildlife and the development and application of computer-based habitat assessment techniques. He has authored or co-authored more than 30 technical and semi-technical articles describing accomplishments in these areas. Currently, Lowell is employed by the Chugach National Forest where he is implementing analytic techniques and tools that may be used to evaluate the capability of habitats to support wildlife and the effects of land management activities on habitat capability. To support these efforts he has had extensive training and experience in the application of ESRI's ARC/INFO geographic information system. Lowell will have primary responsibility in development of the human use dispersion model.

Karen Murphy received a Masters in Environmental Management from Duke University in 1995. Her thesis emphasis was on applying decision theory and risk assessment to wildlife management. Karen has extensive experience with fish and wildlife management on the Chugach National Forest. She began working in Alaska in 1984 as a biological technician responsible for conducting field surveys and monitoring in PWS, Copper River Delta and other areas of the Chugach National Forest. In 1991, she began working with the EVOS Restoration Planning Work Group. She participated in the development of the EVOS Restoration Plan and companion EIS. Since 1996, Karen has been the wildlife biologist for the Glacier Ranger District which covers western PWS and Turnagain Arm. Her current position, combined with her EVOS experience will enhance the opportunity to integrate this project with other EVOS projects and to apply the results to wildlife management on the Chugach National Forest. Karen will have primary responsibility for administering and coordinating this project and for the development of management recommendations.

OTHER KEY PERSONNEL

A Natural Resources Manager who works for ADNR will represent the Division of Lands and the Division of State Parks and Outdoor Recreation on this project.

Chenega Corporation

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1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998	PROPOSED FY 1998 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
Personnel	$0.0	$80.2						
Travel	$0.0	$1.2						
Contractual	$0.0	$40.5						
Commodities	$0.0	$1.9						
Equipment	$0.0	$5.5	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$129.3		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration	$0.0	$14.9						
Project Total	$0.0	$144.2		$53.1	$0.0	$0.0	$0.0	
Full-time Equivalents (FTE)	0.0	1.4						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0		$0.0	$0.0	$0.0	$0.0	

Comments:

1998

Prepared: 1 of 9

Project Number: 98~~XX~~X 339
Project Title: PWS Human Use and Wildlife Disturbance Model
Lead Agency: US Forest Service

FORM 2A
MULTI-TRUSTEE
AGENCY SUMMARY

4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998
Personnel		$65.2
Travel		$0.0
Contractual		$38.5
Commodities		$1.3
Equipment		$5.5
Subtotal	$0.0	$110.5
General Administration		$12.5
Project Total	$0.0	$123.0
Full-time Equivalents (FTE)		1.1
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
	$47.3				

Dollar amounts are shown in thousands of dollars.

Comments:

1998

Prepared:

Project Number:98XXX
Project Title: PWS Human Use and Wildlife Disturbance Model
Agency: US Forest Service

FORM 3A
TRUSTEE
AGENCY
SUMMARY

5/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1998
K.Murphy	Project Leader	GS-9	4.3	4.4		18.9
L.Suring	Wildlife Biologist	GS-12	4.0	6.0		24.0
D.Gillikin	Fish Biologist	GS-9	2.0	4.1		8.2
Seasonal	Bio Tech	GS-7	1.0	2.6		2.6
D.Hacket	Recreation Planner	GS-12	1.0	5.7		5.7
Karen Preston	GIS	GS-9	0.5	4.6		2.3
Seasonal	Bio Tech	GS-9	0.8	4.4		3.5
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		13.6	31.8	0.0	
					Personnel Total	$65.2

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

1998

Project Number: 98XXX
Project Title: PWS Human Use and Wildlife Disturbance Model
Agency: US Forest Service

FORM 3B
Personnel
& Travel
DETAIL

Prepared:

4/15/97

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

Contractual Costs:	Proposed
Description	FY 1998
Air Charter 4 hrs @ $250/hour	1.0
Contract with Chenega Corp for planning	5.0
Air Survey contract	32.5
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$38.5

Commodities Costs:	Proposed
Description	FY 1998
Train Tickets	0.1
Training for GIS GRID	1.2
Commodities Total	$1.3

1998

Project Number: 98XXX
Project Title: PWS Human Use and Wildlife Disturbance Model
Agency: US Forest Service

FORM 3B
Contractual &
Commodities
DETAIL

Prepared:

4/15/97

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

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Computer			3.0
Soft ware			1.5
Misc supplies			1.0
			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**	$5.5

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1998

Project Number: 98XXX
Project Title: PWS Human Use and Wildlife Disturbance Model
Agency: US Forest Service

FORM 3B
Equipment
DETAIL

Prepared:

4/15/97

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$15.0						
Travel		$1.2						
Contractual		$2.0						
Commodities		$0.6						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$18.8		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$2.4						
Project Total	$0.0	$21.2		$5.8				
Full-time Equivalents (FTE)		0.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1998	Project Number: 98XXX Project Title: PWS Human Use and Wildlife Disturbance Model Agency: ADNR	FORM 3A TRUSTEE AGENCY SUMMARY

Prepared:

4/15/97

1998 EXXON VALDEZ TRUS'.__ ;OUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1998
	Natural Resource Manager	16	3.0	5.0		15.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.0	5.0	0.0	
					Personnel Total	$15.0
Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 1998
RT Anchorage to Cordova		225.0	1	5	150.0	975.0
Day trips to Whitter				5	42.0	210.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$1,185.0

1998

Project Number: 98XXX
Project Title: PWS Human Use and Wildlife Disturbance Model
Agency: ADNR

FORM 3B
Personnel
& Travel
DETAIL

Prepared:

4/15/97

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

Contractual Costs:	Proposed
Description	FY 1998
User Survey, printing, mail	2.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$2.0

Commodities Costs:	Proposed
Description	FY 1998
Train tickets	0.1
Misc supplies	0.5
Commodities Total	$0.6

1998

Prepared:

Project Number: 98XXX
Project Title: PWS Human Use and Wildlife Disturbance Model
Agency: ADNR

FORM 3B
Contractual &
Commodities
DETAIL

4/15/97

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

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1998

Project Number: 98XXX
Project Title: PWS Human Use and Wildlife Disturbance Model
Agency: ADNR

FORM 3B
Equipment
DETAIL

Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem

Project Number:	98 340
Restoration Category:	Monitoring
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	
Cooperating Agency:	
Alaska SeaLife Center:	
Duration:	1st year, 4-year project
Cost FY 98:	$79,795
Cost FY 99:	$94,100
Cost FY 00:	$62,000
Cost FY 01:	$62,800
Geographic Area:	Resurrection Bay/Gulf of Alaska shelf
Injured Resource/Service:	All organisms and services

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TRUSTEE COUNCIL

ABSTRACT

The 27-year time series of temperature and salinity data from hydrographic station GAK1 near Seward shows substantial interannual and interdecadal variability that could influence the Gulf of Alaska shelf ecosystem. This program will continue this time series and quantify the interannual and interdecadal variability of this shelf. A related goal is to resolve better the time and vertical structure of this variability at periods ranging from the tidal to the interannual. This information will aid in assessing progress in the recovery and restoration of organisms and services affected by the *Exxon Valdez* oil spill, and it will aid in designing a long-term, cost-effective ecosystem monitoring program for this shelf.

INTRODUCTION

This proposal describes a four-year program to maintain the existing 27-year time series of conductivity–temperature versus depth (CTD) data collected at hydrographic station GAK1 on the north central Gulf of Alaska shelf. We will continue this time series by monthly CTD sampling that will provide vertical profiles of temperature and salinity that extend from the surface to the bottom and with hourly sample of temperature and salinity collected by instruments at several fixed depths. These instruments will be mounted on a subsurface mooring that will be deployed year-round. Our goals are to: 1) maintain the GAK1 sampling so that the substantial interannual variability in temperature and salinity in the Gulf of Alaska can be documented, and 2) assist in building an inexpensive long-term, comprehensive monitoring program for this shelf. The GAK1 environmental data are representative of conditions in the northern Gulf of Alaska and the Bering Sea (Royer, 1993) and are being used to assess the role of environmental variability in the ecology of fisheries and marine mammals in these regions. Station GAK1 lies in 260 m of water at the mouth of Resurrection Bay, midway between Prince William Sound and Cook Inlet (Figure 1). GAK1 data should be helpful in placing many of the restoration studies sponsored by the Trustee Council in the context of interannual and interdecadal hydrographic variability. These data would also complement the goals of the Gulf of Alaska component of the U.S. Global Ocean Ecosystem Dynamics program (GLOBEC), scheduled to commence in 1998. GLOBEC is supported by the National Science Foundation (NSF) and the National Oceanic and Atmospheric Administration (NOAA). It consists of three components: monitoring, process studies, and modeling. Monitoring will begin in the Gulf of Alaska in 1998, with modeling and process studies following in 2001. The proposal described here will encourage synthesis of the ecosystem studies supported by the Trustee Council and GLOBEC. In the following paragraphs we summarize the regional oceanography and the historical data from GAK1. This background information provides the context for understanding the rationale and the design of the project described in subsequent sections.

The circulation on the shelf and over the slope of the Gulf of Alaska is predominantly alongshore and cyclonic (counterclockwise) on average (Reed and Schumacher, 1986). Along the continental slope the flow consists of the Alaska Current, a relatively broad, diffuse current in the north and northeast gulf, which intensifies to become the swift and narrow western boundary current, the Alaskan Stream, in the west and northwest gulf (Figure 2). Together these currents comprise the poleward limb of the North Pacific Ocean's subarctic gyre and provide the oceanic connection between the Alaskan shelf and the Pacific Ocean.

The Alaska Coastal Current is the most striking shelf circulation feature in the gulf, and station GAK1 is positioned along its inshore edge. The main axis of this swift (0.2–1.8 m s^{-1}) westward-flowing current is within 35 km of the coast (Royer, 1981; Johnson et al., 1988; Stabeno et al., 1995). The coastal current is a perennial feature that circumscribes the Gulf of Alaska shelf for some 2500 km (at a minimum) from its origin on the northern British Columbia shelf (or possibly even the Columbia River depending on the season) to where it enters the Bering Sea in the western gulf. The current is intimately connected to Prince William Sound; feeding the sound through Hinchinbrook Entrance and draining it primarily through Montague Strait and the westernmost passes (Niebauer et al., 1994). It is also the source of shelf waters for Cook Inlet and transports inlet waters southwestward through Shelikof Strait (Muench et al., 1981). The Alaska Coastal Current transported much of the oil spilled by the *Exxon Valdez* along the south and west coasts of Alaska (Royer et al., 1990).

The dynamics of the Gulf of Alaska shelf are closely coupled to the Aleutian Low atmospheric pressure system. Storms propagate eastward into the gulf and are blocked by the mountain ranges of Alaska and British Columbia. Consequently regional winds are strong and cyclonic and precipitation rates are very high. On the shelf, these winds impel an onshore surface Ekman drift and establish a cross-shore pressure gradient that forces the Alaska Coastal Current. The high rates of precipitation, up to 8 m yr^{-1}, cause an enormous freshwater flux (~20 % larger than the average Mississippi River discharge) that feeds the shelf as a "coastal line source" extending from Southeast Alaska to Kodiak Island (Royer, 1982). The seasonal variability in winds and freshwater discharge (Figure 2) is large. (Winds are represented in Figure 2 as the upwelling index, a measure of the strength of cyclonic wind stress in the gulf. Negative values mean coastal convergence and downwelling while positive values signify coastal divergence and upwelling. With respect to Alaska's south coast negative values imply winds blowing to the west and positive values imply that the winds blow to the east.) The mean monthly "upwelling index" at locations on the Gulf of Alaska shelf is negative in most months, indicating the prevalence of coastal convergence. Cyclonic winds are strongest from November through March and feeble or even weakly anticyclonic in summer when the Aleutian Low is displaced by the North Pacific High (Royer, 1975; Wilson and Overland, 1986). The seasonal runoff cycle (Figure 2) exhibits slightly different phasing from the winds: it is maximum in early fall, decreases rapidly through winter when precipitation is stored as snow, and attains a secondary maximum in spring due to snowmelt (Royer, 1982).

Shelf hydrography and circulation vary in response to the annual cycles of wind and runoff. Figure 3 contrasts the cross-shore salinity structure in April and September 1983. (Density gradients are important in ocean dynamics and salinity is the predominant influence on ocean density in the Gulf of Alaska.). In April, the stratification and the offshore front (defined here to be the surface intersection of the 32.0 isohaline) are relatively weak. By contrast, in September a 25 km wide wedge of strongly stratified water lies adjacent to the coast and is bounded on the offshore side by a prominent front. The swiftest alongshore flows are found within and inshore of the front (Johnson et al., 1988), and most of the total transport is associated with the baroclinic component (Stabeno et al., 1995). The latter result probably accounts for Royer's (1979) finding that monthly coastal sea level variations at Seward are in-phase with, and have nearly the same amplitude as, the upper ocean dynamic height at GAK1. (Dynamic height is a function of the vertically integrated ocean density. Horizontal gradients of dynamic height are proportional to the pressure gradients that accelerate ocean currents and provide an estimate of the oceanic transport.) His finding is remarkable given the different nature of the sampling techniques: the sea level records were sampled hourly and then averaged into monthly means whereas the dynamic heights were from hydrographic measurements at GAK1 occupied several months apart. He also found that sea-level and precipitation anomalies were well correlated.

Both of Royer's results suggest that there might be a relationship between monthly (and perhaps shorter period) *cross-shelf dynamic height (or upper ocean density) gradients* and winds and/or freshwater discharge. Conceivably, the monthly anomalies of these variables are also correlated. If firm relationships among these parameters can be established, then the alongshelf (baroclinic) transport might be gauged from a conveniently located (e.g., GAK1) hydrographic station or mooring. Moreover, observations at a single location would probably reflect fluctuations in transport along vast portions of the shelf since variations in forcing (wind and runoff) are also coherent over a broad alongshore distance (Royer, 1982, Livingstone and Royer, 1980). Such a result would be enormously useful for model evaluation (and perhaps for data assimilation), retrospective studies, and monitoring.

It is very likely that transport variations in the Alaska Coastal Current affect the survival and/or condition of a number of marine organisms. This flow is apparently important in advecting zooplankton to important juvenile fish foraging areas. Napp et al. (1996) and Incze and Ainaire (1994) find that the major cohort of naupliar stage larvae available to first-feeding pollock larvae in Shelikof Strait originate in February–March on the shelf offshore of Prince William Sound and east of GAK1. Other studies indicate that the coastal current is an important feeding and migratory corridor for numerous species of marine mammals (Calkins, 1986) and seabirds (DeGange and Sanger, 1986).

Figure 3 also suggests that near-bottom salinities are higher in fall than in spring and this is the case on annual average. Xiong and Royer (1984) showed that maximum bottom salinities occur in fall and are nearly coincident with minimum surface salinities and maximum inshore stratification (Figure 4). Although surface waters are diluted by coastal discharge (which peaks in fall), the source of the high salinity water is the onshore intrusion of slope water (Figure 5) in response to the seasonal relaxation (or reversal) in downwelling (Royer, 1975; 1979). The deep water influx in summer from across the continental slope could be important in re-supplying nutrients to the Gulf of Alaska shelf and adjacent embayments and therefore, plays an important role in biological production.

The oceanographic description sketched above stems from research that began in 1970. Beginning that year research vessels from the University of Alaska and other organizations opportunistically sampled station GAK1 while in transit to and from the Seward Marine Center. This ad hoc sampling, conducted at nominally monthly intervals, was the beginning of what is now a 27-year time series for this station. Sampling became more routine (~monthly) in the past five years with support from NOAA and using a 25 foot vessel operated by the University of Alaska's Institute of Marine Science. As a result of these efforts the GAK1 data set comprises the longest ocean time series for the high-latitude North Pacific Ocean, and the only one that includes salinity (Royer, 1993). These data reveal substantial interannual and decadal scale variability in both temperature (Royer, 1993) and salinity (Royer, 1996).

For example, Royer (1993) showed pronounced interdecadal temperature variations that [illegible] colder water in the 1970s, followed by warmer conditions in the 1980s and a return to normal or cooling conditions in the 1990s. Coincidentally, the relative dominance of commercially important fish species changed in the mid-1970s; crab and shrimp declined while salmon and groundfish populations increased (Albers and Anderson, 1985; Blau, 1986; Hollowed et al., 1994; Thompson and Zenger, 1994; Francis and Hare, 1994). These population shifts coincided with the beginning of a decadal North Pacific change in the atmosphere and ocean (Trenberth and Hurrell, 1994). Subsequent changes in this ecosystem followed in the 1980s with substantial declines in populations of sea lions (Merrick et al., 1987) and puffins (Hatch and Sanger, 1992).

Royer (1993) also showed that Sitka (Alaska) air temperature variability (for which records extend back to the mid-1800s) correlates with the GAK1 temperature anomalies at 200 and 250 m depths. He found that the 18.6 year lunar nodal tide accounts for a statistically significant fraction of the Sitka air temperature variability. Using the Sitka air temperatures as a proxy for shelf water temperatures, Parker et al. (1995) subsequently showed that the abundance of halibut and other commercially important species varies on a similar time scale and in conjunction with northern North Pacific Ocean temperatures. While these correlations do not imply causality, they underscore the possible significance of monitoring ocean climate to detect both periodic changes and more radical shifts in the marine environment.

There are also low-frequency variations in upper ocean salinities at what might be an 11–12 year period, which Royer (1996) ascribed to variations in runoff and precipitation. Much of the interannual variability in precipitation in the Gulf of Alaska is associated with changes in the strength and position of the Aleutian Low (Cayan and Peterson; 1989). Changes in upper ocean salinity could affect circulation in the Alaska Coastal Current and also influence biological production by varying frontal properties and the vertical stratification of the water column (Mann and Lazier, 1991). The GAK1 data also show substantial interannual variations in bottom water salinities, although these are not linearly correlated with variations in surface salinity. The absence of a correlation is not surprising because near-bottom salinities are linked to shelfbreak processes, while surface variations are associated with precipitation and runoff.

Salinities of deeper shelf water (depths > ~125 m) are likely correlated with nutrient concentrations at these depths. This potentially valuable relationship is suggested by Figure 6 showing the salinity–NO_3 relationship at stations within the Alaskan Stream and on the western shelf. The data come from the only synoptic deep ocean and shelf nutrient data available for the northern Gulf of Alaska, collected in May–June 1993, between 125 and 450 m depth during the WOCE (World Ocean Circulation Experiment) P17N section. This depth interval covers the range of bottom water salinities observed by Royer (1996) and Xiong and Royer (1984) and the correlation appears to be good. Note that a change in salinity from 32.0 to 33.0 involves a near doubling of the NO_3 concentration. Similarly tight relationships are apparent in plots of salinity versus phosphate and silicate. If salinity–macronutrient relationships can be statistically quantified for the shelf it might be possible to use the GAK1 salinity time series as a proxy for subsurface nutrient concentrations. This relationship could be exploited in retrospective studies and would aid in the design and maintenance of future monitoring programs because salinity can be accurately measured much more easily (and inexpensively) than nutrients.

In summary several data sets now suggest that the Gulf of Alaska ecosystem is sensitive to environmental variations on time scales ranging from interannual to interdecadal. Other data sets suggest possible biophysical linkages that cause these ecological responses. However, we lack an adequate characterization of shorter period (seasonal to synoptic) variations that might impinge on the biological components of this ecosystem. Moreover, a mechanistic understanding of the physical dynamics of the Gulf of Alaska shelf and the processes linking environmental variability to ecosystem alterations is lacking. These are complex problems that require a concerted and interdisciplinary approach involving process-specific studies in addition to ecosystem monitoring. Some of these programs (APEX and SEA) are sponsored by the Trustee Council while a new initiative, the US Global Ocean Ecosystem Dynamics program will begin in 1998 on the Gulf of Alaska shelf. The GLOBEC program is specifically designed to elucidate details of the mechanisms underlying physical and biological environmental change on the shelf. For example, the nutrient cycles and concentrations on the Gulf of Alaska shelf are poorly understood at present (Reeburgh and Kipphut, 1986) but will be investigated in the GLOBEC program. Those results should benefit the monitoring proposed herein. In tandem, the GLOBEC and Trustees supported efforts will lead to improvements in ecosystem monitoring.

While the GAK1 time series has illuminated ocean variations having potentially significant ramifications for the marine ecosystem, the monthly sampling will not detect what might be important variations on shorter time scales. Present-day technology now allows inexpensive and accurate sampling at high temporal resolution of temperature and salinity from moorings deployed year round. In combination with monthly CTD sampling, this technology will enhance the value of the historical record, maintain the GAK1 time series, and contribute to the design of long-term ecosystem monitoring programs. The collection of these data form the basis of this proposal.

NEED FOR THE PROJECT

A. Statement of the Problem

The GAK1 monthly time series portrays the very large interannual and interdecadal variability of the high latitude North Pacific. With a greater sampling rate, shorter period variations can be detected, revealing any temporal aliasing problems. The results will enhance interpretations of the historical data and place the magnitude of previous anomalies in a better statistical framework. Moreover, the time series could serve as a proxy for transport in the Alaska Coastal Current. Variability in the marine environment, as reflected in ocean temperatures and salinities, and, if possible, shelf circulation, need to be quantified to understand the structure of, and changes in, the northern Gulf of Alaska marine ecosystem. Such changes might influence the recovery of many of the marine species and marine services listed in Table 4 of the Proposal Invitation. In conjunction with the historical data set from GAK1, the monitoring program described below will provide a useful data set to EVOS investigators and others concerned with ocean climate variations.

B. Rationale/Link to Restoration

This monitoring proposal provides an information service to current and future investigators working in the Gulf of Alaska and adjacent waters who need information on environmental variability. The information will help assess recovery and restoration progress by allowing these issues to be analyzed within the context of the long-term variability of the physical environment.

The GAK1 data set provides some of that information and the proposed measurements will enable continuation of these efforts by collecting time series at GAK1 of:

1. Monthly temperature and salinity at every meter throughout the water column using a conductivity–temperature–depth (CTD) instrument, and
2. Hourly temperature and salinity at several fixed depths distributed throughout the water column.

This information will assist in:

1. Understanding thermohaline variability on time scales ranging from the tidal to the interdecadal,
2. Interpreting historical data sets for use in retrospective studies,
3. Configuring a cost-effective long-term monitoring program, and
4. Designing process studies necessary to develop ecosystem models for this shelf.

C. Location

The field work will be conducted at Station GAK1 at the mouth of Resurrection Bay. Both the CTD work and the mooring deployment and recovery operations will be conducted from the Seward Marine Center using the 25 foot vessel, *Little Dipper*. All data collected as part of this program will be available to any who desire it via files on internet. The monthly CTD data will be combined with the existing historical data that are on the homepage, http://ims.alaska.edu:8000/gak1/gak.dat. A new homepage will be created for the hourly time series after mooring recovery and editing of the data. The homepages will be linked.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

We do not see any overt connection to traditional ecological knowledge. However, the most expedient way to share these data with both the public and scientific communities is via the internet. Such a link will allow easy access to the data for those working at the community level and with traditional ecological knowledge. The principal investigator is a member of the National Science Foundation's Partners in Science Program and is interested in sharing these data with the K–12 public school system. Again, this connection is primarily effected through the internet and broadens the public's ability to understand the marine environment and research. Through the Partners in Science Program, school children can explore marine science by accessing and using the data from GAK1. At this moment, the Partners program includes public schools (and home schoolers) in the Fairbanks, Grayling, Anchorage, and Juneau school districts. This data will form the basis of educational modules that explore ocean variability at time scales ranging from the interdecadal to the semi-diurnal. More importantly, student and teacher access to this data will allow them to explore it according to their own interests. Very likely these data will eventually contribute to displays at the Alaska SeaLife Center. We have had preliminary discussions with the Executive and Science Directors of the center regarding this matter.

PROJECT DESIGN

A. Objectives

There are two overarching objectives of this multi-year program. First, we want to continue the 27-year time series at station GAK1 through a combination of monthly CTD measurements and year-long deployments of a mooring containing temperature and conductivity (T/C) recorders. Second, we want to contribute to the design of a monitoring program for the Gulf of Alaska shelf. The optimal system is one that is cost-effective yet minimizes contamination associated with spatial and/or temporal aliasing in sampling. It is unclear if aliasing is a problem and neither sampling procedure alone can adequately address this issue. The CTD measurements provide high vertical resolution but, with monthly sampling, they could lead to temporal aliasing. In contrast, the T/C data provides high temporal resolution but could be spatially aliased because they are distributed over a limited number of depths. The sampling schemes complement one another and can resolve these problems. We recognize that our generic goal of ecosystem monitoring is a long-term undertaking requiring incremental efforts. This proposal is one essential step toward that goal and to guide our efforts we have formulated several project–specific objectives. These are:

1. Determine the within-month variance of temperature and salinity at a given depth. Such data are lacking and it is difficult to determine the significance of a single monthly measurement (as determined from the CTD data) relative to the variability observed within a given month. These basic statistics can be used to estimate the statistical significance of temperature or salinity anomalies observed in the past. This information will be placed on the GAK1 homepage so that users will have access to it as they use the historical data.
2. Determine the rate of change of water mass properties (temperature and salinity) and the phasing of these changes at different depths. Some of these features might be temporally aliased by monthly sampling. These changes need to be resolved to understand the dominant oceanic time scales and the relationship between low-frequency variations (monthly and longer) and shorter period fluctuations (synoptic scale events). The data files will be made available on the time series homepage for downloading and as a graphical display. Key events will be highlighted and discussed as part of the graphical display.
3. Determine how variance in temperature, salinity and dynamic height are distributed seasonally and over depth. Are there distinct vertical "modes" of variability that change with season? These results will also be summarized in a file containing textual, tabulated, and graphical information and will be accessible via the time series homepage.
4. If the temperature/conductivity recorders provide a useful estimate of dynamic height, then determine the joint effects on Seward sea-level of dynamic height and winds. Over what time-scales are these variables coherent with one another and with Seward sea-level? The results will be placed on the time series homepage.

The first three objectives will continue the historical data base and aid in monitoring design. The fourth objective is a feasibility study that will contribute to monitoring design.

B. Methods

Funds are requested to monitor Gulf of Alaska temperature and salinity through FY 01, at which time a restructuring of the program described here will probably occur. By this time, the APEX and SEA programs will be completed and preliminary results from the U.S. GLOBEC sponsored Gulf of Alaska monitoring component will be available (US GLOBEC, 1996). Accomplishments from these programs (and from the work proposed herein) will catalyze a reconsideration of the monitoring effort. In addition, researchers working at the Alaska SeaLife Center will probably have monitoring interests to be considered as well.

We propose to collect data monthly with the Institute of Marine Science's 25' *Little Dipper* using a Seabird SBE-25 internally-recording CTD deployed from the vessel's winch. The sensors on this CTD are calibrated annually by the manufacturer. Field checks on the conductivity sensor are made from bottle salinities collected during each cast and analyzed on the salinometer at the Seward Marine Center. This procedure allows detection of CTD drift between calibrations by the manufacturer. The historical salinity data has an accuracy of ~0.01 or better using this instrument and these procedures. Temperatures are accurate to within 0.005°C.

The monthly sampling will be complemented by hourly measurements from six temperature/conductivity recorders (Seabird MicroCats; SBE model 37-SM) incorporated in a taut wire, subsurface mooring at GAK1. The mooring can be deployed and recovered by the *Little Dipper* during the CTD cruises. The instruments will make hourly measurements at nominal depths of 30, 60, 100, 150, 200, and 250 meters. This distribution covers the near-surface (30 m), the upper ocean (30–100 m), mid-depth (150–200 m) and bottom (200–250 m) of the water column. (Although observations at the surface would be useful, obtaining these would entail a mooring with substantially higher hardware and fabrication costs and the need for a larger vessel for servicing.) The MicroCat at 30 m depth includes a pressure sensor to measure mooring motion. (Strong currents can cause the mooring to lean with the flow, which results in instruments sampling at depths other than those desired. While we do not believe that this will be a severe problem at GAK1, the possibility needs to be assessed. Data from the uppermost instrument is most susceptible to contamination by mooring motion. The pressure data will identify suspect sections of the data record. These portions might be correctable using the monthly CTD data with the time record of instrument depth.)

Our prior experience with Seabird instruments similar to the MicroCats stems from nearly 25 year-long deployments in the Chukchi Sea. The maximum drift (and therefore uncertainty) in salinity over a one year period was ~0.05. More often salinity uncertainties were ~0.01, an order of magnitude smaller than anomalies reported by Royer (1996). Finally, the monthly CTD sampling will provide an additional check on MicroCat performance.

We request funds for the purchase of two sets of mooring equipment (MicroCats and acoustic releases) so that continual monitoring can be maintained while instruments are being serviced and/or calibrated annually. These procedures require that instruments be out of the water from 3–4 months. Therefore, reliance on a single set of equipment would mean that one-fourth to one-third of the annual cycle would not be acquired by the moored instruments. We envision purchasing one mooring in FY 98 and a second in FY 99. Thereafter, only expendable parts would need to be purchased as the instruments will be recycled. This procedure will leave data gaps of only a few hours duration at most.

The analyses of the data sets are straightforward.

Objective 1 will be achieved using univariate statistics. The effective number of degrees of freedom, based on the integral time scales for the temperature and salinity time series, will be used to construct confidence limits. The integral time scales are determined from the autocorrelation function (e.g., Kundu et al., 1975) and provide insights on the temporal characteristics of these variables at each depth.

Objective 2 is largely concerned with temporal aliasing issues associated with monthly sampling. Among the important processes that might be aliased are the summer onshelf influx of dense bottom water, changes in upper ocean stratification throughout the year as a consequence of winds and runoff, and the response of the thermohaline structure of the water column to synoptic scale forcing by the wind.

Objective 3 will be achieved by examining the empirical orthogonal functions (EOFs) of the temperature and salinity time series. The EOFs decompose the system variance into a set of linearly independent functions with each describing a unique spatial and temporal structure. For the mooring data the system variance would be that computed from the salinity (or temperature) time series at all depths. Six EOF modes will result from the analysis because six depths are sampled. The modes are ordered by the proportion of the total system variance that each comprises; the first mode accounts for the greatest fraction of system variance and the sixth mode accounts for the smallest proportion. Often only a few modes are required to describe the system variance and the significance of a given mode will be assessed following Overland and Preisendorfer (1982). The spatial structure of a mode describes the distribution of amplitude with depth, while its temporal structure describes how the mode varies through time. The EOFs are useful in consolidating large and complicated data sets into smaller correlated subsets that facilitate physical interpretation. They might also contribute to future monitoring design by suggesting times and/or depths that are either over or under sampled. In the latter case, the EOFs could identify potential temporal or spatial aliasing problems.

Objective 4 will correlate winds and upper ocean density (dynamic height) with Seward sea-level. This motivation follows from Royer's (1979) observation of a statistically significant relationship between monthly dynamic height and Seward sea level. His findings suggest that a time series of sea-level and/or dynamic height at a single location might provide an index of transport variability in the Alaska Coastal Current. To firmly establish the relationship between coastal transport and sea-level will require making direct current measurements in [illegible] current and comparing these with sea level. While such measurements are beyond the scope of this proposal, detection of significant relationships would provide compelling support to undertake a more ambitious transport measurement program. We regard this last objective as a feasibility study that will relate sea-level fluctuations to the two dominant forcing mechanisms for the shelf circulation: freshwater (which affects upper ocean density) and alongshore winds.

The statistical analyses will entail multi-variate spectral techniques (Groves and Hannon, 1968; Bendat and Piersol, 1971) to examine the multiple and partial coherences among the independent (winds and dynamic height) and dependent (sea-level) variables. This technique, analogous to partial and multiple correlation, identifies statistically significant relationships among these variables as a function of frequency (time period). Estimates of dynamic height using the MicroCats will depend upon the numerical technique used to perform the vertical integrations. The choice will be guided by comparisons of dynamic height with high resolution CTD data and consideration of EOF results.

Our analysis will use winds derived from gridded surface pressures available from NOAA's Pacific Fisheries Environmental Group (PFEG) on a 1° by 1° grid at six-hourly intervals. We will follow Luick et al.'s (1987) calculation procedure. These pressure fields are based on a blend of observations and forecasts from numerical models made by the U.S. Navy's Fleet Numerical Meteorology and Oceanography Center (FNMOC). Hourly sea-levels for Seward are available from the Ocean and Lakes Level Division of NOAA and through their homepage. Atmospheric pressure for correcting sea level is collected from a weather package at the Seward Marine Center.

SCHEDULE

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

October 1	Begin purchase of mooring equipment (MicroCats, etc.)
October 15 September 15	Monthly CTD surveys scheduled at mid-month, update homepage as CTD data are processed and edited; prepare wind fields and correct sea level for atmosphere pressure effects as the pressure data become available from PFEG
November - December, 1997	Deploy mooring (the mooring will be deployed as soon as instruments can be delivered from the manufacturer) during this month's CTD sampling
September 1998	If FY 99 field monitoring is not funded then recover mooring, send MicroCats for post-calibrations, begin data processing. Otherwise mooring will be recovered in November or December of 1998 when replacement mooring is deployed

B. Project Milestones and Endpoints

The data collected as part of this project will be available to a broad community of users. We anticipate that some will want "immediate" access to it. This desire often conflicts with the goal (and required time) of producing data of the highest possible quality. From past experience the final CTD data are generally placed online 1–2 months after collection. The final edited temperature and salinity data from the mooring should be ready three months after instrument recovery. The delays arise because of post-calibration requirements (performed by the manufacturer) and final editing of the data sets (performed at the Institute of Marine Science).

We intend to make much of the data, along with preliminary results, available for rapid dissemination. From a practical point of view this approach is prudent because for many users the differences between the raw and the final edited product are insignificant. We will attach appropriate warnings concerning data quality to both preliminary and final data products. Thus we anticipate making most of the data available on the homepage one month after recovery of the mooring. However, we will not release any data for which there are severe concerns regarding quality unless and until these concerns are resolved. In addition to these general considerations we anticipate the following project milestones:

1. The first objective pertains to basic statistical results which will be made available in both preliminary and final fashion. When the final data product is ready we will update the GAK1 CTD homepage describing these statistics and their relevance to historical GAK1 data.
2. The second objective is to examine rates of change of water mass properties (temperature and salinity) and the phasing of these changes at different depths. This work is largely descriptive and will begin immediately after instrument recovery. Graphical data displays will be made available within 1–2 months of recovery. These will include textural information indicating features of interest. Displays will be updated periodically as new findings emerge. Eventually these results will be merged with those of the third objective.
3. The third objective provides the modal description of system variance. These calculations are straightforward and the results and preliminary interpretations would be made available within two months of mooring recovery. Further interpretation will entail more reflection and likely require completion of the last objective.
4. Four months after recovering the mooring, correlations among winds, corrected sea-level, and upper ocean density will begin. We will first compare dynamic height determined from CTD data with that from the moorings. Combining these results with those from objective 3, we will perform the multiple coherence calculations. We estimate that this objective will be completed two months after beginning.

If the mooring is recovered in September 1998, all objectives will be reached by early April 1999. If the mooring is recovered in November 1998, all objectives will be reached by early June 1999. Similar type analyses and schedules will occur for each year of support. Comparison of the results between years will provide additional indications of statistical variability.

C. Completion Date

This project will be completed in FY 01.

PUBLICATIONS AND REPORTS

No manuscripts will be submitted in FY 98. Data and results will be provided via internet as indicated above.

PROFESSIONAL CONFERENCES

No conference presentations will be made in FY 98 because data collection will not be completed.

COORDINATION AND RESTORATION

We have discussed aspects of the GAK1 historical data with several investigators supported by the Trustee Council. Many have expressed interest in these data and know how to access it. Other scientists are aware of these data through papers and meetings, (e.g., the American Geophysical Union which serves primarily the US oceanographic community and the North Pacific Marine Science Organization [PICES] comprised of marine scientists from around the Pacific Rim). While we discussed how we would make these data available in previous sections, we welcome advice from the Trustee Council on additional ways to share these data with other investigators and/or the public.

Several UAF scientists are co-investigators on a GLOBEC proposal whose results would complement this proposal. The UAF investigators (Haldorson, Paul, Coyle, Weingartner) along with Royer (Old Dominion University) and Whitledge (University of Texas) have submitted an interdisciplinary proposal to the NSF/NOAA GLOBEC program to examine the Gulf of Alaska shelf ecosystem for the three year period 1998–2000. That proposal calls for six R/V *Alpha Helix* cruises spaced throughout the year to examine the cross-shelf hydrography (including nutrients) and the distribution of phytoplankton, primary production, zooplankton and fish (mainly juvenile salmon and forage fish) in relation to the physical environment.

We see these programs as highly complementary in several ways. First, the cross-shelf hydrography will provide a basis for comparison with variations observed at GAK1. Second, a sufficient number of cross-shelf dynamic height *gradients* (proportional to the ocean transport) would be available (36 in three years) to examine the correlation between this gradient and dynamic height at GAK1. This result will help determine if dynamic height at a single station can provide an index of transport in the Alaska Coastal Current. Third, a comprehensive nutrient data set will be made available for establishing the type of correlations alluded to in the introduction. If significant correlations are obtained at several depths in the water column, then the GAK1 data would be a proxy indicator of historical variations in nutrient concentrations (for some depths).

The GLOBEC proposal makes connections to other investigators. For example, we have offered berth space on the *Alpha Helix* during our GLOBEC cruises to Dr. Robert Day of Alaska Biological Research, Inc., Fairbanks, for his seabird and marine mammal studies. (Dr. Day is submitting a proposal to the Trustees for this project.) Dr. Jeffrey Napp of the NOAA Alaska Fisheries Science Center in Seattle has submitted a GLOBEC proposal to join our cruises to conduct specialized zooplankton hydroacoustic studies. He hopes to a "acoustically tune" a hydroacoustic package to the zooplankton assemblages of the Gulf of Alaska shelf. By so doing he will have an optimally configured instrument that could be incorporated into a mooring for long-term monitoring purposes.

Dr. Geoffrey Wheat, a chemical oceanographer with the West Coast National Undersea Research Center, will contribute an automatic nutrient analyzer for installation on the mooring. At no cost to the Trustee Council, we will install his instrument at the 30 m depth where it will take daily measurements of nitrate, silicate, and phosphate throughout the year. As part of the monthly CTD sampling from the *Little Dipper*, we will collect bottle samples for nutrients that he will analyze for comparison with the instrument results. This in-kind contribution by Dr. Wheat is roughly valued at $8,000. Assuming satisfactory performance of this instrument, his results will constitute the first year-round synoptic nutrient measurements from the Gulf of Alaska shelf. Of equal importance, the GAK1 mooring will provide an opportunity to assess the potential contribution of this technology in long-term ecosystem monitoring.

Additional support for this program will be provided by the University of Alaska Fairbanks' Office of Arctic Research (OAR). OAR will provide funds in FY 98 for the purchase of two of the Microcats for use in this program. Hence, the proposed FY 98 budget reflects an equipment request of four Microcats.

The effort described in this proposal takes a modest, but important step toward achieving the goal of long-term, comprehensive ecosystem monitoring. There are compelling scientific and logistical reasons for believing that GAK1 will be a long-term site and that the sampling will eventually expand to include other disciplines. Resurrection Bay and the adjacent ocean are paradigmatic for much of the Gulf of Alaska shelf and this area is easily accessible by marine scientists at Seward. Although our understanding of chemical cycling and biological processes on this shelf is limited at the moment, programs such as SEA, APEX, and GLOBEC will provide substantial new information for these disciplines. Results from these programs and those anticipated from the work proposed herein will contribute to the design of a comprehensive long-term monitoring strategy. Additional impetus for expanding the monitoring activities at GAK1 will occur as programs at the Alaska SeaLife Center evolve.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

THOMAS J. WEINGARTNER

EDUCATION:

Ph.D. Physical Oceanography, 1990, North Carolina State University
M.S., Physical Oceanography, 1980, University of Alaska
B.S., Biology, 1974, Cornell University

MEMBERSHIPS:

American Geophysical Union; American Meteorological Society

PUBLIC SERVICE:

Member, Science Steering Committee, NSF – Arctic System Science–Ocean Atmosphere Ice Interaction (OAII) component.
Member, Science Steering Committee, NSF – ARCSS–OAII Shelf–Basin Initiative
Member, Science Steering Committee, NSF – ARCSS–Human Dimensions of the Arctic component
Member, UNOLS – Fleet Improvement Committee; UNOLS – Arctic Icebreaker Coordinating Committee
Member, Partners in Science Program with the Fairbanks North Star Borough School District

PROFESSIONAL EXPERIENCE:

Assistant Professor; Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks 11/93 – present
Research Associate; Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks; 9/91 – 10/93
Postdoctoral Student; Institute of Marine Science, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks; 7/88 – 8/91
Graduate Research Assistant; Department of Marine, Earth and Atmospheric Sciences, North Carolina State University; Raleigh, North Carolina; and Department of Marine Science, University of South Florida; St. Petersburg, Florida; 8/84 – 10/88

PROFESSIONAL INTERESTS:

Physical oceanography of the Arctic and North Pacific Ocean and the adjacent shelves, biophysical linkages in oceanography; public education.

PUBLICATIONS:

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MANUSCRIPTS IN PREPARATION:

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Weingartner, T.J., K. Aagaard, and Y. Sasaki. Circulation in Barrow Canyon and implications on shelf–basin exchange.

Weingartner, T.J. and A. Münchow. Summer conditions in the East Siberian Sea: the enigma of arctic coastal currents.

OTHER KEY PERSONNEL

Dave Allen is the technician responsible for the design and deployment of the mooring.

Phyllis Shoemaker is the Seward based marine technician who will conduct the monthly CTD sampling from the *Little Dipper*. Both are employees of the Institute of Marine Science.

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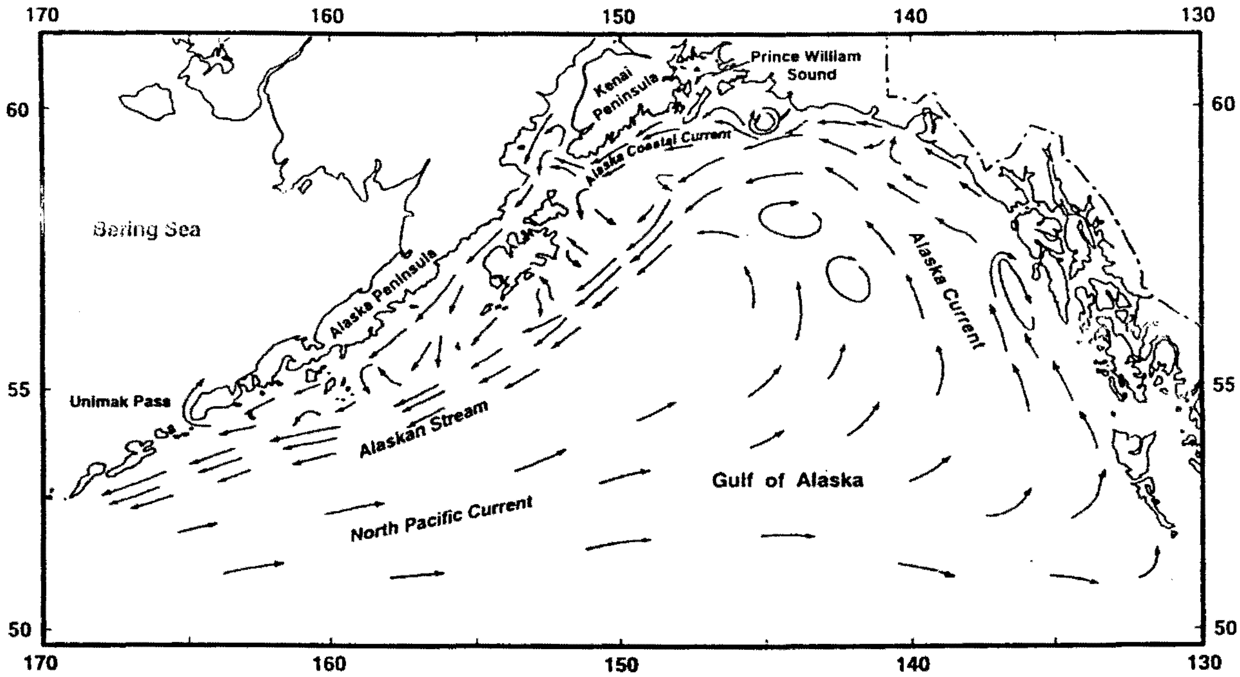

Figure 1. Schematic of the circulation of the Northeast Pacific and Gulf of Alaska (From Reed and Schumaker, 1986).

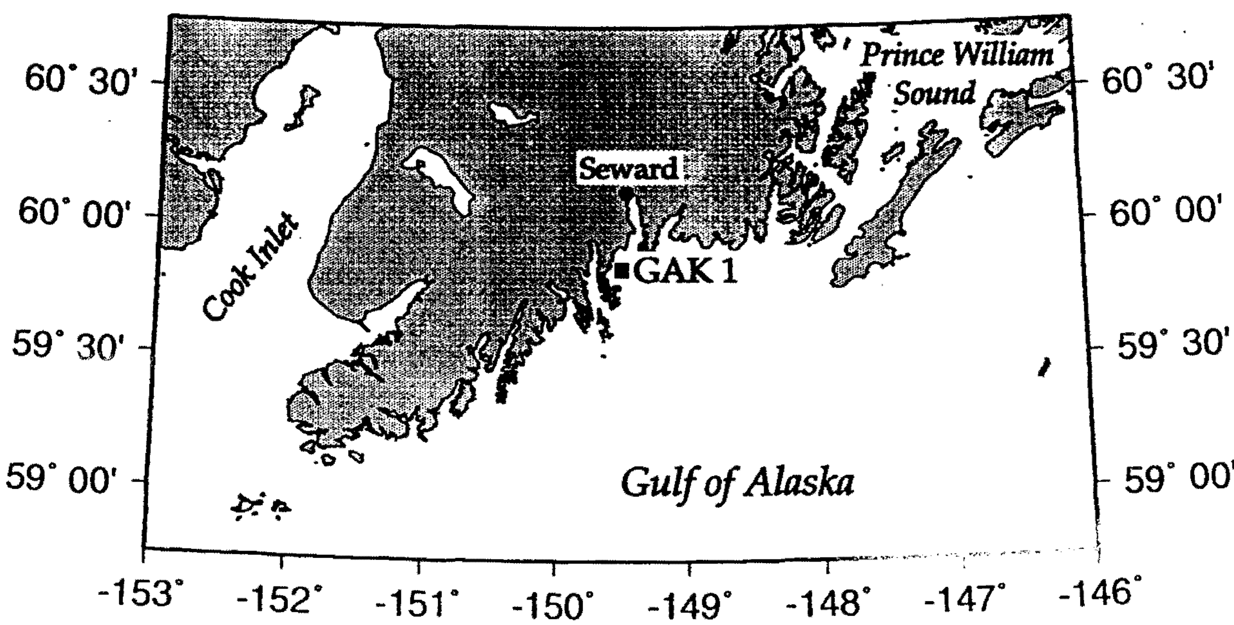

Figure 2. Map showing location of hydrographic station GAK1 in relation to Prince William Sound, Cook Inlet and Seward.

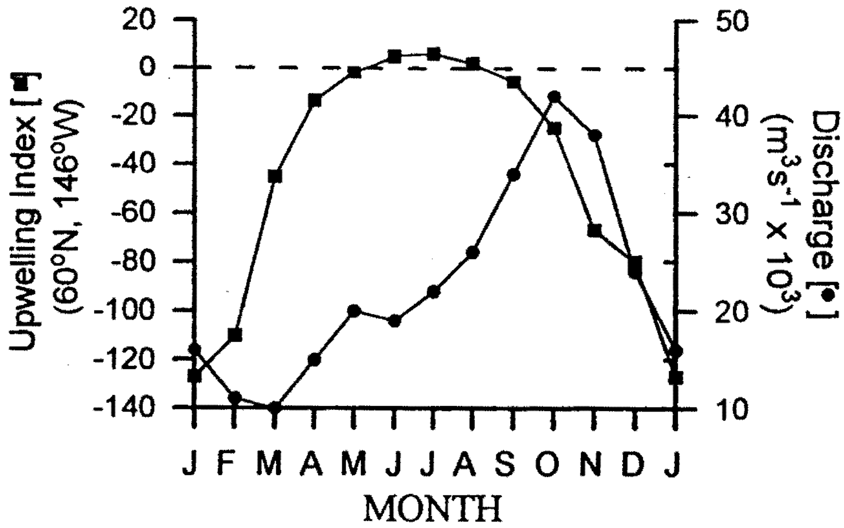

Figure 3. Mean monthly values of the upwelling index (from 1946–1995) and the estimated freshwater discharge (from 1930–1992) into the Gulf of Alaska using the hydrology model of Royer (1982).

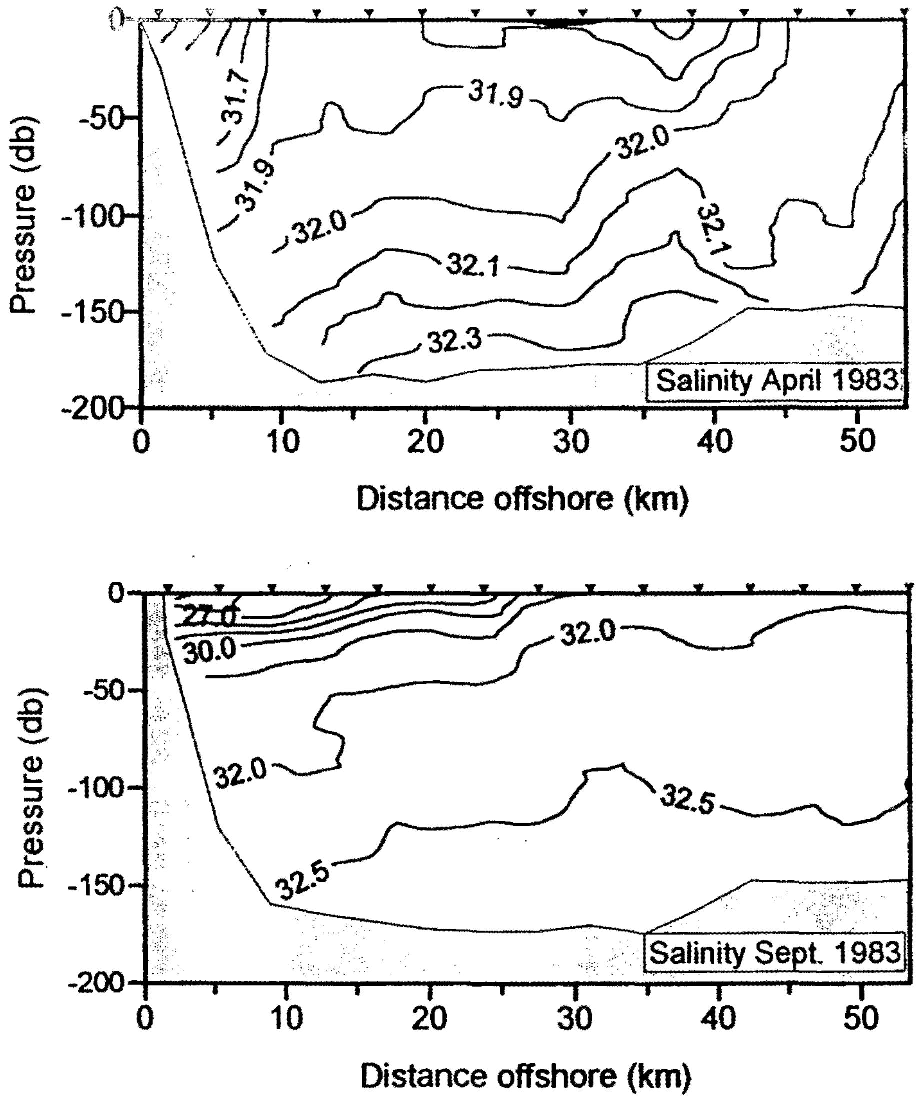

Figure 4. Contours of salinity as a function of depth and position in the Gulf of Alaska on a cross-shelf transect near GAK1. The upper panel is from April 1983 and the lower panel is from September 1983.

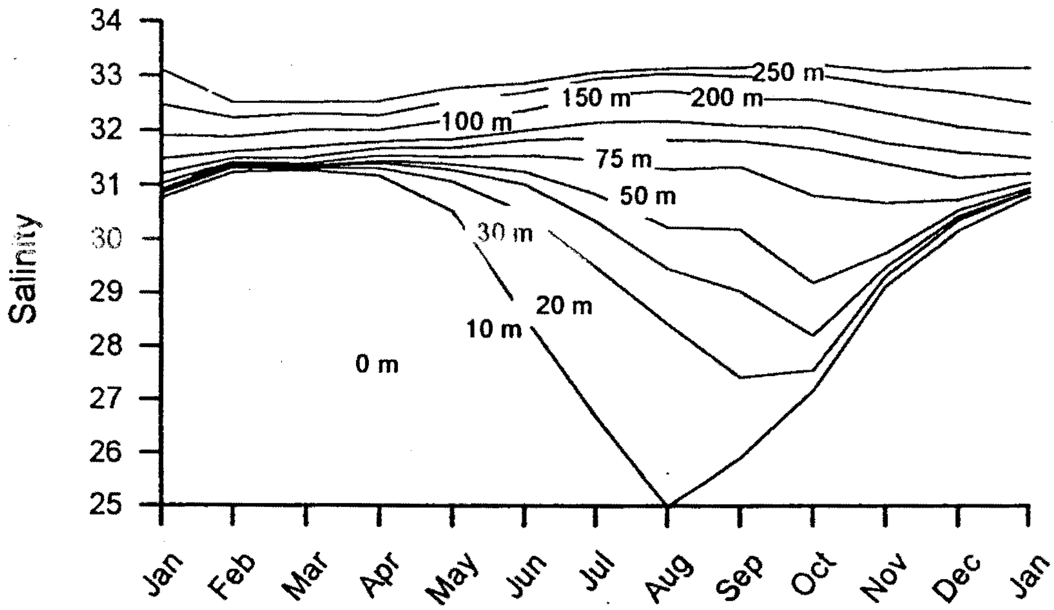

Figure 5. Mean monthly salinity at GAK1 as a function of depth. The means are computed from data collected between 1970 and 1996.

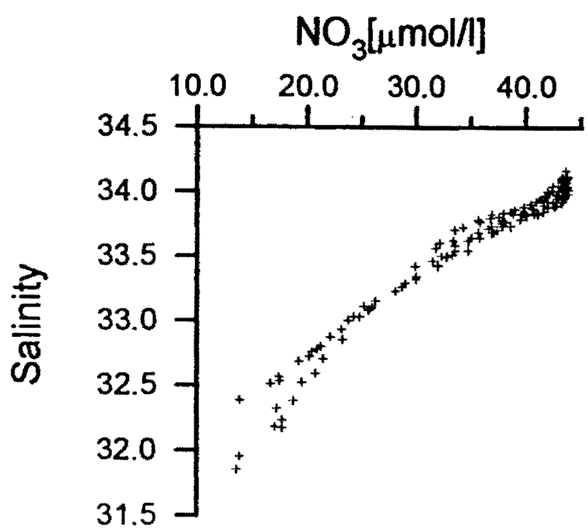

Figure 6. NO3-salinity scatter plot from the shelf and slope of the northwest Gulf of Alaska in May–June 1993.

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

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$26.5						
Travel		$3.1						
Contractual		$8.3						
Commodities		$2.1						
Equipment		$23.8	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$63.8	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Indirect		$16.0						
Project Total		$79.8	$94.1	$62.0	$62.8			
Full-time Equivalents (FTE)		0.4						
	Dollar amounts are shown in thousands of dollars.							
Other Funds								

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

FY 98

Prepared: 04/11/97

Project Number: 98340
Project Title: Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUS . __ COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:		Months	Monthly		Proposed
Name	Position Description	Budgeted	Costs	Overtime	FY 1998
T. Weingartner	Professor – P.I.	1.0	6.6		6.6
S. Sweet	Technician	1.0	4.0		4.0
E. Shoemaker	Technician	1.0	4.8		4.8
D. Allen	Technician	1.8	4.6	2.6	11.1
	Subtotal	4.8	20.0	2.6	
				Personnel Total	$26.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
Fairbanks - Seward -- place oceanographic equipment/mooring	200	2	10	155	2.0
Fairbanks - Anchorage -- Attend EVOS Meeting	200	1	5	187	1.1
				Travel Total	$3.1

FY 98

Prepared: 04/11/97

Project Number:
Project Title: Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

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

Contractual Costs:	Proposed
Description	FY 1998
CTD Calibration	0.6
Shipping of instrumentation	0.2
Microcat calibrations -- 6 @ $500/each	3.0
Vessel Charter -- Little Dipper 6 full days @ $500/day, 6 half days @ $250/half-day	4.5
Contractual Total	$8.3

Commodities Costs:	Proposed
Description	FY 1998
Batteries, O-rings, tools	1.0
Safety Shackles and Sling Links for moorings	0.3
Mooring thimbles	0.1
Mooring anchor and lashing chain	0.3
Standard salinity seawater, 12 @ $30/vial	0.4
Commodities Total	$2.1

FY 98

Project Number:
Project Title: Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem
Name: University of Alaska Fairbanks

FORM 4B
Contractual &
Commodities
DETAIL

Prepared: 04/11/97

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

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Seabird Electronic SBE 37 SM w/pressure	1	4,355	4.4
Seabird Electronic SBE 37 SM	3	3,155	9.5
Edgetech BACS 8202 Acoustic Release	1	10,000	10.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$23.8

Existing Equipment Usage: Description	Number of Units	

FY 98

Project Number:
Project Title: Toward Long-Term Oceanographic Monitoring of the Gulf of Alaska Ecosystem
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 04/11/97

98341

Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet

Project Number:	98341
Restoration Category:	Research
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	
Cooperating Agencies:	None
Alaska SeaLife Center:	Yes
Duration:	1st year, 4-year project
Cost FY 98:	$124,105
Cost FY 99:	$116,900
Cost FY 00:	$124,100
Cost FY 01:	$85,400
Geographic area:	Kenai Peninsula, Seward
Injured Resource:	Harbor seal

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APR 15 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT

This program begins a long-term study that quantifies the impact of feeding controlled fish diets on the health and body condition of harbor seals. Even though health status biomarkers for marine mammals in Prince William Sound were established during field trials, the critical test on how each marker varies in an individual seal fed differing prey diets has not been conducted. The ability to test these markers directly, under controlled conditions, is now available at the Alaska SeaLife Center. This project proposes to conduct those experiments on harbor seals, but the approach would apply to any of the injured top predators, whether bird or mammal.

INTRODUCTION

An underlying component of the ecosystem-based research approach supported by the Trustee Council has been the hypothesis that food limitation could be inhibiting the recovery of injured species in the Prince William Sound (PWS). Inherent in this concept is the assumption that food stressed animals can be distinguished by population-wide surveys of critical health parameters. Following this approach, an extensive sampling effort by multiple projects established a series of biomarkers used to profile the health and body condition of wild populations of marine mammals inside PWS. Population health status and body condition indices were, and continue to be, developed and tested for a range of birds, sea otters and seals. On the basis of this wide-ranging effort, reference range values for these health parameters have been established and are being used to compare whole groups of animals across time and space (1-7). This approach is critical to understand how these markers work on a population health level.

Establishing such a series of population-wide health indicators is necessary, but not sufficient, to link their biological activity to known health problems or food limitation. This is because the variance of each indicator over time or under different feeding conditions in any one individual cannot be tested in the field. In the sea otter and seals studies conducted under Trustee Council funding, each individual animal can only be captured once. Recaptures of individuals are extremely rare and certainly not planned. Thus, we can establish the range of reference values for any particular indicator across a whole group of animals, but we do not know how this indicator varies within any given animal under changing conditions of health or feeding status. In human health studies for example, this would be equivalent to establishing the reference ranges for body mass index (BMI) in a study group, but not testing how varying BMI was correlated with changing health status, such as hypertension, coronary heart disease, diabetes or anorexia. It has only been through the careful study of how these health states relate to BMI, that this index can now be used as one of a series of important biomarkers for human health. Thus, medical advice suggests we keep our BMI within given ranges to reduce our chances of health related problems. This type of combination of population monitoring and laboratory study is routine in human health and should be extended to include other species.

The Trustee Council has supported the population monitoring component of health biomarkers for marine mammals in Prince William Sound. Now, with the creation of the Alaska SeaLife Center in Seward, we are in the position to test those biomarkers under controlled conditions, in the same animals over time and under changing experimental conditions. Work on birds using the basic elements of this concept has already been initiated (6).

NEED FOR THE PROJECT

A. Statement of Problem

The Restoration Program has established a strong field component that has tested a series of health and body condition biomarkers for many of the top-level predators in the Sound (2,3,5-7), including harbor seals (1,4). Many of these indices are related to metabolic alterations that might occur in animals that were food limited, or stressed. These include markers for fat, protein and carbohydrate metabolism (fatty acid patterns, blood urea nitrogen, ketone bodies, glucose), water balance (plasma and whole blood water), blubber quality in harbor seals (energetic density, lipid distribution, histology) and total body fat. Other markers have addressed more health or contaminant related issues such as indicators of oil contamination (P450, PAH), whole body inflammatory response (haptoglobin, interleukin), organic residue contamination (PCB) and clinical indicators of disease state (clinical chemistry panels, blood hemograms).

While this significant field-based effort is critical, these markers must now be tested in the laboratory where animals can be fed different food diets and put onto controlled caloric intakes. These markers must also be tested in the same animals over long time periods so that individual variance and seasonal differences can be monitored and experimental conditions altered. For example, we suspect that molting conditions in harbor seals impact haptoglobin levels, an indicator of inflammatory response, but until we follow the same animal through a whole season, we will not be able to test this theory. Finally, these markers must also be tested in animals known to be sick (rehabilitation, stranded) to quantify how they vary with disease or poor health.

B. Rationale

The rationale for this project is if we theorize that various health and body condition markers react in the field to ecosystem wide changes in food availability or animal health, then we should be able to quantify those mechanisms in the laboratory under controlled conditions. The SeaLife Center will have research animals that are healthy and can be put onto differing diets of prey and it will have sick animals that are brought in for rehabilitation. Both groups will allow us to examine how these health markers respond to food and health status. Experiments following the same conceptual protocol have been carried out in Europe on harbor seals fed diets of fish that differed in contaminant loads (8). In those studies, it was found that seals fed contaminated fish showed measurable decreases in immune function. In this proposal, we do not suggest feeding contaminated fish, but rather fish of differing energy densities (pollock, herring, salmon and ground fish) and monitoring sick animals that are at the Center for rehabilitation. These "rehab" animals represent seals whose ability to survive in the wild has been compromised and they present a unique view into the biology of "sick" animals that may have been under-represented in our field studies in the Sound.

An additional rationale concerns the "junk food" hypothesis. One of the most popular hypotheses concerning the cause for the decline of marine mammals and birds in Alaskan waters was first voiced at a SeaGrant sponsored workshop in 1991 on whether or not food limitation could account for the observed population patterns (9). At that workshop, the "junk food" hypothesis was proposed. This thesis stated that Alaskan waters had a sufficient biomass of pollock to support the harbor seals and Steller sea lions populations, BUT that the pollock was nutritionally poor compared to other less common species, such as herring and capelin. Because the marine ecosystem of Alaska experienced a "regime shift" in the late 1970s that moved the system from a groundfish/herring based food web to a pollock dominated food web, the high-energy food that pinnipeds used to eat simply disappeared. Thus, the hypothesis proposes that seals and sea lions may be starving in a sea full of pollock. The presence of The Alaska SeaLife Center will allow us to critically test this hypothesis.

C. Location

The experiments for this work will be conducted at the Alaska SeaLife Center in Seward. We suspect that similar experiments will be proposed for birds and sea otters. If so, there should be considerable collaboration between the projects and the possibility of significant sharing of resources and personnel. There are also proposed experiments on detailed metabolic alterations in stable isotope ratios in harbor seals that would occur under different feeding regimes (Schell project /071) and will interact closely with this project. The PI (Castellini) has also proposed a program to Alaska SeaGrant for support to conduct identical experiments on Steller sea lions at the Center.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The field work on harbor seals has had integral collaboration with Native communities throughout the Gulf region in conjunction with the BIOSAMPLING program (Project 96244) and we anticipate Native collaboration to continue. Given that the Alaska SeaLife Center, the EVOS Trustee Council, the Alaska Native Science Commission and the Alaska Native Harbor Seal Commission are all currently working on joint scientific collaboration. we expect this project to include involvement with Native communities. However, at this time we cannot predict what form this involvement will take. Since harbor seals are food items for these communities, it is likely that the results of this work will be of interest to the Alaska Native Harbor Seal Commission.

PROJECT DESIGN

A. Objectives

This project will quantify the nutritional value of several key Alaskan fish species for harbor seals and will follow health indices over time in both healthy and rehabilitation animals. There are four major objectives:

1. Feed controlled diets of pollock, salmon, herring and several ground fish to harbor seals to quantify the amount of fish necessary to maintain seal body mass.

2. Quantify body condition, health, and blood chemistry biomarker alterations in the seals during the feeding trials.

3. Assess the assimilation efficiency (AE) of the differing fish diets (how much energy can be utilized) for harbor seals.

4. Quantify seasonal, metabolic state, growth status and clinical health impacts on biomarkers and health indices.

B. Methods

Feeding trials.
Given the possibility that many different species (birds and mammals) may be put onto controlled diets, feeding schedules and timing patterns will be developed in conjunction with the ASLC veterinarian, pinniped staff and research personnel.

We are basing our experimental protocols on models using four to six harbor seals in any given period of time or for any given feeding trial. It is possible that the resident population of harbor seals at the ASLC will be large enough to accommodate additional animals per feeding trial.

Estimating prey or nutrition requirements of a predator population using an energy model necessitates that assimilation efficiency be quantified (10). Assimilation efficiency, which is defined as the proportion of dry matter assimilated from a prey source, is influenced by food quality, meal size, feeding frequency and digestive passage rate (11,13). Recent studies have suggested that assimilation efficiency is low when food quality is low (12,13,14). For example, harp seals (*Phoca groenlandica*) fed Atlantic herring or capelin had a higher AE, and consumed less food, than those fed invertebrates of lower energy density (14). However, conflicting results have been reported for harbor seals (15), and studies of California sea lions fed pollock did not show a large decrease in AE with the lower energy density food (16).

During the feeding experiments to quantify AE, harbor seals will be placed in individual holding tanks. Each feeding experiment will consist of three sections; an acclimation period (approximately 5 d), a collection period (10 d), and an evacuation period (7 d). During each trial, captive seals will be fed a pure diet of one primary prey item during the acclimation and collection periods, keeping other variables such as meal size and feeding frequency constant. The acclimation period allows food to equilibrate in the digestive tract (17) whereas the evacuation period ensures the total removal of the previous prey item. The actual length of the acclimation period will be determined in a preliminary study in which assimilation efficiency will be monitored daily until a stable value is achieved. The design and interpretation of feeding experiments will also need to take into account the potential effects of seasonal variation in AE. During longer term feeding experiments (weeks or months) harbor seals will be kept together in the large natural habitat tanks. In these cases, assimilation efficiency cannot easily be determined, but health indices and body mass, etc. will be measured.

Manganese (Mn^{++}) is used as a naturally occurring, inassimilable dietary marker. It's use has been widely applied to pinniped AE studies (13,16,18). To determine the digestibility of food absorbed in the digestive tract of juvenile seals, Mn^{++} concentrations will be analyzed from subsamples of prey items fed to individual seals during the acclimation and collection periods. Feces will be collected during the entire feeding experiment, in order to determine the clearance rate of prey items and fecal Mn^{++} concentrations. Differences in the Mn^{++} concentrations between diet and feces will be used to calculate AE. Mn^{++} concentrations will be determined using atomic absorption spectrophotometry (18). In addition, diet and fecal samples will be freeze-dried and analyzed for energy (cal/g), nitrogen, total lipid, and ash.

Body condition.
Harbor seals in this study will be measured for mass, length, axillary and hip girth and blubber thickness at the dorsal hips at least weekly for the long term experiments and every other day during the short term AE protocols. Sick animals will be weighed daily in the clinic.

Health markers.
Blood samples for clinical and research health markers will be collected at the times of weighing for all experiments and as allowed by the attending veterinarian for the sick seals. The protocols for blood sampling, collection, storage and analysis have all been tested and verified during the field trials. Basically, several Vacutainers of blood are collected from the intravertebral extradural vein in seals and immediately processed or prepared for storage. The clinical laboratory at the ASLC should be able to handle most of the routine chemistries, but our own analytical procedures will be used for others.

C. Cooperating Agencies, Contracts, and Other Agency Assistance.

Interactions with other agencies on this project are not known at this time. Given the interest other agencies have expressed in supporting similar feeding trials on different species, this work will have to be organized through the science support staff at the ASLC. Marine Mammal Protection Act permits and internal UAF and ASLC Institutional Animal Care and Use Committee applications will need to be written before this work can begin.

SCHEDULE

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

We predict that each feeding trial will take several months and work with sick animals may occur at any given time of year. The ASLC may be able to work with pinnipeds as early as March 1998.

Oct 1997 - Feb 1998:	Set up Mn^{++} analysis, test laboratory AE protocols
March - June:	Initial surveys of health for harbor seals
June - August:	Health surveys of stranded and rehabilitation harbor seal pups
June - September:	Food trials of healthy animals on mixed fish diets

B. Project Milestones and Endpoints

Major milestones will occur in each of the four years of this project, but the four objectives listed above will be carried through the life of the project.

FY 98:	Health status of initial groups of harbor seals; feeding trial quality control studies: first year of stranded pups and/or rehabilitation animals: first controlled diet studies.
FY 99:	Full year of feeding trials on several species of fish; second year of stranded pups and/or rehabilitation animals.
FY 00:	Full year of feeding trials on remaining species of fish or re-trials of previous runs; third year of pups and/or rehabilitation animals.
FY 01:	Wrap up of protocols, close out of project, final reports.

C. Completion Date

This project will finish on September 30, 2001.

PUBLICATIONS AND REPORTS

Since this is a new project, there are no current relevant publications. We do not anticipate any full refereed articles in FY 98, however by FY 99 we should be at the stage of publishing short papers on how several of the health biomarkers change through seasons, in healthy vs sick animals, etc.

PROFESSIONAL CONFERENCES

The PI requests funds to attend a major medical conference each year to work with colleagues who follow such biomarkers in human health studies. Dr. Castellini has a long history of participating in these meetings (Experimental Biology) and they occur each April. Work on this project will be presented at these meetings. In November of 1999, the PI and the primary Ph.D. student on this project request funds to attend the Society of Marine Mammal Biology meetings. We anticipate that the involved students will attend several other smaller or regional meetings throughout the life of this project. Funds are also requested for the PI and one student to attend the annual EVOS workshops each year.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

As noted above, we anticipate that there will be several projects looking at controlled diets in birds and mammals at the ASLC. These multiple experiments will require close coordination from the associated principal investigators, the ASLC animal staff, veterinarian and staff, science officer and executive director.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

Michael Castellini, Ph.D., specializes in metabolic chemistry problems associated with marine mammals. He is a tenured Associate Professor of Marine Science at UAF and has worked in this field for over 20 years.

Publications by Dr. Castellini since 1990 relevant to the proposal include:

Castellini, M.A. and G.L. Kooyman. Length, girth, and mass relationships in Weddell seals (*Leptonychotes weddellii*). Marine Mammal Science. 6(1): 75-77. 1990.

Castellini, J.M., M.A. Castellini and M.B. Kretzmann. Circulatory water balance in suckling and fasting northern elephant seal pups. Journal of Comparative Physiology B. 160(5): 537-542. 1990.

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Rea, L.D., R. Groscolas, E. Mioskowski and M. Castellini. Changes in the fatty acid composition of plasma lipids indicate nutritional status in developing Weddell seal pups. Polar Biology. Submitted September 1996.

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Zenteno-Savin, T., M.A. Castellini. Plasma angiotensin II, arginine vasopressin and atrial natriuretic peptide in free ranging and captive seals and sea lions. Comparative Biochemistry and Physiology. Submitted February 1997.

OTHER KEY PERSONNEL

J. Castellini, M.Sc., is a UAF Research Associate and has worked on marine mammal biochemistry/physiology projects since 1986. She is currently the laboratory director and provides daily project monitoring. Her role will include blood chemistry analysis, quality control, computer analysis and publication preparation.

Steve Trumble received his M.S. degree in 1995 from California State University Fresno (Moss Landing Marine Laboratory) where he worked on the feeding pattern and lactation habits of harbor seals. He has recently been awarded the UAF Rasmuson Fisheries Research Fellowship for his proposed Ph.D. thesis on feeding patterns and health issues for harbor seals in Alaska. This proposal deals with the laboratory component of his thesis and support from ADF&G covers the field components. No salary is requested as it is covered by the Rasmuson Fellowship.

Students (TBA). There are several new students (Ph.D. And M.S.) in the Castellini laboratory who will use this project as a base for their thesis research.

LITERATURE CITED

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2. EVOS Project 96102. Comprehensive killer whale investigations in Prince William Sound.

3. EVOS Project 96025. Mechanisms of impact and potential recovery of Nearshore Vertebrate Predators.

4. EVOS Project 96064. Monitoring, habitat use and trophic interactions of harbor seals in Prince William Sound.

5. EVOS Project 96163G. Diet composition, reproductive energetics and productivity of seabirds damaged by the *Exxon Valdez* Oil Spill.

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

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$67.5						
Travel		$15.7						
Contractual		$11.1						
Commodities		$5.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$99.3	Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	Estimated FY 2003	Estimated FY 2004
Indirect		$24.8						
Project Total		$124.1	$116.9	$124.1	$85.4			
Full-time Equivalents (FTE)		2.4						
	Dollar amounts are shown in thousands of dollars.							
Other Funds								

Comments:

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

Student salaries include $5544 in tuition each.

FY 98

Prepared: 04/10/97

Project Number: 98341
Project Title: Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

1998 EXXON VALDEZ TRUST OUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
M. Castellini	Associate Professor – P.I.		2.9	7.4		21.3
J. Castellini	Research Associate		2.3	3.8		8.7
Vacant	Ph.D. Student		12.0	1.7		19.9
Vacant	M.S. Student		12.0	1.5		17.6
	Subtotal		29.2	14.4	0.0	
					Personnel Total	$67.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
6 R/T Fairbanks–Seward	200	6	87	138	13.2
2 R/T Fairbanks–Anchorage, EVOS Workshop	150	2	8	120	1.3
1 R/T Fairbanks–San Francisco, Experimental Biology Meeting, April 1998	600	1	5	130	1.2
				Travel Total	$15.7

FY 98

Prepared: 04/10/97

Project Number:
Project Title: Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

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

Contractual Costs: Description	Proposed FY 1998
Chemical analysis of blood samples @ $35	10.5
Long distance phone and communication	0.6
Contractual Total	$11.1

Commodities Costs: Description	Proposed FY 1998
Laboratory expendables for collection of blood samples	2.5
Laboratory expendables for analysis of blood samples	2.5
Commodities Total	$5.0

FY 98

Prepared: 04/10/97

Project Number:
Project Title: Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet
Name: University of Alaska Fairbanks

FORM 4B
Contractual & Commodities
DETAIL

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

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

Existing Equipment Usage: Description	Number of Units	

FY 98

Prepared: 04/10/97

Project Number:
Project Title: Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

UNIVERSITY OF ALASKA BUDGET INFORMATION

The University of Alaska accounting system accumulates data according to an established system of accounts codes. This differs from the level or category of detail required on this proposal. Per the new Cost Accounting Standards Board (CASB) guidelines, costs are to be listed in a proposal only to the level of detail at which the subsequent expenditures may be tracked. Therefore, please note that supplies itemized on the budget form may be tracked to UA accounting system categories such as the following examples: 1) project supplies; 2) professional, technical and scientific supplies; 3) field camp supplies; and 4) hazardous materials. Service listings are also broad, but include specific categories such as duplicating, postage, toll charges, and software licensing. A complete list of University of Alaska Accounts Codes is available upon request.

98342-BAA

Pilot Monitoring Program for Prince William Sound - Marine Assessment of Resources (MAR). Submitted under the BAA

RECEIVED
APR 1 5 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Project Number: 98-342-BAA

Restoration category: Research

Proposer: Prince William Sound Science Center

Lead Trustee Agency: NOAA
Cooperating Agencies:

Alaska SeaLife Center:

Duration: 1st year of 4

Cost FY98: $282.1K
Cost FY99: $0.00K
Cost FY00: $

Geographic Area: Prince William Sound, Cook Inlet

Injured Resource/Service: Pink salmon, herring and other fish and wildlife that are dependent upon the physical-biological state of the Sound

ABSTRACT

The complaint that pink salmon, herring and other pelagic resources in the spill-area suffered long-term impacts from the oil spill has been repeatedly voiced by residents of the Sound over the past seven years. The Sound Ecosystem Assessment program has developed the first generation of models, a physical-biological model (circulation and plankton) and a nekton model, for pink salmon to simulate population changes as a result of natural causes so that they can be separated from anthropogenic impacts, such as caused by oil spills. We propose to initiate a pilot monitoring program that will systematically measure weather conditions, physical conditions (water temperature, salinity. etc.) and plankton for input to the physical-biological model, and macrozooplankton and pelagic nekton as input to the nekton model. These data will be collected with remote sensors and on a vessel of opportunity to make the model-based monitoring very cost-effective. These data are essential for the development of second generation models that can be used by management.

INTRODUCTION

In 1989, the National Science Foundation GLOBEC program defined the limitations of predicting animal population change in marine ecosystems. They sited that past failures of ecosystem models to improve prediction were that they were not based upon mechanistic understanding of the physical-biological environment and that the information commonly used were sparse, discrete measurements that are confounded by temporal and spatial variation. They proposed an observational oceanographic program be developed which used new quasi-continuous sampling technologies to synoptically measure the physics and biology that cause change in specific animal populations. This would be used to test hypotheses and build a first generation of numerical models that improve prediction.

Since 1994, the SEA program has implemented a large-scale observational oceanographic program that uses new measurement technologies to test specific hypotheses (river-lake and prey-switching). The goal was to develop a new generation of models to predict pink salmon and herring population changes in Prince William Sound. The numerical models include a two-part physical-biological model (circulation and plankton) and a nekton model that is specific to the early life history of the pink salmon or herring. The absence of the cumulative physical-biological affect on the survival of age 0 fish has been considered the primary weakness past predictive tools. Since the dominant source of variability in physical-biological mechanisms that affect survival is weather, and weather cannot be reliably predicted for more than a week in advance, the cumulative affect of these variables need to be determined by regular monitoring and fed into the numerical models for now-casting purposes. With forecasting being subject to unpredictable weather events in the future, the best improvements to prediction will come from monitoring selected physical-biological variables through critical life history stages of these animals. With this kind of now-cast capability accounting for the major source of mortality during a early life history phase where a large amount of mortality occurs, such as for pink salmon fry where as much as 90% of total mortality occurs in the first 90 days, the accuracy of forecasting survival to adult stages will be improved.

The SEA program has developed first-generation circulation of Prince William Sound, a plankton model to simulate primary and secondary production that support food web of the Sound and a species-specific nekton model for pink salmon (a herring overwintering model is still a year or more away). In addition, we have developed software tools and alpha-beta tested hardware that will allow for the development of a cost-effective monitoring program for the data needed to initialize and verify the models.

This proposal requests funding to implement a pilot monitoring program to begin providing the data needed for now-casting and verification.

We propose to instrument a SERVES vessel with a towed, sensor array and conduct systematic surveys of the eastern and western corridors of Prince William Sound. The sensor package will consist of a towed vehicle equipped with a CTD, fluorometer, high and a low frequency acoustic sensors and a video plankton recorder. The acquisition and transfer operations for near-real time input for the models will be developed.

We propose to acquire:

weather measurements from an array of weather stations (USFS, FAA, USCG, and Science Center) and instrument buoys (NOAA and CFOS) in the Sound;

and measure from a towed vehicle;
water temperature, salinity and depth with a CTD,
- chlorophyll with a fluorometer,
- macrozooplankton prey densities (calanoid copepods) with high frequency acoustics,
- macrozooplankton species and size with a video plankton recorder (VPR), and

dominant nekton predators (walleye pollock) with a low-frequency, digital echosounder towed at the surface, respectively.

The pink salmon and pollock are valued resources and the physical-biological measurements are important to many other valuable resources in the Sound. Residents of Cordova, Valdez, Kodiak, Chenega Bay, Tatitlek, the village of Eyak and more have been contacted for traditional ecological knowledge of these resources and requested that we find out more about them.

During the SEA work (1994-present), we surveyed the pelagic habitat of Prince William Sound extensively because users had previously expressed concern about pink salmon survival. We noted that the *Neocalanus spps.* and walleye pollock were the dominant prey and predator species, respectively, along the out-migration route of the pink salmon fry. The SEA surveys were designed to test the river-lake and prey switching hypotheses and develop quasi-continuous measurements systems to improve accuracy of plankton and nekton population data. With the first-generation of models developed, it is time to develop a cost-effective, monitoring program to provide the input data to initialize the model simulations and the output data to verify the simulation results. The SEA program field implementation program ends in 1997, so this proposal, a pilot model-based monitoring effort, is the logical extension of SEA research and a crucial step toward implementing research findings for improved management. Since the distribution of *Neocalnus spps.* and walleye pollock are amenable to acoustic assessment, the implementation of a survey on vessels of opportunity is a cost effective step for development of a monitoring program as well as long term implementation.

NEED FOR THE PROJECT

A. Statement of the problem

One of the original questions sought by the SEA program was to explain why the pink salmon abundance fluctuated dramatically after the oil spill. Pink salmon suffered a major decline in abundance in 1992 and 1993, two and three years subsequent to the spill. Declines in abundance may have resulted from habitat, food supply or genetic degradation following the oil spill, or from other anthropogenic (hatchery management) and natural events (Lake-river, Prey-switching). In 1994, the EVOS Trustee Council made a commitment to invest some resources into improving prediction in accord with the GLOBEC program design. This was the SEA program. With SEA's development of the physical-biological model and the nekton model for pink salmon, it should be possible to hind-cast, now-cast and forecast conditions that will aid the interpretation of past damage assessments, present status and future risks. Such predictive capability is the foundation for good-decision making relative to the design of restoration activities that promote the conservation and sustainable use of the stock.

After 3 years of intensive field and modeling efforts, the SEA program has developed the first-generation of predictive tools. At the conclusion of FY98 (Oct 1998) SEA will be completing the first version of coupled models for ocean circulation, plankton, and outmigrating pink salmon fry for Prince William Sound. At the end of FY97 (Oct 1997) nearly all of the observational efforts will be concluded and the work of SEA will (except for the herring project) be focused on model completion and validation. During this period the SEA database of observations will be used for within-in year model development, both for the each of the three models and the combined, coupled model. Figure 1 shows the relationship between model develepment and SEA project schedules using the case of the SEA ocean circulation model to illustrate these points.

During the last half of FY98 model development will begin work on the "nowcast" versions of each of the three models. The SEA models have two functions. In the "what if" function special conditions prevailing in unique time periods can be studied to determine the consequences. In this role numerical simulations are used to expose properties of the system. In the "nowcast" role the time series of present conditions are used to determine consequences to juvenile fish as they unfold. It is in the nowcast mode that the effects of the SEA hypotheses on outmigrating fry are accumulated in the model. It is from this accumulation by forcing the model with present that the estimate of spring mortality is made. Specifically, it is the nowcast mode that provides the means for the real testing of the model functioning of the various SEA hypotheses. This same scenario applies for models for Pacific herring.

The models, albeit in 0-order, will have nowcast capability at the conclusion of FY98. However, there is not presently in place the means to have available prototypical near realtime data for use with these models. The first priority for SEA has been the acquisition of the within-year data sets required for construction and validation of the models. This has been done. This leaves a one year gap in the schedule during which the model development will move ahead of the data acquistion technology and procedures. In April 1998 SEA will propose to EVOS a plan for monitoring for use with the SEA models. With the foregoing gap there will be no prior trials with monitoring and the proposal will by necessity restate much of this proposal and the models will be forced to wait for a year as procedures are tested and brought on-line.

This proposal addresses the unnecessary delay of one year. It proposes a pilot effort to formuate a 0-order monitoring schedule and a "test data set" from that schedule. The findings from this effort will make possible an informed proposal for monitoring in April 1998. They will further provide "test set" near realtime data to use with the three models in nowcast mode. If schedules evolve as envisioned this proposal will move the implementation of the first SEA models in predictive mode forward by one year.

The pilot effort proposed here is for the first outlines of what is often referred to as model-based monitoring, since the measurements are directly explicitly at the needs for forcing and initializing the models. A specific advantage sought is cost effectiveness through the addition of model structure. This proposal is intended to be a demonstration of that advantage. Specifically it will exploit the cost efficiecies dut to both models and sensors compatible with the model requirements. Further it will exploit cost effective ships of opportunity.

B. Rationale/Link to Restoration

This project provides the preliminary monitoring that is necessary before a fully operational model-based monitoring plan can be implemented in PWS to assess the status of the pink salmon and herring populations for guiding restoration and management activities. Successful restoration of pink salmon would promote the recovery of the commercial fishery and related services and may also assist recovery of harbor seals, Steller sea lions, killer whales and other foragers such as salmon shark, halibut, eagles, lingcod, bears and more. The ultimate goal of the model-based monitoring is to increase the capability to predict natural changes that are occurring with the pink salmon population. This capability is a prerequisite to the assessment of anthropogenic impacts such as caused by oil, assessment of restoration, and are of value to management and the industry for predicting run size. In terms of its role in science, this is the first case history test of the GLOBEC design for predicting marine animal population changes by using the physical-biological model as a foundation for the cause and effect of natural events. Success in this arena could result in significant changes to the science and management of marine resources. Ultimately, the relevance of this research will be measured in its contribution to sustaining human use of healthy marine populations.

Basically, we are looking at a two year pilot program to complete the transition from the research program to a fully operational model-based monitoring program. Initially, the physical and nekton monitoring will be the first sampling protocols that are standardized. Subsequently, the zooplankton monitoring will be implemented. This is due to the introduction of new plankton video recording system (VPR) to provide species composition and size information for the models. Concurrent with the monitoring will be the now-casting efforts that will refine the physical-biological and nekton models.

C. Location

Research will be conducted in Prince William Sound. Communities that may benefit include Whittier, Valdez, Cordova, Tatitlek, Chenega Bay, Port Graham, Kodiac, Homer and

Nanwalek. All communities in the oil spill area could benefit if a successful restoration technique is developed.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Local, traditional and scientific knowledge have led to the development of this proposal. Such knowledge may provide further insight during the course of this work. Due to the importance of this resource to local and native communities, we feel it is appropriate as well as beneficial to the project to recruit some of our research assistants from the local and native communities. The project work force and budget are designed with this intent.

The following procedures have worked well for the SEA program and the Prince William Sound Science Center and will be followed for this project: 1) consult with community facilitators in local communities during the conception and design of the project to seek input; 2) advertise all boat hires and employment opportunities in communities near where the work is to be performed; 3) visit local communities during the course of the field work and, where appropriate, base field work out of the villages using local lodging and/or boats; 4) provide a written report in non-technical language on project results after the second year and upon completion of the project; 5) acknowledge all local contributions appropriately, and 6) apply the results of the research in ways designed to benefit local communities, people, and cultural practices.

PROJECT DESIGN

A. Objectives

Develop, evaluate and refine a cost-effective model-based monitoring program for now-casting with the physical-biological and pink salmon nekton model developed by the SEA program.

Methods

Integrate optical technology (VPR) developed by the GLOBEC program with digital acoustic technologies developed by the SEA program into a multi-sensor package that allows for cost-effective measurement of SEA model input variables. Implement, analyze and review survey data and model simulations to develop the most cost-effective program to now-cast and forecast pink salmon population changes.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

No funds are allocated for charter of a vessel which will be provided by SERVES as a vessel of opportunity. SERVES vessels have been used in the past by Science Center programs at a savings of $4000/da in charter costs to the EVOS Trustee Council. We plan 60 survey days in 1998 and 1999 for a savings of $240,000. We plan to challenge the Oil Spill Recovery Institute to provide an equal match of EVOS funds for this effort.

SCHEDULE

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

Oct. 1 - Dec. 31: Examination of models and databases for survey design; design and begin fabrication of VPR system, design and begin assembling multi-processor computing system for running model simulations, obtain NEPA categorical exclusion; implement surveying;

January 1998: Attend EVOS workshop in Anchorage

Jan 1 - Mar 31: Continue surveys; alpha test VPR system; alpha test multi-processor computing system

Apr 1 - Jun 30: Conclude surveys; beta testing of VPR, beta testing of multi-processor computer system, community visits; focus begins on data for models

Jul 1 - Sep 30: Establish data formats, procedures, autonomous reduction.

B. Project Milestones and Endpoints

FY98 Identify and establish physical-biological-nekton survey and develop VPR sampling system

C. Completion Date

End of FY98.

PUBLICATIONS AND REPORTS

An annual report will be prepared to meet the Council's requirements for work done in 1998. No peer-reviewed articles are anticipated from the first year's work, although they will be prepared if results warrant. However, in the second year we will prepare manuscripts presenting results of the first two years of work for publication in professional journals.

PROFESSIONAL CONFERENCES

Presentations are planned for the International Council for Exploration of the Seas: Fisheries

Acoustics Symposium in 1998 and the World Fisheries Congress in 1999.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will make use of preceding Council research through the designation of common field sites and sampling design. This project will also make use of data generated in the SEA, APEX and NSP projects as well as seek the input of researchers involved in other projects within the region.

PRINCIPAL INVESTIGATORS

Gary Thomas, Remote sensing specialist
Vince Patrick, Numerical modeling specialist
Kenric Osgood, Biological Oceanographer (zooplankton)
Prince William Sound Science Center
P.O. Box 705
Cordova, AK 99574
tel: (907) 424-5800
fax: (907) 424-5820
e-mail: loon-, patrick-, or osgood@grizzly.pwssc.gen.ak.us

Responsibilities: Dr. Thomas will be responsible for project administration and acoustic sampling. He has been working as a PI on the SEA program for the past three years.

Dr. Patrick will be responsible for running and refinement of the Nekton model. He has been working as a PI on the SEA program for the past three years in the spill impacted area. He is a member of the SEA Executive Committee and will be acting to insure maximal SEA particiapation in the design, implementation, and evaluation of the pilot study. This will be carried out through subcontracts.

C.V.s for both investigators are attached. Please address all correspondence related to this proposal to Gary Thomas.

KEY PERSONNEL

Project biologist/field manager (staff):	Primary responsibility for field scheduling and logistics, equipment and data management, assists with analyses and report writing.
Field assistants (staff):	Assists with all aspects of field work and sampling.

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CURRICULUM VITAE

G.L. Thomas, Ph.D.
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Cordova, Alaska 99574
(907) 424-3117, -5800 (work), -5820 (fax)

Education

B.A., 1970, California Western University, San Diego, CA.
M.S., 1973, California State University, San Diego, CA.
Ph.D., 1978, University of Washington, Seattle, WA

Professional Experience

1990 to present - Prince William Sound Science Center (President)
1992 to present - Oil Spill Recovery Institute (Acting Director)
1996 to present - University of Miami, RSMAS (Professor, affliate)
1992 to 1994 - University of Alaska (Associate Professor, affiliate)
1973 to 1990 - University of Washington (Pre-doctoral Res. Associate- Res. Assistant Professor)
1971 to 1973 - Scripps Institute of Oceanography (Research Associate)

Academic Honors

1974 - Tacoma Sportsmen's Scholarship
1976 - Ellis Memorial Scholarship
1986 - Outstanding Service Award, North Pacific
International Chapter of the American Fisheries Society
1990 - Outstanding Service Award
Region 1, U.S. Fish and Wildlife Service

Professional Memberships

American Fisheries Society (life member)
American Institute of Fisheries Research Biologists
American Association for the Advancement of Science

Personal

Married 27 years: Mariola, housewife and volunteer
Children: Melanie, Jeremy, Emily and Heather

Selected Publications

Thomas, G.L., Jay Kirsch, Jenny Allen and Vince Patrick. 1997. Development of a multi-species ecosystem model for managing the fisheries resources in the Greater Prince William Sound. 2nd World Fisheries Congress. In Press.

Thomas, G.L. and Ole Mathisen (Guest Editors). 1993. Special Issue: Biological interactions between enhanced and wild salmon in Alaska. Fisheries Research. 18(1-2):1-159 and 18(1-2):1-17.

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Hunter, J. R. and G. L. Thomas. 1973. The effect of prey density and distribution on the searching and feeding behavior of larval anchovy, Engraulis mordax, Giard. In: J.H.S. Blaxter (Ed.). The Early Life History of Fish, pp. 559-574.

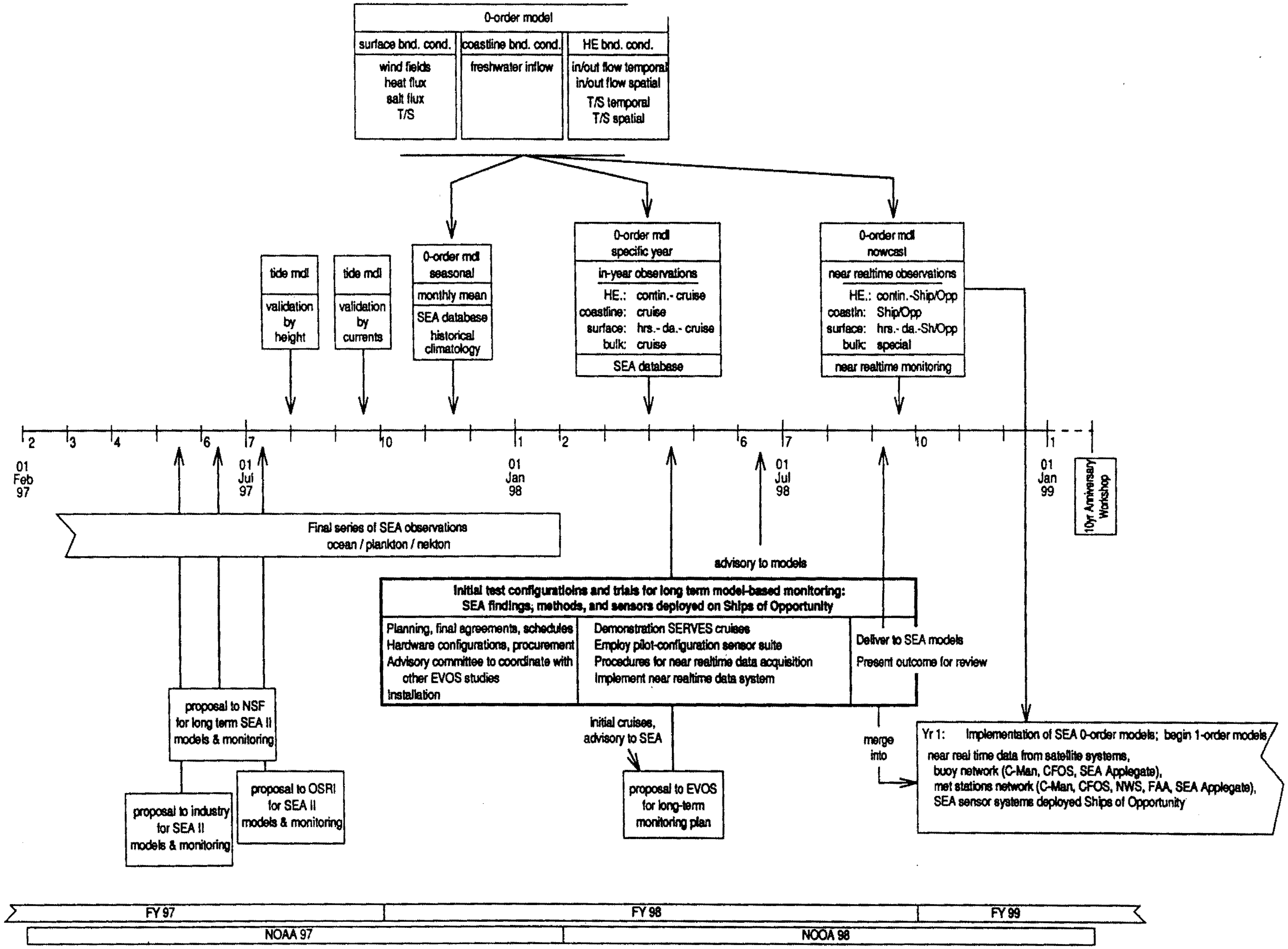
0-order model
surface bnd. cond.
wind fields
heat flux
salt flux
T/S
coastline bnd. cond.
freshwater inflow
HE bnd. cond.
in/out flow temporal
in/out flow spatial
T/S temporal
T/S spatial
tide mdl
validation by height
tide mdl
validation by currents
0-order mdl seasonal
monthly mean
SEA database
historical climatology
0-order mdl specific year
in-year observations
HE.: contin.- cruise
coastline: cruise
surface: hrs.- da.- cruise
bulk: cruise
SEA database
0-order mdl nowcast
near realtime observations
HE.: contin.-Ship/Opp
coastln: Ship/Opp
surface: hrs.- da.-Sh/Opp
bulk: special
near realtime monitoring
01 Feb 97
01 Jul 97
01 Jan 98
01 Jul 98
01 Jan 99
10yr Anniversary Workshop
Final series of SEA observations
ocean / plankton / nekton
advisory to models
Initial test configuratioins and trials for long term model-based monitoring:
SEA findings, methods, and sensors deployed on Ships of Opportunity
Planning, final agreements, schedules
Hardware configurations, procurement
Advisory committee to coordinate with other EVOS studies
Installation
Demonstration SERVES cruises
Employ pilot-configuration sensor suite
Procedures for near realtime data acquisition
Implement near realtime data system
Deliver to SEA models
Present outcome for review
proposal to NSF for long term SEA II models & monitoring
proposal to industry for SEA II models & monitoring
proposal to OSRI for SEA II models & monitoring
initial cruises, advisory to SEA
proposal to EVOS for long-term monitoring plan
merge into
Yr 1: Implementation of SEA 0-order models; begin 1-order models
near real time data from satellite systems,
buoy network (C-Man, CFOS, SEA Applegate),
met stations network (C-Man, CFOS, NWS, FAA, SEA Applegate),
SEA sensor systems deployed Ships of Opportunity
FY 97
FY 98
FY 99
NOAA 97
NOOA 98

Figure 1

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	1.Proposal FY 1998	Proposed FY 1998						
Personnel	$59	$86.9						
Travel	$8	$5.2						
Contractual	$36	$71.0						
Commodities	$12	$7.0						
Equipment	$120	$65.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$235	$235.1		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect @ 20% TDC	$47	$47.0						
Project Total	$282	$282.1						
Full-time Equivalents (FTE)		1.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources (2. proposal)		$280.0						

Comments:

Other resources are: We plan a three-way match of approximately $280,000 each between EVOS, OSRI and industry to fund the model-based-monitoring program development.

1. We plan a proposal to the Oil Spill Recovery Institute for a 50% match of EVOS funds in accordance with their mission to cooperative with government on EVOS programs. This includes a new central processor needed for simulations of the three dimensional models and (physical oceanography and modeling.
2. We have used SERVES vessels in the past to conduct ADCP surveys and will request 70 days of vessel time, valued at $4000 per day, for a total match of $280,000 to conduct monitoring surveys in 1998. We anticipate 25 days of sensor testing, 25 days of data collection, and 20 days of inclement weather.

1998

Project Number: 98342-BAA
Project Title: Pilot Monitoring Program for PWS
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

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

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
Vince Patrick	Co-PI (Modeler-Nekton)		0.5	7.5		3.8
GL Thomas	Co-PI (Nekton and Plankton Acoustics)		0.5	13.6		6.8
Dorn Mason	Co-PI (Modeler-Nekton)		0.5	6.6		3.3
Staff	physical sensors		0.0	5.5		NC
Staff	nekton sensors		2.0	5.5		11.0
Staff	plankton sensors		6.0	5.5		33.0
Staff	data base and internet management		3.0	5.5		16.5
Staff	data automation/interface		2.0	5.5		11.0
Staff	hourly		0.5	3.0		1.5
Mark Willette, ADF&G	Co-PI (Nekton-pink salmon)					NC
	Subtotal		15.0	58.2	0.0	
					Personnel Total	$86.9

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
Fairbanks to Cordova (Eslinger, Cooney, McRoy, Stokesbury)	437.0	4	20	171.0	5,168.0
Miami to Cordova (Moores and Wang)	823.0	2	10	171.0	NC
Madison to Cordova (Mason)	755.0	2	10	171.0	NC
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.2

1998

Project Number:
Project Title: Pilot Monitoring Program for PWS
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Prepared:

4/14/97

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

Contractual Costs:	Proposed
Description	FY 1998
Vessel Charter @ $4,000 d/70 days for $280,000 of in-kind services (Alyeska Serves Vessel)	NC
Phone, fax, network costs	2.0
Publications	3.5
Mail, freight, shipping	2.0
Calibration of Acoustic gear	1.5
Software, annual license's	1.0
Internet services	3.0
University of Alaska Fairbanks (IMS) subcontract (Eslinger, Cooney, McRoy, Stokesbury)	58.0
University of Miami (RSMAS) subcontract (Mooers and Wang)	NC
Contractual Total	$71.0

Commodities Costs:	Proposed
Description	FY 1998
Compter Supplies	2.0
Office Supplies	2.0
Field Supplies	3.0
Commodities Total	$7.0

1998

Project Number:
Project Title: Pilot Monitoring Program for PWS
Name: Prince William Sound Science Center

FORM 4B
Contractual &
Commodities
DETAIL

Prepare

4/14/97

1998 EXXON VALDEZ TRUS.__ COUNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Video Plankton Recorder	1	50.0	50.0
Fast-high storage portable PC for acoustics	1	5.0	5.0
Shipboard fluorometer	1	10.0	10.0
Sun enterprize central processor (OSRI)	1	0.0	NC
			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**	$65.0

Existing Equipment Usage: Description	Number of Units	
Aquashuttle & Aquapack System		
DT4000 - 38 KZ system		
DT5000 - 420 Kz system		
8' Biofin		

1998

Project Number:
Project Title: Pilot Monitoring Program for PWS
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

98343-BAA

DESCRIPTIVE OCEANOGRAPHY OF GLACIAL FJORDS IN PRINCE WILLIAM SOUND USED AS HABITAT BY KITTLITZ'S MURRELETS
Submitted Under the BAA

RECEIVED
APR 15 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Project Number:	98343-BAA
Restoration Category:	Research
Proposer:	Prince William Sound Science Center
Lead Trustee Agency:	
Cooperating Agencies:	
Duration:	1st year, 1-year project
Cost FY 98:	$154.4K
Geographic Area:	Prince William Sound
Injured Resource/Service:	Kittlitz's Murrelet

ABSTRACT

Descriptive oceanographic studies of glaciated fjords in Prince William Sound are limited mainly to research conducted in Port Valdez and Unakwik Inlet during the late 1960s and early 1970s. Recent work done under the Sound Ecosystem Assessment (SEA) Herring project in Unakwik Inlet and Icy Bay has confirmed previously measured patterns and has revealed the unique oceanographic characteristics that these fjords exhibit as habitats for marine fishes, birds, and mammals. The goal of this project is to describe the characteristics of four glaciated fjords used by Kittlitz's Murrelets during the summer and to link these characteristics to the high biological productivity seen in these fjords.

INTRODUCTION

Glaciated fjords in Prince William Sound (PWS), Alaska, form the primary habitat for numerous species of seabirds, including Kittlitz's Murrelet (Brachyramphus brevirostris), a poorly known seabird that was found to be injured by the Exxon Valdez oil spill (Exxon Valdez Oil Spill Trustee Council 1996). In 1996, a study (Project No. 96142-BAA; "Status and ecology of Kittlitz's Murrelet in Prince William Sound") that looked at population sizes and trends, habitat use, reproductive performance, feeding ecology, and trophic levels of these birds in Northwestern PWS was initiated (Day and Nigro 1997). That study was designed to develop an understanding of basic life-history attributes, so that knowledge of such basic issues as population size and trends could be used for development of effective recovery and management plans. The initial results of that study have indicated that Kittlitz's Murrelets prefer the glacially affected inner basins of fjords, particularly in nearshore areas in the vicinity of tidewater glaciers. Kittlitz's Murrelets also have been seen foraging in the vicinity of old terminal moraines, which form submarine sills in places such as Unakwik Inlet (Isleib and Kessel 1973).

Important prey of this seabird include euphausiids (e.g., *Thysanoessa inermis* and *T. spinifera*) and 0- and 1-year forage fishes such as Pacific sandlance (*Ammodytes hexapterus*), capelin (*Mallotus villosus*), Pacific herring (*Clupea pallasi*), Pacific sandfish (*Trichodon trichodon*), and walleye pollock (*Theragra chalcogramma*; Sanger 1987, Piatt et al. 1994, Day and Nigro 1997). Many of the above juvenile forage fish prey species are thought to be abundant within these glaciated fjords, particularly during the summer. This belief is based upon observations of seabird foraging behavior by Day and Nigro (1997) and from personal communications with glacial fjord tour operator Dean Rand. With the exception of Port Valdez, however, information about the oceanography of these glaciated fjords is very limited, and past research has focused mainly on only one aspect of fjord dynamics: renewal of the deep water (Muench and Niebert 1973, Colonell 1981, Muench and Heggie 1978).

Recent work conducted within Unakwik Inlet and Icy Bay (Gay In review) has found that late-winter temperature/salinity (T/S) conditions differ considerably between the inner basins of glacial fjords and the marine source water seaward of their sills. These data support previous hypotheses about the exchange of deep water within shallow silled fjords during late winter, a process that prevents anoxic conditions from occurring within a fjords' deep water later in the year (Muench and Heggie 1978). Hydrographic measurements taken during July and August 1996 have shown that T/S differences between the inner fjord basins and PWS source water persist through the summer, and dissolved-oxygen concentration in the deep inner basin water to remain high. Upwelling observed in association with tidal flow across shallow sills may be one mechanism bringing euphausiids, other macrozooplankton (such as large calanoid copepods), and larval fishes to shallower depths, making these organisms available to foraging birds (e.g., Mercier and Gaskin 1985). At this time, however, links between oceanography and Kittlitz's Murrelet foraging within the inner basins are purely hypothetical and require measurements of tidal currents and hydrography to evaluate the relative importance of the various factors involved. Nutrient samples and measurements of phytoplankton and zooplankton also are needed to describe the basic structure of these ecosystems.

This project will primarily provide information about these fjord's foraging habitats used by Kittlitz's Murrelets, other seabirds, and marine mammals and will help explain why Kittlitz's Murrelets forage where they do. In addition, it will provide oceanographic data useful to other SEA projects that have not focused specifically on these glaciated fjords in Northwestern PWS. For example, the information from this project will help the SEA research effort in modeling the circulation within PWS and will aid in determining the contribution of the discharge of fresh water from this glaciated region to the hydrography of western PWS.

NEED FOR THE PROJECT

A. Statement of Problem

The Kittlitz's Murrelet currently is on the Exxon Valdez Oil Spill Trustee Council's list of injured resources as "injured with recovery unknown" (Exxon Valdez Oil Spill Trustee Council 1996). The effects of the oil spill on this bird in PWS are difficult to assess, because of the limited information about the ecology of this rare species. The primary at-sea habitat of these murrelets during the summer breeding season is the glaciated fjords that are located in the Northwestern quarter of the Sound. Recent work there on the population and reproductive ecology of Kittlitz's Murrelets indicates a need for oceanographic data for fully determining the factors influencing the use of these fjords by these birds (Day and Nigro 1997). For example, one year of data suggest that Kittlitz's Murrelets appear to feed primarily in nearshore waters in the vicinity of tidewater glaciers, and proportionately more around slack tides than when tidal currents are running strongly; further, they have no diel pattern of feeding and have large eyes that suggest an adaptation for foraging in low light levels. These results suggest that Kittlitz's Murrelets are adapted to glacial or near-glacial feeding, and that although diel vertical migration of prey appears unimportant, tidal currents may adversely affect foraging behavior. It is unclear, however, why these patterns of feeding exist, since no data on hydrography or on the distribution and abundance of prey species in these fjords are available for understanding why Kittlitz's Murrelets forage where and when they do. Similar questions could be raised as well about the large number of other seabirds and marine mammals occupying these fjords. Few oceanographic data exist for this part of PWS, however, and all other Trustee-sponsored projects such as SEA and the Alaska Predator Ecosystem Experiment (APEX) currently focus only on non-glaciated parts of the Sound.

B. Rationale/Link to Restoration

The rationale for studies of the Kittlitz's Murrelet within PWS are dealt with in detail in Project 98142; therefore, it is mentioned here only briefly. Project 98142 focuses on the ecology of this poorly known seabird, including its habitat characteristics and attempting to understand how, where, and on what it feeds. This proposed study will provide a basis for describing the habitat of Kittlitz's Murrelets by collecting physical and biological oceanographic data from selected fjords where they live and feed. Hence, it will bridge the present gap between Project 98142 and the SEA and APEX studies and should provide an understanding of the effects of prey availability on the ecology of Kittlitz's Murrelets.

In addition to its findings with respect to Kittlitz's Murrelet feeding ecology, this proposed study will fill a gap in our understanding of the oceanography of PWS; therefore, it should be of value to both the SEA and APEX projects. This research should also be of great value to the scientific community in general as it deals with a region of PWS for which very little scientific work has been done, with the exception of glaciology.

C. Location

This research will be done in conjunction with the ecological studies of the Kittlitz's Murrelet (Project 98142) in the glaciated fjords of Northwestern Prince William Sound. Communities that may benefit financially from this project through the charter of boats include Valdez, Cordova, and Whittier. To our knowledge, no communities will be otherwise affected by this project.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

In FY98 the Kittlitz's Murrelet study (Project 98142) will charter a boat and crew from a local PWS community to provide berthing and logistical support. We intend to select a boat that will be capable of performing both as an oceanographic platform and a logistics vessel, thereby reducing the overall costs of this study.

There are several sources of local knowledge about the productivity and dynamics of ice calving within the glaciated fjords of Prince William Sound, and we would welcome any traditional ecological information that may help in planning the logistics of this research. In addition to Native hunters from both Tatitlek and Chenega, some charter operators (e.g., Dean Rand) have extensive experience in the Northwestern Sound.

PROJECT DESIGN

A. Objectives

1. To determine the influence of tidal currents and the distribution of physical and biological properties in glaciated fjords on the timing and location of feeding by Kittlitz's murrelets.

2. To provide physical and biological data which will help fill a gap in the general knowledge of oceanography in the glacially affected regions of Prince William Sound.

B. Methods

This study proposes to characterize oceanographic factors within glaciated fjord habitats used by Kittlitz's Murrelets following the general sampling design and schedule used by Project 98142. In that project, sampling will be done during two cruises per year: (1) ~1–20 June (early summer), and (2) ~15 July–10 August (late summer). During each cruise, we will sample four fjords in Northwestern PWS (Unakwik Inlet, College Fjord, Barry Arm/Harriman Fjord, and Blackstone Bay) concurrently with the sampling done by Project 98142. Following Day and

Nigro (1997), oceanographic station lines will be located in two geographic zones: nearshore (less than or equal to 200 m from shore) and offshore (>200 m from shore). Within each of these zones, we will measure physical and biological oceanographic properties in locations where murrelets do and do not forage. Oceanographic station lines will be oriented along each fjord forming a grid of stations. The number of stations will vary between locations according to each fjords' bathymetric, T/S, and turbidity characteristics.

Along each station line, we will measure currents with a 150-kHz Acoustic Doppler Current Profiler (ADCP). The ADCP will measure the currents throughout the water column at 4-8 m depth intervals. Vertical profiles of temperature and salinity will be made over the entire water column at each station along the lines with a CTD (conductivity, temperature and depth instrument). Additional sensors mounted on the CTD will determine the oxygen concentration, turbidity (glacial silt) and fluorescence (a proxy for phytoplankton) throughout the water column. Nutrient samples will be collected at standard depths of 5, 10, 25, 50 and 100 m at a minimum of three stations per fjord using a Niskin bottle during the ctd casts. Samples will be filtered to remove organic material and frozen for later analysis of concentrations of silica, nitrates and phosphates. Zooplankton will be sampled over specific depths with a closing net at oceanographic stations. Because of our interest in determining why Kittlitz's Murrelets do not forage in certain locations, we will have a series of fixed station locations; however, other sampling locations will be flexible, depending on location of dense aggregations of zooplankton.

Our success in capturing the largest zooplankton (euphausiids) will depend in part on the size of the concentrations. For example, if euphausiids occur in low densities, they may be able to avoid a net, however, when they occur in dense aggregations their ability to escape is decreased. A special technique can also be used in which a closing net is inverted on its line and allowed to free-fall, thus eliminating disturbance of the water in advance of the net and diminishing the avoidance reaction by euphausiids. Net samples will also be done at night to determine if euphausiids and other macrozooplankton undergo diel vertical migration. This could be important, in that barring some other oceanographic factor causing localized upward advection, it may severely limit the availability of these species to diving birds during the day.

If it is feasible to use a boat of suitable size an additional data set will be collected with a CTD-fluorometer (Aquapack) and an optical plankton counter (OPC). These sensors are housed in a towbody which is lowered and raised via a deck-winch while the vessel is underway. Thus a series of oblique profiles of temperature, salinity, fluorescence and zooplankton within the upper 50 m of the water column would be obtained. The continuous T/S records from the Aquapack will help reveal the presence of horizontal temperature and/or salinity gradients, which indicate fronts where changes in water mass density may concentrate plankton and fish. These zones can occur between regions of stratified water and regions of mixing caused by turbulence from either tidal flow interacting with the bathymetry or mixing of subglacial streams as they enter the water column (Mann and Lazier 1991). The hydrography will also confirm the existence of estuarine surface flow, a common feature of fjord circulation in which a surface current moves out of the fjord due to large amounts of fresh water input at the head creating a pressure gradient (Dyer 1973). It is possible that the reversal in flow that occurs under the shallow fresh layer in response to estuarine flow may serve to advect zooplankton across the shallow sills of these fjords, especially during the flood tide, and cause them to become trapped inside the inner basins. If high amounts of glacial silt limit the primary production, and hence the amount of zooplankton able to be sustained, within these fjords, this advection of zooplankton may help replenish their stocks.

Since the OPC can count and size zooplankton-sized particles, it provides data on the volume of zooplankton in the water. However, since the OPC cannot identify what it counts, the zooplankton data from net samples will be used to calibrate the OPC measurements to help identify macrozooplankton such as euphausiids, amphipods, and calanoid copepods.
The data quality from the OPC will depend on the performance of this instrument in a moderately to highly turbid environment. The OPC can adjust for a certain amount of light attenuance, but the upper threshold is uncertain. Therefore, the use of this instrument will be experimental for the purposes of this study.

Forage fish observations will be limited to shipboard acoustics for the purpose of this study, since net based sampling would require an additional fishing vessel to deploy trawl gear. We will equip the boat with a fathometer/fish finder with a frequency that does not interfere with the ADCP but will show both dense concentrations of macrozooplankton and schools of fishes. These sightings will be mapped along the station lines and will help in sampling the macrozooplankton with nets.

The relationship between oceanography and habitat use of Kittlitz's Murrelets within the fjords will be examined by Project 98142 by stratifying the oceanographic observations within the nearshore and offshore zones into four standardized habitat strata (following Day and Nigro 1997): (1) glacial affected (either less than or equal to 200 m from the glacier face or its ice edge, or in greater than or equal to 75% ice cover); (2) glacial stream affected (a zone where sub-glacial and surface meltwater streams flow out into the fjord, excluding that from tidewater glaciers); (3) marine glacial sill affected (less than or equal to 200 m from a sill); and (4) glacial unaffected (greater than 200 m from the glacier face or its ice edge, in less than 75% ice cover, and without one or more glacial affected streams flowing into the area). For example, segments of the nearshore zone are classified into one of these four strata; hence, collecting data in each segment will enable us to compare oceanographic characteristics with feeding frequency by Kittlitz's Murrelets. We will conduct oceanographic sampling within all four habitat strata until it becomes logistically impossible to proceed in the direction of the fjord's head because of excessive ice cover. When ice cover becomes excessive, hydrographic and net-based sampling will be conducted from a small boat. The CTD casts will complement the sea-surface T/S and Secchi disk measurements proposed to be taken from the murrelet observation boat (see proposal 98142).

Analysis of the oceanographic data sets will identify both patterns in tidal currents, such as eddies and upwelling zones, and horizontal gradients of physical properties (i.e., fronts) that may concentrate prey items such as zooplankton and larval fishes. The CTD and turbidity measurements made near the glacier face will trace locations in which sub-glacial streams enter the estuarine system, creating turbulent zones with reversals and eddies that could concentrate prey items for murrelets. Some of these circulation features may be of too small a scale to measure effectively with an ADCP; however, the hydrography should document the existence of such features, and net samples will collect zooplankton in these areas.

Vertical sections of temperature, salinity, density, ,oxygen, turbidity, currents, nutrients and abundance of phytoplankton, zooplankton, and fish will be integrated with the Kittlitz's Murrelets feeding data. We will use these data to determine any oceanographic differences among locations within glacial fjord habitats used by Kittlitz's Murrelets, and to evaluate the following hypotheses: (1) Ho: Water-column structure does not differ between areas where Kittlitz's Murrelets do and do not feed; (2) Ho: Kittlitz's murrelets do not feed preferentially around physical structures such as fronts; and (3) Ho: There is no oceanographic difference (physical or reflecting the abundance and distribution of macrozooplankton and fishes) between standardized habitats where Kittlitz's Murrelets do and do not feed.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

A research vessel will be contracted from a PWS community to provide berthing, logistical support, and a platform from which to conduct the oceanographic surveys. All ornithology work will be conducted by ABR, Inc. through a subcontract, and all field oceanography work will be done by PWSSC personnel. Other management costs will involve a Program Manager and general administration; these management costs will be funded directly from the Trustee Council to the managing agency.

SCHEDULE

A. Measurable Project Tasks for FY98(October 1, 1997-September 30,1998

January–March 1998:	Arrange logistics (boats, equipment, etc.)
Late May–20 June 1998:	Conduct early summer cruise
~15 July–10 August 1998:	Conduct late summer cruise
August–November 1998:	Analyze oceanographic data
November 1998–April 1999:	Preparation of Final Report and manuscripts
15 April 1999:	Submit Final Report on FY98 research

B. Project Milestones and Endpoints

"To determine the influence of tidal currents and the distribution of physical and biological properties in glaciated fjords on the timing and location of feeding by Kittlitz's murrelets." Field work and data analysis will be done in FY98.

"To provide physical and biological data which will help fill a gap in the general knowledge of oceanography in the glacially affected regions of Prince William Sound." Field work and data analysis will be done in FY98.

C. Completion Date

Sampling for the project will be completed in FY98, along the same schedule as Project 98142-BAA. Data analysis and preparation of the Final Report will be completed in FY98, but publications may run into FY99.

PUBLICATIONS AND REPORTS

We will submit a Final Report to the Chief Scientist no later than 15 April 1999. This report will include a description of the physical and biological oceanography results and an integration with information on Kittlitz's Murrelet habitat and foraging behavior.

At least two publications should arise from these data sets involving the descriptive physical and biological oceanography, and relationship of the oceanography to murrelet ecology. For these publications, we request 1.5 months of salary per paper for each of the Co-principal and Collaborating Investigators. We understand about the Acknowledgement and Disclaimer that are required for publication and agree to abide by them.

PROFESSIONAL CONFERENCES

Attend AGU Ocean Sciences Meeting or other oceanographic society meeting in 1999 to present a paper on the descriptive physical and biological oceanography of the glacial fjords in Northwestern PWS.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

To our knowledge, no other Trustee-sponsored oceanographic studies are being conducted in the glaciated fjords of Northwestern PWS. Integration of these data with past and concurrent restoration projects will be confined to filling gaps in the overall understanding of the oceanographic structure and marine ecology of Prince William Sound. These data will be important to confirm whether future empirical data need be collected from this large region of the sound for model validation (e.g., the Circulation Model that is being developed by the SEA project) and better description of oceanographic conditions in western PWS (descriptive physical oceanography component of the SEA project). We also believe that the data on food availability and type (i.e., zooplankton, forage fishes) will enable us to integrate better the feeding ecology of Kittlitz's Murrelet with that of other seabird species being studied by the APEX project.

PROPOSED CO-PRINCIPAL INVESTIGATORS

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Shelton Gay will be a Co-Principal Investigator for the project. Shelton began working in Alaska in 1991 as technical personnel for the Institute of Marine Science (IMS) conducting the damage assessment of intertidal zones in Prince William Sound (PWS) resulting from the Exxon Valdez Oil Spill (EVOS). In 1992 while at UAF he began work in Physical Oceanography as a data analyst for Dr. Tom Weingartner and during this time participated in a seabird ecology research project in the Aleutian Islands. In 1994 shelton began working for the Prince William Sound Science Center as a field engineer and oceanographer conducting research for the EVOS Trustee sponsored Sound Ecosystem Assessment project (98320-M). Since then he has been project leader for all of the nearshore oceanographic work (SEA Herring) which has involved field logistics and collection and analysis of physical oceanographic data within bays and fjords in PWS. Shelton will be responsible for coordinating the oceanographic field work with the Kittlitz's Murrelet project, and for analysis of oceanographic data, report writing and publications.

Dr. Kenric Osgood will be a Co-Principal Investigator for the project. Kenric has conducted oceanographic research since 1983, working in both physical and biological oceanography. His professional experience includes the following: 1983 to 1988 Research Assistant, Curriculum in Marine Sciences, University of North Carolina, Chapel Hill; 1988 to 1993, Research Assistant, School of Oceanography, University of Washington, Seattle; 1993 to 1996, Post-doctoral Researcher, Marine Life Research Group, Scripps Institution of Oceanography, La Jolla, California; 1996 to Present, Research Associate, Prince William Sound Science Center, Cordova Alaska. Kenric will be responsible for coordinating analysis and publication of oceanographic data, and report writing.

Dr. Robert H. Day will be a Collaborating Principal Investigator for the project. Bob has conducted research on seabirds, marine ecology, impacts of marine pollution, and marine conservation topics in Alaska since 1975. His research topics have included the biology of poorly known seabirds in Alaska; the ingestion of plastic pollutants by seabirds in Alaska; the mortality of seabirds in the high-seas drift-gillnet fishery of the North Pacific; and the distribution, abundance, and decomposition of plastic pollution and other marine debris in the North Pacific. Recently, he conducted several years of research on impacts of the Exxon Valdez oil spill on habitat use by marine-oriented birds and on bird communities. Bob will be responsible for coordination of the field work for the Kittlitz's Murrelet research with the oceanography field work, and for integrating the oceanographic and avian ecological data, report writing and publications.

OTHER KEY PERSONNEL

Loren Tuttle: M.Sc. Biological Oceanographer, PWSSC: Aquapack/OPC deployments and zooplankton sample collection; data analysis and contribute to journal publications.

LITERATURE CITED

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

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$52.6						
Travel		$2.0						
Contractual		$67.1						
Commodities		$1.6						
Equipment		$5.4	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$128.7		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect at 20% TDC		$25.7						
Project Total	$0.0	$154.4						
Full-time Equivalents (FTE)		10.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: Our Federal Negotiated Indirect Cost Rate is currently 28.6 % of Modified Total Direct Costs. This equates to the 20% of the Tota Direct Cost that is the maximum we are currently allocated from the Trustee Council. This budget is for a research project that is supplimentary to SEA project 98320-M. NEPA costs will not be incurred during this project. Approximately half of the salary costs in this proposal will be for report writing and preparation of journal publications, and less than 3% will be used for professional conferences and attendance of the EVOS workshop. There are no matching funds available for this project.

Note - The salary includes a 3% annual increase.

1998

Project Number:
Project Title: Descriptive Oceanography of Glacial Fjords in PWS......
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

Prepared: 10-Apr-97

4/14/97

1998 EXXON VALDEZ TRUSTEE C(IL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs:				Months	Monthly		Proposed
Name		Position Description		Budgeted	Costs	Overtime	FY 1998
Shelton	Gay	Physical Oceanographer		3.5	5.2		18.2
Kenric	Osgood	Biological Oceanographer		3.5	4.9		17.2
Loren	Tuttle	Biological Oceanographer		3.5	4.7		17.2
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		10.5	14.8	0.0	
						Personnel Total	$52.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
EVOS Workshop	160.0	1	4	140.0	720.0
AGU Ocean Sciences Meeting San Diego 9-13	600.0	1	5	140.0	1,300.0
(1 r/t @ $600, 5 days @ $140/day)					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.0

1998

Project Number:
Project Title: Descriptive Physical Oceanography of Glacial Fjords
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Prepared: April 10,1997

4/14/97

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

Contractual Costs:	Proposed
Description	FY 1998
1 vessel charter @ $700 per day for 20 days	14.0
phone,fax, network costs	1.3
publications	2.0
mail, freight, shipping	1.0
1 Calibration of SBE 19.03 CTD Profiler and Oxygen Probe	0.8
Subcontract to Alaska Biological Research, Inc. for coordinating & integrating Kittlitz's, Murrelettes & Oceanography data.	44.0
UAF - (Lab work to analyse nutrient samples)	4.0
Contractual Total	$67.1

Commodities Costs:	Proposed
Description	FY 1998
computer supplies	0.5
Office supplies	0.5
Field Supplies	0.6
zooplankton and nutrient sampling supplies	
Commodities Total	$1.6

1998

Project Number:
Project Title: Descriptive Physical Oceanography of Glacial Fjords
Name: Prince William Sound Science Center

FORM 4B
Contractual &
Commodities
DETAIL

Prepared: April 10,1997

4/14/97

1998 EXXON VALDEZ TRUSTEE C CIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 1998
Seapoint Sensors Optical Backscatter Turbidity Sensor mounted to SBE 19.03 CTD Profiler	1	1140.0	1,140.0
Seapoint Sensors Fluorometer mounted to SBE 19.03 CTD Profiler	1	3540.0	3,540.0
Y - Cable for connecting sensors to electronics of CTD	1	305.0	305.0
Jumpers for changing measurement range of fluorometer	2	135.0	270.0
kit for mounting sensors to CTD housing	2	50.0	100.0
* The above is a breakdown of auxillary sensor kits for CTD Profiler			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		$5.4

Existing Equipment Usage:	Number	
Description	of Units	
RDInstruments 150 khz Acoustic Doppler Current Profiler (ADCP) w/ deck interface unit and conducting cable	1	
SeaBird Electronics (SBE) 19.03 Profiler CTD	1	
Bracket for mounting ADCP to hull of survey vessel (designed and fabricated in Cordova 1995)	1	
lines for CTD and zooplankton nets	2	
closing zooplankton net/ open ring net	2	
Chelsea Inst. Aquashuttle w/ Aquapack ctd-fluorometer and FOCAL Technologies Optical Plankton Counter (OP	1	
Deck Winch and conducting cable for Aquashuttle	1	
Computers for data aquisition	3	
Niskin Bottles for sampling water for nutrients		

1998

Project Number:
Project Title: Descriptive Physical Oceanography of Glacial Fjords
Name: Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Prepared: April 10,1997

4/14/97

Blowdown Effects on Salmon Habitat

Project Number:	98344
Restoration Category:	
Proposer:	Michael L. Murphy NMFS, Auke Bay Laboratory ABL Program Manager: Dr. Stan Rice NOAA Program Manager: Bruce Wright
Lead Trustee Agency:	NOAA
Cooperating Agencies:	
Alaska SeaLife Center:	
Duration:	1st year, 2-year project
Cost FY 98:	$203,300
Cost FY 99:	$110,000
Geographic Area:	Montague Island, Prince William Sound
Injured Resource/Service:	Pink salmon, Dolly Varden, cutthroat trout, harlequin ducks

ABSTRACT

High winds off the Gulf of Alaska in 1996 caused extensive blowdown in riparian buffer zones left for stream protection after timber harvest on Montague Island, Prince William Sound. Such large-scale blowdown is much greater than observed elsewhere, and effects on habitat of pink salmon, Dolly Varden, cutthroat trout, and other salmonids are unknown. This project would determine the distribution and amount of blowdown on Montague Island, evaluate its effects on habitat and fish populations, and use models to predict long-term trends in habitat condition. This information would help in evaluating current management of buffer zones, monitoring trends in habitat condition, and assessing the need for habitat restoration in streams in Prince William Sound.

INTRODUCTION

The Trustee Council protects habitat of injured resources and services primarily by acquiring land that would otherwise be used in ways that might hinder recovery. Most such lands are being acquired to provide long-term protection from potential effects of timber harvest, yet little information is available on the effects of timber harvest in the Prince William Sound area. Almost all studies of effects of timber harvest on anadromous fish habitat in Alaska have been conducted in Southeast where habitat conditions and forest stands are different than in Prince William Sound and Southcentral Alaska (Murphy and Milner 1997). Forest stands on Montague Island and other areas of Prince William Sound and Southcentral Alaska are unique in that they are directly exposed to high winds off the Gulf of Alaska. Thus, riparian buffer zones required by the Alaska Forest Resources and Practices Act for stream protection are subject to a high rate of blowdown with unknown effects on fish habitat.

Small-scale blowdown after timber harvest is common in the Pacific Northwest (Murphy 1995), but amount of blowdown is usually much less than occurred recently on Montague Island. On one tributary of the Nelly Martin River, 95% of the standing trees in 0.5 miles of buffer zone blew down in winter 1996 (G. McNaughton, Koncor Forest Products, Inc., personal communication 1997). In contrast, a study in Southeast Alaska found the median amount of blowdown was 7% (Lorenz and Paustian 1995). Effects of small-scale blowdown in buffer zones are generally minor or even beneficial because blowdown provides additional large woody debris, a key component of fish habitat (Murphy 1995; Murphy et al. 1986). When an entire buffer zone blows down, however, fish habitat could be adversely affected by an overloading of woody debris which could cause silting of spawning areas, short-term changes in sediment input, channel stability, shade, and other factors, and long-term changes in woody debris recruitment.

Effects of blowdown are controversial, particularly in Prince William Sound and Southcentral Alaska, where timber harvest has increased in recent years. For example, the Anchorage Daily News (October 5, 1994) reported that blowdown in a buffer in Windy Bay, Kenai Peninsula, was "endangering the river's pink salmon and raising questions about the adequacy of a state law meant to protect fish from clearcutting." Timber operators believe they need more flexibility in designing no-cut zones, and ADFG believes buffers should be wider. Questions remain as to the actual effects of blowdown in Prince William Sound and whether any changes are needed in timber harvest strategies or the management of buffer zones to protect fish habitat.

Large-scale blowdown represents an unknown threat to the recovery of several injured resources, including pink salmon and harlequin ducks. This project would determine the short-term effects of blowdown on habitat and salmonids, and model the long-term trend in habitat condition. This information would help in evaluating the effectiveness of current management of buffer zones in Prince William Sound and similar areas of Southcentral Alaska. For example, it would indicate whether buffer zones in wind hazard areas need to be wider or thinned to prevent habitat damage. This information would also help in monitoring changes in habitat by establishing the current baseline and modeling long-term trends in habitat condition in areas affected by blowdown. Lastly, the information would help in evaluating the possible need for debris removal, planting of streamside zones, and other forms of habitat restoration.

NEED FOR THE PROJECT

A. Statement of Problem

High winds caused extensive blowdown of riparian buffer zones after timber harvest on Montague Island in 1996, with unknown effects on habitat of pink salmon, Dolly Varden, cutthroat trout, and other salmonids. Whereas small-scale blowdown in buffer zones has possible beneficial effects on fish habitat, large-scale blowdown theoretically could have significant adverse effects by covering and impounding spawning areas, increasing sediment input, decreasing shade, destabilizing stream channels, blocking fish passage, and reducing future recruitment of woody debris. Without data on such large-scale blowdown events, the short- and long-term implications for streamside management and condition of fish habitat remain unknown.

B. Rationale/Link to Restoration

Results from this research would be useful in evaluating effectiveness of current habitat protection measures where data are currently lacking. In addition, the condition and trend in salmonid habitat in the area affected by blowdown are not known. This project would identify short-term effects, if any, and develop a model to evaluate longer-term trends in habitat condition over time. The project would also assess the possible need for habitat restoration, such as debris removal or tree planting. Lastly, this project would help indicate the importance of spending Trustee funds on land acquisition for salmonid habitat protection.

C. Location

The study sites would be on Montague Island, primarily in the Patton River and Nelly Martin River drainages. These lands are owned by the Chugach Alaska Corporation, and timber harvest was conducted by Koncor Forest Products, Inc. The Chugach Alaska Corporation has granted permission to conduct this study on their lands. Koncor has expressed support for the project and would cooperate on the project by leading reconnaissance, providing maps, photos, and other background data, and use of logging camp facilities for field operations on Montague Island.

COMMUNITY INVOLVEMENT

This project would strive to involve and obtain input from the Chugach Alaska Corporation which owns the land. They have granted permission to operate on their lands, and efforts would be made to involve Corporation shareholders in conducting the study and reviewing results. Specifically, the project would attempt to hire two Chugach Alaska shareholders for several months to assist in field work and data collection. After the field season and some data analysis, results would be shared with the Corporation.

PROJECT DESIGN

A. Objectives

Principal study objectives are to:

1. Determine the amount and distribution of recent and past blowdown on Montague Island. Determine whether any environmental factors (e.g., aspect, topography) are related to amount of blowdown.

2. Evaluate short-term effects of blowdown on condition of fish habitat, including sediment input, channel stability, water temperature, available spawning area, pool habitat, and cover.

3. Determine effects of short-term habitat changes on salmonid spawning and rearing.

4. Evaluate long-term (200 years) effects of blowdown on recruitment of large woody debris.

B. Methods

This project would test several specific hypotheses related to the above objectives. The hypothesis related to the first objective (H1) is that the amount and distribution of blowdown is related to historical natural blowdown, orientation of buffer zones to prevailing wind, and topographic features (Harris 1989). Data to test this hypothesis would be obtained from a review of air photos, maps, and aerial surveys. A series of photographs is available showing changes in the forest stands from the 1960s until the 1990s. Data from these photos would be used to show amount of blowdown through time and its relation to timber harvest. Sites with blowdown would be classified by topographic position (e.g., windward slope, lee slope) and direction of tree fall to generate probability distributions for blowdown risk.

The following hypotheses are related to the short-term effects of blowdown on fish habitat:

H2: Sediment input increases because of the uplifting of root masses along stream banks;
H3: Water temperature increases because of the loss of shade canopy;
H4: Aquatic productivity increases because of increased solar radiation reaching the stream.
H5: Channel stability decreases because of scour and deposition associated with new channel obstructions;
H6: Area of pool habitat and cover increase because of the addition debris and pool-forming obstructions; and
H7: Available spawning area decreases because it becomes covered by fallen debris and fine sediment trapped by the debris.

Data for testing these hypotheses would be obtained from habitat surveys in areas with and without blowdown. Five reaches with blowdown and five reaches without recent blowdown (controls) would be sampled for habitat condition once in summer 1998. Reach length would equal 10 channel widths. Reaches would be classified according to channel type (Paustian et al. 1992), and only channels of the floodplain process group would be included. Attempts would be made to use a paired-site study design wherein each blowdown reach would be paired with a nearby control reach of similar channel type. In each reach, size, amount, position, and stability of large woody debris would be measured. The stream area would be measured by habitat type (Bisson et al. 1987). Amount of bank disturbance and bare soil would be quantified. Recording thermographs would be placed in each reach to monitor water temperature. Pebble counts (Montgomery et al. 1996) would be used to quantify streambed grain size. Stream width and depth would be measured at transects to determine stream area and width-to-depth ratio. Stream gradient would be measured with a level and stadia rod. Area of available spawning area would be quantified. Four benthic samples in each reach would be taken and analyzed to determine density of invertebrates as a measure of stream productivity. Statistical significance would be evaluated with a paired *t*-test.

The project would test two principal hypotheses relating to short-term effects of blowdown on habitat utilization by salmonids:

H8. Utilization by rearing juvenile salmonids (Dolly Varden, coho salmon, cutthroat trout) increase because of additional cover provided by blowdown; and

H9. Spawning is reduced because spawning areas become covered or impounded by fallen debris.

Data for testing these hypotheses would be obtained by sampling the study reaches described above. Juvenile salmonid populations in each reach would be estimated in summer and late winter as in Murphy et al. (1986). Utilization by spawning pink salmon would be determined by stream surveys at peak spawning period, counting the number of adults and number of redds in each reach. Spawning areas would be sampled for pre-emergent fry in late winter to determine abundance and viability of deposited eggs.

Long-term effects of blowdown would be assessed through modeling. A model of woody debris dynamics, modified from Murphy and Koski (1989), would be used to examine rates of debris input and depletion through time. Parameters of the model would be estimated to fit conditions at Montague Island. These parameters include site-specific regrowth of riparian trees based on tree species, climatic zone, and site index; amount of residual standing trees and seedlings; delayed input of windthrown trees that initially bridge stream channels; site-specific rates of debris input based on frequency of wind storms; and site-specific rates of debris depletion based on woody debris size and channel type. Projections from this model would be used to predict changes over the next 200 years in large woody debris, channel morphology, and fish habitat.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Koncor Forest Products and ADFG Habitat Restoration Division would be consulted in establishing study sites, obtaining historical air photos, and other data. Koncor Forest Products has indicated support for the project and would assist in planning and logistical support. A contract would be used for the analysis of benthic samples of stream invertebrates, and two contracts would be established for hiring of Chugach Alaska shareholders.

SCHEDULE

A. Measurable Project Tasks for FY 98

Summer 1997:	Reconnaissance trip to Montague Island to evaluate study design and logistics (No cost to Trustees).
October - December 1997:	Collect air photos and maps identifying blowdown.
January - April 1998:	Analyze map data; select candidate study sites; plan logistics and field schedule; acquire sampling equipment and field gear.
May 1998:	Site reconnaissance; select final study sites; install thermographs.
June-August 1998:	Sample study sites for habitat condition and abundance of juvenile salmonids.
September 1998	Sample study sites for adult spawners and redds.

The following project tasks would be accomplished in FY 99:

Oct. 1998 - April 1999:	Parameterize simulation models and predict habitat changes for next 200 years.
March 1999:	Sample study sites for late-winter populations of juvenile salmonids and pre-emergent fry.
June - September 1999:	Analyze data; prepare manuscripts for review and publication.

B. Project Milestones and Endpoints

January 1998:	Photo and map data acquired.
May 1998:	Site reconnaissance: study sites selected.
August 1998:	Summer habitat and juvenile fish data collected.
October 1998:	Spawner and redd surveys completed.
March 1999:	Late-winter juvenile populations and pre-emergent fry sampled.
April 1999:	Model simulations of future habitat change.
September 1999:	Final Report; manuscripts submitted for publication.

C. Completion Date

This project would be completed in Fiscal Year 1999.

PUBLICATIONS AND REPORTS

In FY 1998, one manuscript would be submitted to the North American Journal of Fisheries Management. This manuscript would address the recent history of blowdown on Montague Island, amount and distribution of blowdown, and factors related to blowdown risk. In FY 1999, two manuscripts would be produced. One would address the short-term effects of blowdown on fish habitat, with recommendations for possible changes in buffer zone management. The second manuscript would address the long-term effects of blowdown, with recommendations for possible restoration.

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 project. NOAA NMFS proposes to make a significant contribution (as stated in the proposed budget) to the operation of this project, making it truly cooperative.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project would be coordinated with other projects conducted by ABL. In addition, Koncor Forest Products and ADFG have been consulted in developing this proposal, and Koncor has expressed support for the project and interest in participating in the study. Data from this project would be relevant to Restoration goals of habitat protection and ongoing Restoration efforts in land acquisition for habitat protection. This project would provide one indication of the benefits of such acquisition for protection of anadromous fish habitat.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

Michael L. Murphy, a GS-12 Fisheries Research Biologist, received a BA in Zoology from University of Wisconsin, Madison, in 1974 and an MS in Fisheries Science from Oregon State University, Corvallis, in 1978. Mike has been employed at the Auke Bay Laboratory since 1981. His principal studies have included research on stream/riparian habitat issues and ecology of juvenile salmonids, and he has published more than 40 papers and syntheses related to these topics. Mike is a nationally recognized expert on the effects of timber harvest on anadromous fish habitat, and has served on numerous invited science panels, including the National Interagency Salvage Program Review, the Tongass Land Management Plan EIS, the Interior Columbia Basin Forest Plan EISs, and the Alaska Science/Technical Committee advising the Board of Forestry on adequacy of the Alaska Forest Practices and Resources Act. Mike presently leads the Anadromous Fish Habitat Task at the Auke Bay Laboratory.

OTHER KEY PERSONNEL

GS-12 Fisheries Research Biologist - John F. Thedinga. John received a BS in Fisheries and Wildlife Management, University of North Dakota in 1975 and an MS in Fisheries Science, University of Alaska in 1986. He has been employed by the National Marine Fisheries Service Auke Bay Laboratory since 1978, specializing in research on effects of timber harvest on salmon and freshwater habitat. John has been principal investigator and co-investigator on several projects and has published over 25 scientific papers. John's principal responsibilities in this project would be to assist the Principal Investigator in planning, conducting field work, and analyzing data.

LITERATURE CITED

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Murphy, M. L., and A. M. Milner. 1997. Alaska timber harvest and fish habitat. Pages 229-263 in A. M. Milner and M. W. Oswood (editors) Freshwaters of Alaska: ecological syntheses. Springer-Verlag New York, Inc.

Paustian, S. J. (editor), K. Anderson, D. Blanchet, S. Brady, M. Cropley, J. Edgington, J. Fryxell, G. Johnejack, D. Kelliher, M. Kuehn, S. Maki, R. Olson, J. Seesz, and M. Wolanek. 1992. Channel type user guide. USDA Forest Service R10-TP-26.

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FFY 1997	Proposed FFY 1998						
Personnel		$111.6						
Travel		$18.5						
Contractual		$35.5						
Commodities		$14.1						
Equipment		$4.4	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$184.1	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002		
General Administration		$19.2						
Project Total		$203.3	$110.0	$0.0	$0.0	$0.0		
Full-time Equivalents (FTE)		1.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources		$10.0	$4.0					

Comments:

Other Resources: Contributions from Koncor Forest Products, Inc. (use of housing facilities and vehicle) = $9.0 K. Contribution from ADF&G (air photos) = $1.0 K, for a total estimated contribution of $10.0 K.

1998

Prepared: 4/11/97

Project Number: 98344
Project Title: Blowdown Effects on Salmon Habitat
Agency: National Oceanic & Atmospheric Administration

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUS' :OUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1998
M Murphy	Fishery Research Biologist	12/4	6.0	7.0	2.0	44.0
J. Thedinga	Fishery Research Biologist	12/3	2.0	6.9	1.0	14.8
S. Johnson	Fishery Research Biologist	12/3	2.0	6.9	1.0	14.8
?	Fishery Research Biologist	11/	6.0	6.0	2.0	38.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		16.0	26.8	6.0	
					Personnel Total	$111.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1998
Anchorage, Workshop & other Planning Mtgs., 2	0.4	2	6	0.3	2.6
Car Rental and miscellaneous for above					0.3
Field travel includes (per person) airline ($0.6), air charter ($0.5) and per diem ($0.1):					0.0
Site reconnaissance, May 1998, two people	1.2	2			2.4
					0.0
Field trips to sample habitat and fish, July-August, 1998	1.2	8			9.6
(two trips of crew of four)					0.0
					0.0
Field trip to sample adult spawners, Sept. 1998 (one trip, crew of three)	1.2	3			3.6
					0.0
					0.0
					0.0
				Travel Total	$18.5

1998

Project Number: 98___
Project Title: Blowdown Effects on Salmon Habitat
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Personnel
& Travel
DETAIL

Prepared: 4/11/97

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

Contractual Costs: Description	Proposed FFY 1998
Contract Labor (two contracts for 3 months each)	28.5
Analysis of benthos samples	5.0
Charter vessel for transport of gear to field sites	2.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$35.5

Commodities Costs: Description	Proposed FFY 1997
Field operations (fuel, groceries, air freight to Montague)	7.0
Miscellaneous (film, maps, sampling jars, etc.)	3.0
Computer repairs, maintenance, software upgrades	1.0
Production of Reports	1.8
Raingear, waders	1.3
Commodities Total	$14.1

1998

Project Number: 98___
Project Title: Blowdown Effects on Salmon Habitat
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Contractual &
Commodities
DETAIL

Prepared: 4/11/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1997 · ember 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1998
			0.0
Thermographs	10	0.2	2.0
Electroshocker	2	1.0	2.0
Nets	4	0.1	0.4
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$4.4

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1998

Project Number: 98___
Project Title: Blowdown Effects on Salmon Habitat
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Equipment
DETAIL

Prepared: 4/11/97

98346

Project Title: **Publication of a Indexed Bibliography of the Genus *Ammodytes* (Sand Lance)**

RECEIVED
APR 1 1 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Project Number: 98346

Restoration Category:

Proposer: Robert H. Armstrong (individual/University of Alaska), Mary F. Willson (U. S. Forest Service) and Martin Robards (U.S.G.S. Biological Research Division).

Lead Trustee Agency:

Cooperating Agencies: University of Alaska, U. S. Forest Service, U.S.G.S.

Alaska SeaLife Center:

Duration: 1st year, 1-year project

Cost FY 98: $5,000

Cost FY 99:

Geographic Area: Worldwide

Injured Resource/Service: Publication of sand lance bibliography and review of Alaskan studies.

ABSTRACT

Several trustee funded programs and other studies have stressed the importance of Pacific sand lance in the diet of birds, fish and sea mammals within Prince William Sound and elsewhere in Alaska. However, little is known about this species in Alaska. Also, much of the information on Pacific sand lance and related species is found in agency reports and gray literature. These reports are usually not attainable by library electronic searching methods. The proposed publication will review all studies of Pacific sand lance in Alaska and provide recommendations for further research. Studies on Pacific sand lance and related species done outside of Alaska will be integrated where local knowledge is lacking. The bibliography will cover all published and unpublished references on the genus Ammodytes. Key words and a summary of information will be provided for each reference. All references will be incorporated into a taxonomic, geographic and subject index.

INTRODUCTION

This proposal requests funds to publish an indexed bibliography on the genus Ammodytes (Sand Lance) coupled with a review of studies on Pacific sand lance in Alaska. The bibliography will include all of the published and unpublished reports that we can find. Each reference will include a list of key words and a summary of pertinent information on sand lance. All references will be incorporated into an index by taxon, geographic area and subject. A review of what is known about the Pacific sand lance in Alaska and recommendations for further studies will be included.

For over a year, Martin Robards in Anchorage and Mary Willson and Robert Armstrong in Juneau have been gathering references on the genus Ammodytes. We only recently discovered each other efforts' and decided to cooperate on a joint publication. Our combined efforts will be incorporated into an electronically accessible bibliography with key words and a written published bibliography and review that includes key words, summaries and index. This proposal seeks funds for the written publication only.

Another project to conduct a sand lance literature review and synthesis was submitted as a restoration proposal for the fiscal year 1997 (number 97235). This proposal was turned down by the Trustee Council. We feel our proposal is different because it is much cheaper ($5,000 vs $42,300), and it requests publication costs only and does not include any salary.

NEED FOR THE PROJECT

A. Statement of Problem

Pacific sand lance were largely ignored in the initial studies after the *Exxon Valdez* oil spill. No studies of sand lance were presented in the proceedings of the *Exxon Valdez* oil spill symposium. However a brief mention of its occurrence in Prince William Sound was made by Laur and Haldorson (1996) and Norcross and Frandsen (1996). Also sand lance were mentioned as being important forage for Black-legged Kittiwakes (Irons 1996), Marbled Murrelets, Common Murres, Horned Puffins, Tufted Puffins (Kuletz 1996, Piatt and Anderson 1996) and Pigeon Guillemots (Oakley and Kuletz 1996).

More recently, however, the importance of Pacific sand lance within the Prince William Sound ecosystem has been well emphasized by several studies presented at the 1996 International Role of Forage Fishes in Marine Ecosystems and by studies conducted under the APEX project. In particular, sand lance may be critical to the maintenance of two species listed as not recovered in the Exxon Valdez Oil Spill

Restoration Plan: Pigeon Guillemots (Hayes and Kuletz 1996) and Marbled Murrelets (Burkett 1995). Pacific sand lance are also considered to be an important part of the diet of harbor seals, Dolly Varden, salmon, Common Murres and Kittlitz's Murrelets.

The reasons for these bird species' reduced survival are under investigation by Trustee projects and could be related to a reduced availability of prey, included sand lance. Because of the Pacific sand lance's behavior -- i. e. nearshore habitation, burrowing in substrate at night and during winter -- it is likely the species has been negatively impacted from the spilled oil. In partial response to this possibility and to the documented importance of sand lance as a forage fish in Prince William Sound, a project on the ecology and demographics of sand lance is being conducted in lower Cook Inlet. This Trustee funded project is expected to conclude in FY 99. Since little is known about Pacific sand lance in Alaska, a literature search on this and related species has been ongoing and is nearing completion. There is a need to obtain funding to publish the resulting bibliography and review.

B. Rationale/Link to Restoration

The proposed project would provide researchers with what is known about Pacific sand lance and related species. This would help several Trustee-funded projects by providing ready access to comprehensive information on an important forage fish as well as several Prince William Sound predators.

C. Location

To be determined, but may be published as a Biological Paper of the University of Alaska, Institute of Arctic Biology -- Fairbanks or as a Pacific Northwest Research Station General Technical Report.

COMMUNITY INVOLVEMENT

This project does not involve field work. Research agencies, science centers, public schools, native corporations, universities, environmental organizations and others will have access to the publication.

PROJECT DESIGN

A. Objectives

1. To publish an indexed bibliography on the genus Ammodytes. The bibliography will include all published and unpublished reports that we can find. Each citation will

include key words and a summary of the work. An index by taxon, geographic area, and subject will be included. All work related to Prince William Sound will be identified.

2. To publish, with the bibliography, a related article covering what is known about the Pacific sand lance in Alaska. Subjects covered will include life history, importance, distribution, vulnerability to pollution (including oil) and others. Information from studies done on related species will be integrated if it enhances our ability to understand the Pacific sand lance.

B. Methods

Bids will be obtained from printers associated with the Biological Papers of the University of Alaska. In addition, other referred sources will be contacted for bids.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

No contracts are anticipated. The project is a cooperation between the University of Alaska, U. S. Forest Service and U. S. Geological Survey.

SCHEDULE

A. Measurable Project Tasks for FY 98

Oct. 1 - Dec. 31 1997:	Finish Key Words and Summaries
Nov 1 - Feb 29 1998:	Write final report and submit for review
Mar 1 - Sept. 30 1998:	Send report to printer

B. Project Milestones and Endpoints

December	1997:	Key Words and Summaries completed.
March	1998:	Final report completed.
September	1998:	Report submitted to printer.

C. Completion Date

The completion date for submitting the project for publication would be during FY 98.

PUBLICATIONS AND REPORTS

Armstrong, R. H., M. F. Willson and M. Robards. 1998. Indexed bibliography of the genus *Ammodytes* (sand lance) to 1997. Biological Papers of the University of Alaska.

Willson, M. F., M. Robards and R. H. Armstrong. 1998. A review of Pacific sand lance (*Ammodytes hexapterus*) studies in Alaska. Biological Papers of the University of Alaska.

A computer bibliography with key words will also be produced (not directly connected to the funding request).

PROFESSIONAL CONFERENCES

NORMAL AGENCY MANAGEMENT

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Coordination is ongoing between the University of Alaska, U. S. Forest Service and U. S. Geological Survey in acquiring references.

PROPOSED PRINCIPAL INVESTIGATORS

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Phone: (907)

PRINCIPAL INVESTIGATOR

Robert H. Armstrong
Education:
BS and MS University of Washington (Fisheries)
Honorary Doctor of Science, 1987, University of Alaska, Juneau
Experience:
Robert Armstrong has written and published two bibliographies: an Indexed bibliography of the holarctic genus *Thymallus* (grayling) to 1985 (Biological Papers of the University of Alaska) and a annotated bibliography on Dolly Varden char (Research Report, Alaska Department of Fish and Game). In addition, he has written and published reviews of both Arctic grayling and Dolly Varden. Robert Armstrong worked for the Alaska Department of Fish and Game for 23 years where he was Research Supervisor and assistant leader for the Alaska Cooperative Fisheries Research Unit in Fairbanks. In addition, he was an Associate Professor of Fisheries at the University of Alaska in Fairbanks. He will be teaching Ornithology and Ichthyology at the University of Alaska in Juneau next fall.

Co-Principal Investigator: Dr. Mary F. Willson
Education:
BA Grinnell College
PhD University of Washington (zoology-ecology)
Experience:
Dr. Willson has authored or co-authored 3 books, several monographs and over 130 professional research papers, including numerous review articles on diverse subjects. She was professor of ecology at the University of Illinois for 25 years before joining Forestry Sciences Research in 1989, as a Research Ecologist. Her current research is on interactions between fish and wildlife in southeast Alaska. She holds a courtesy appointment as senior researcher in the Institute of Arctic Biology at the University of Alaska in Fairbanks.

Co-Principal Investigator: Martin Robards
Martin Robards is currently conducting a Trustee funded project titled Ecology and Demographics of Sand Lance. He is attending the Memorial University of Newfoundland working towards a MS or PhD.

LITERATURE CITED

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1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel								
Travel								
Contractual		5,000						
Commodities								
Equipment			LONG RANGE FUNDING REQUIREMENTS					
Subtotal				Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect								
Project Total								
Full-time Equivalents (FTE)								
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: $5,000 - printing costs of indexed bibliography of the Genus Ammodytes with Review.

1998

Prepared: 5 of 8

Project Number: 98____
Project Title: Publication of Sand Lance Bibliography.
Name: Robert H. Armstrong

FORM 4A
Non-Trustee
SUMMARY

4/8/97

98347

FATTY ACID PROFILE AND LIPID CLASS ANALYSIS FOR ESTIMATING DIET COMPOSITION AND QUALITY AT DIFFERENT TROPHIC LEVELS

RECEIVED
APR 1 5 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Project Number:	98347
Restoration Category:	Research Monitoring
Proposer:	Ron A. Heintz, M. Larsen NMFS, Auke Bay Laboratory ABL Project Manager: Jeffery W. Short NOAA Program Manager: Bruce Wright
Lead Trustee Agency:	National Marine Fisheries Service
Alaska Sea Life Center:	Yes
Duration:	1st year, of 3-year project
Cost FY 98:	$110.7 k
Cost FY 99:	$92.6 k
Cost FY 00:	$35.3 k
Geographic Area:	Seward Sea Life Center; Prince William Sound
Injured Resource/Service:	Various

ABSTRACT

This project begins the systematic development of fatty acid profiles and lipid class analysis to identify diet differences and quality in predators on several trophic levels. Specifically we propose to relate the spatial variability of fatty acid profiles in herring and sandlance to their prey, and examine the nutritional consequences of high and low lipid diets in sea lions. Results of the fish studies will benefit APEX investigators by demonstrating the utility of fatty acid analysis for establishing dietary and energetic differences between aggregates of forage fish. Results of the sea lion study will address recent hypotheses concerning their declines in population size. Combined, the results of these two studies will provide a basis for future examinations of wild sea lion diets.

INTRODUCTION

This project seeks to expand the utility of fatty acid analysis for estimating diet composition, by relating fatty acid compositions in forage fish and sea lions to their prey and examining the nutritional condition of these animals through lipid class analysis. Iverson et al (in press) have indicated that fatty acid profiles in seals in Prince William Sound (PWS) reflect the profiles found in their prey. This represents an important advance in the evaluation of trophic relationships between seals and their prey, by providing a relatively non-invasive method of examining seal diets that removes the bias introduced by variation in the digestibility of their prey. In view of its promise, the utility of fatty acid analysis for estimating diet composition warrants investigation in other marine mammals. Additionally, Iverson et al. (In press) clearly demonstrate that fatty acid profiles in herring vary with location and size, but the spatial scale of this variability has not been defined. This spatial variation is important to understand since a predator's fatty acid profile will be influenced by the fatty acids available in its foraging range. The 2 studies described below are designed to demonstrate the potential for using fatty acid analysis to differentiate diets in sea lions and forage fish and the use of lipid class analysis for interpreting the biological meaning of observed dietary differences.

Fatty acids can be viewed as the energetic currency that is exchanged when predators consume prey. After consumption, some fraction of the consumed fatty acids are used to provide energy for the Krebs cycle, while surplus fatty acids are distributed via the blood stream to fat depots located throughout the organism. In many cases, essential fatty acids (fatty acids that cannot be synthesized) identified in predator fatty acid profiles can be used to directly link predators with their prey. This mechanism provides opportunities to identify recently consumed prey by analysis of the fatty acid profiles in the predator's blood, as well as the fatty acid profile of all prey integrated over time by analysis of fatty acid composition in depot fats.

Examination of the relative abundance of lipid classes in organisms provides a measure of their nutritional condition. Lipids can be classified by their structure into several classes. Each class represents lipids used for either membranes, energy reserves, structural elements or hormones. Comparing the relative abundance of the energy reserve class, triacylglycerides (TAG), to the total amount of lipid provides a measure of the relative amount of energy reserve, thus the nutritional condition of the specimen. Combining observations of dietary differences with evaluations of nutritional condition can lead to extremely powerful interpretations of efficiencies in predator prey relationships. This power is easily obtained since fatty acid analysis for estimating prey composition is most sensitive when performed on the neutral lipid portion of the total lipid composition, thus lipid class analysis is the first step to analyzing fatty acid composition.

We propose one field and one laboratory project, designed to demonstrate 1) the analysis of fatty acid profiles and lipid class analysis for examining the nutritional consequences for predators consuming different diets and 2) the potential for estimating sea lion diets from fatty acid analysis. These projects are the first steps in the systematic development of these techniques for examining broad scale trophic relationships. Specifically, the projects examine the utility of the technique with another marine mammal and provide detailed information on the spatial variability of fatty acid profiles in marine mammal prey. The field project examines the influence of location, and age on the fatty acid composition of herring and sandlance and measures the consequences of dietary differences by evaluating the availability of surplus energy. Samples, collected from PWS in July, 1997 by APEX 971638A investigators, will be processed in FY 98. For the laboratory project, we propose to examine how changes in diet affect the fatty acid and lipid class compositions of blood and blubber in captive sea lions, by sampling both diet and sea lions as the diets are varied over a 45 week period. The laboratory project will begin as soon as sea lions are available for study at the Sea Life Center in Seward, Alaska. The herring data from the proposed field study can ultimately be coupled with sea lion data from the lab study to extend the analysis of fatty acids to wild sea lions.

NEED FOR THE PROJECT

A. Statement of the Problem

Trustee sponsored projects including APEX, SEA and NVP focus on understanding trophic relationships, but depend on diet information that do not adequately quantify energy transfer between predator and prey. Diet studies are typically underpowered, because parametric techniques for estimating sample sizes are not well understood (Ferry and Cailliet 1996). Even if analysis of stomach contents could provide precise estimates of diet over spatial and temporal scales, the data are biased by differences in prey digestibility and the assumption that stomach contents at collection represent diets averaged over time. Marine mammal diets are usually assessed by examining scats, which have many of the same biases as stomach contents. In addition, diet evaluation by stomach or fecal content analysis provides only an indirect method for estimating the amount of energy transferred between predator and prey, since measurements of energy density and digestibility estimate energy availability rather than energy acquisition.

Fatty acid analysis for estimating prey composition may have tremendous potential for avoiding the biases observed in stomach content or scat analysis, while lipid class analysis provides a more direct measure of energy acquisition in predators. The application of fatty acid analysis in seals was reported in Restoration Project 95064 (Frost et al. 1996). In addition, the fatty acid profiles in predators has been found to reflect the profiles in prey in a number of feeding studies involving herring (Gatten et al. 1983), cod (dos Santos et al. 1993), chinook salmon (Kennish et al. 1992) and pike (Schwalme 1992). However, these latter studies have been under laboratory conditions where developmental stages, diets and environments have been tightly controlled, and field application remains to be examined. Similarly, lipid class analysis coupled with fatty acid analysis has been used to study trophic relationships in closed systems (Fraser 1987). Lipid class analysis measures nutritional condition by expressing the TAG content as a proportion of total lipid, with high proportions of TAG indicating increased amounts of storage lipid (Fraser 1987).

The success of fatty acid analysis for estimating prey composition depends on understanding the nutritional requirements of the predator, its foraging behavior, and the fatty acid composition of its prey. Iverson et al. (In press) demonstrated that herring in PWS have fatty acid profiles that vary both spatially and morphometrically. These differences are thought to arise from dietary differences in herring from different locations, and their consumption of different sized prey. Phocid seals and their prey may be a good model system for this technique since seal foraging ranges may be quite small with respect to the scale of spatial variability in their prey (Frost et al. 1996), while fatty acid profiles of less selective predators, or predators that forage over broad spatial scales may be more difficult to match to prey. Also, establishing direct links between prey and predator is contingent on tracing the route of essential fatty acids from prey to predator.

Systematic development of a trophic relation that can be examined by fatty acid and lipid class analysis requires identification of essential fatty acids in the predator, and examination of the sources of variability in the fatty acid profiles of its prey. Essential fatty acids are best identified in controlled feeding trials where the fatty acid composition of the predator can be evaluated over time and related to known changes in the fatty acid composition of its prey. Ideally, feeding trials will survey several developmental stages in the predator since, fatty acid profiles will change in response to ontogenetic demands (Leger 1985). Sources of variation in the fatty acid profiles of the prey are examined by evaluating the spatial and ontogenetic scales of variation in each of the different prey and relating them to the prey selectivity and foraging range of the predator.

The power of lipid class and fatty acid analysis to examine trophic relationships will ultimately lie in the ability to hindcast predator diets from the fatty acid composition of its depot fats. Ideally, predator fatty acid profiles are compared to a library of prey profiles, and the relative abundance of each prey item in the predator diet is predicted with some measure of statistical confidence. Currently Tree Structures (CHART) are used to specify prey compositions in predator diets, but no statistical confidence is associated with the compositions identified by this technique, nor are the relative contributions of the prey predicted. Development of a parametric model for hindcasting diet composition must wait until the sources of variation in prey fatty acid profiles are better understood. General application of such a model to multiple trophic levels requires careful quantification of the fatty acid profiles of mid-level consumers as both prey and predators. The work proposed here will lead to systematic development of such a model.

B. Rationale/Link to Restoration

We propose to begin systematic development of the trophic relationship between sea lions and their prey by identifying essential fatty acids in sea lions using a controlled feeding study, and examining the spatial and ontogenetic scales of variation in the fatty acid profiles of wild herring. The sea lion feeding study will establish the use of this technique for examining sea lion diets, and the herring field collections will address questions posed by Restoration Study 97064. Consequently, the proposed herring sampling will complement plans made by Restoration Study 97064 and provide those investigators with increased power to resolve harbor seal diets. Like Restoration Study 97064, our herring be collected by APEX investigators. By using the herring sampling program proposed by APEX and comparing the herring collections with simultaneously sampled sandlance and zooplankton collections, we can provide APEX investigators with a cost-effective analysis of energetic relationships between forage fish and their prey. Thus, the two projects proposed here have direct links to a number of ongoing and proposed projects, and will also provide information that is of interest to other Trustee programs.

The importance of understanding the relation between diet and nutritional condition in sea lions is indicated by recent hypotheses concerning the link between recent population declines and diet quality. Merrick and Calkins (1996) showed that sea lion diets have changed since population declines were first observed. Declining populations have demonstrated increasing dependence on pollock, a low fat prey, while more stable populations have more diverse diets (Merrick et al. In Press). Population declines appear to result from the loss of young individuals, presumably through poor nutrition. Substantiation of this hypothesis is impeded because traditional methods of examining diets in sea lions provide little information on individual diet differences among sea lions residing in the same location.

Marine mammals with their large reservoirs of depot fat are the animals most likely to benefit from this analysis, since their diets cannot be adequately characterized by traditional methods. The study proposed here supplements the proposed, "*Pinniped Muscle Response To Diet*" project, by providing detailed analysis of both the fatty acid profiles of sea lion food and blubber, and quantifies the consequences of changes in diet on the relative abundance of surplus fats. While sea lions were not directly injured by the *Exxon Valdez* oil spill they are a threatened species, and their populations in PWS have experienced dramatic declines since the spill (NMFS 1995). In addition, seals and sea lions are important prey to killer whales, so combining results from this proposal with Restoration Study 95064 provides a basis for extending this work to killer whales. Finally, variation in the fatty acid composition of different blubber layers (Freheim et al. 1994, Koopman et al. 1996) has not been systematically evaluated. By systematically varying the diet of the sea lions, we can examine the consequences of different diets on the nutritional condition of the animals and determine if stratification in the fatty acid composition of blubber reflects temporal variation in diet.

A stated objective of the Trustee funded APEX project is to examine the differences in forage fish diets and determine the consequences of the differences at the individual and population level. We propose to supplement the cruder evaluations of energetic content in herring and sandlance proposed under the APEX studies with analysis of lipid class composition and fatty acid profiles, since lipid class composition provides a direct measure of the energetic consequences of different diets (Fraser 1987). Examination of the fatty acid profiles of herring, sandlance and their prey from different locations in PWS will quantify the spatial range of diet variability because dietary differences are reflected in fatty acid profiles. Samples will be collected by APEX 97163A investigators whose design includes fine scale sampling of sandlance, herring and their prey in two disparate locations in PWS. This design allows comparison of fatty acid profiles over several spatial scales, as well as comparison of profiles in allopatric and sympatric sandlance and herring.

Besides supplementing the work under APEX 97163A, the proposed project provides Restoration

Study 97064 with information on the foraging range of seal prey. Plans for Restoration Study 97064 call for examining fatty acid profiles of herring collected in Northeast PWS near Port Gravina area and south central PWS near Port Chalmers. The resolving power of Restoration Study 97064 will be greatly enhanced by the projects described here. The projects proposed here further benefit Restoration Study 97064 by examining herring in southwestern PWS, an area with important seal populations that has not been examined by 97064.

C. Location

This project depends on samples collected either at the Sea Life Center in Seward, Alaska or on forage fish samples collected from various location in PWS. All the samples will be shipped to and processed in Auke Bay, Alaska.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Scientists involved in this study will regularly present progress reports and results in scientific and public forums, including the annual workshop. They will be available to talk with interested public and will provide information for Trustee Council newsletters and annual reports as appropriate. The project uses existing agency labor to process and analyze the samples. Interpretations of differences in the nutritional condition of herring between different locations in PWS can be correlated with traditional knowledge of differences in the palatability of herring from different locations.

PROJECT DESIGN

A. Objectives

The main objectives of the field and laboratory projects are listed below. The forage fish study can begin immediately in FY98 using samples collected in July, 1997 by APEX investigators. While initiation of the sea lion feeding study depends on the the availability of test animals at the Sea Life Center. The results of the field project will directly benefit APEX 97163A investigators by providing them with detailed energetic data on two important forage fish. The herring collections made by Restoration Study 97064 will complement those proposed here leading to greater understanding of the spatial variability of fatty acid profiles. Finally, the results of the sea lion feeding study can be combined with the herring data sets to begin wild sea lion studies.

FY 98 — Examine the spatial scale of variability in the fatty acid profiles of herring, sandlance and their prey.

1. Determine the spatial range of variation in fatty acid profiles of herring and sandlance and relate the differences to nutritional condition.

2. Relate the spatial scale of variation in herring and sandlance fatty acid compositions to the spatial scale of variability in their potential prey.

FY 99 Examine the consequences of low and high fat diets for fatty acid profiles and TAG availability in sea lions.

3. Determine if the fatty acid composition of sea lion diets is reflected in their blood and blubber and relate dietary lipid to nutritional condition.

4. Determine if variability in the fatty acid composition of different blubber layers reflects temporal variability in sea lion diets.

B. Methods

Spatial Scale of Variability in Herring and Sandlance Fatty Acid Profiles (Objectives 1 and 2)

This project supports APEX Project 97163A which is designed to examine the biomass distribution of forage fish and their prey in different portions of PWS. Biomass distributions are examined by hydro acoustic surveys along transects within study areas in either northeastern or southwestern PWS. Targets identified by sonar are sampled with trawl nets to determine species composition. In certain locations, macro plankton samples will be drawn to identify prey available to forage fish, additionally, samples of fish from the same locations will be preserved to examine their stomach contents.

We propose collecting adult sandlance and herring from 2 developmental categories, young of the year, and age > 1+ from each trawl sample where sufficient numbers of these species are recovered to warrant sampling. Age 1+ herring, and sandlance samples will all be taken from the modal length classes of each species. APEX investigators will be responsible for sample collection, storage and shipment to Auke Bay. Fish will be stored in individual airtight containers and labeled with unique sample numbers and codes reflecting the trawl location and date. Priorities for processing samples will be assigned by conferring with APEX investigators and evaluating the distribution of forage fish biomass after the cruise has been completed. The highest priorities will be assigned to samples taken from discrete aggregates of fish with biomass densities near or exceeding 2.5 g fish/m^2 in the locations where detailed macro plankton collections will be made. No more than 10 fish samples from the same category will be processed from 3 such aggregates in both parts of PWS, providing a total of 180 whole fish samples for fatty acid analysis. Note that young of the year herring samples may represent composites of several individuals to ensure adequate sample sizes for lipid analysis.

At locations where macro zooplankton are sampled, collections will be made to examine the fatty acid composition of the prey field and examine the spatial variability of their fatty acid profiles. APEX investigators will be making detailed evaluations of the prey fields, near Port Fidalgo, in northeastern PWS and near Icy Bay in southwestern PWS. In each of these locations, we propose collecting 2 replicate zooplankton tows, hauled from 60 m with a 0.5 m diameter net. There will be 8 separate stations providing a total of 16 zooplankton collections from each part of PWS. Distances between the stations will be recorded and are estimated to range between 0.5 and 4.0 km. Zooplankton composition in each collection will be determined from samples collected simultaneously by APEX investigators. Zooplankton from each tow will be stored in airtight containers, labeled with the date and location of the tow and immediately frozen. At least 2 g (wet weight) of zooplankton from each collection will be processed by methods described below to determine their lipid class composition and fatty acid profiles.

Analysis of the fatty acid composition data relies on the assumption that differences in fatty acid profiles reflect dietary differences. This assumption will be investigated in detail at a later date, however its reliability is demonstrated by a number of studies that relate diet and fatty acid composition in Atlantic herring (Owen and Middleton 1977, Gatten et al. 1983, Fraser et al 1987, and Navarro et al. 1993). The sources of the differences in diet that are revealed by differences in fatty acid profiles cannot be identified unless the fatty acid profiles of all prey are known. This analysis is outside the scope of this proposal. All efforts will be made to correlate the results of our analyses with evaluations of herring diets performed on samples of stomach contents collected and examined by APEX investigators.

Fatty acid profiles of each fish collection will be tested for differences by multivariate analysis of variance (MANOVA) to determine the spatial scale of variation. The following model will be used to test the null hypothesis that fatty acid profiles do not differ between sampling locations:

$$\mathbf{P}_{ijk} = L_i + A_j(L_i) + \epsilon_{ijk}$$

where $\mathbf{P}_{ijk}$ is the vector containing the relative concentrations of each of the fatty acids observed in the k^{th} fish collected from aggregate j in portion i of PWS, and $A_j(L_i)$ indicates the j^{th} aggregate is a random variable nested in the i^{th} portion of PWS. Only similar species or developmental stages will be compared. A similar model will be used to examine spatial variability in zooplankton fatty acid profiles. The consequences of differences in fatty acid profiles will be examined by pooling all similar groups and comparing the availability of surplus energy between different pooled groups using ANOVA to test the hypothesis that the relative concentration of TAG does not differ between groups with different fatty acid profiles.

For all linear models, relative fatty acid concentrations will be normalized by dividing the sum of all fatty acid concentrations into the concentration observed for each fatty acid, and surplus energy will be estimated by calculating the proportion of total lipid that is represented by TAG. All assumptions of homogeneity of variances and normality made by the general linear model will be examined for the data prior to testing, and appropriate transformations will be made. Estimates of the power of this analysis are currently unavailable since this study is designed to provide variance estimates for future analyses

The fatty acid profiles of the zooplankton will be compared to the profiles obtained from fish collected in the same locations by a randomization procedure. An empirical distribution of differences between zooplankton samples collected from the same portion of PWS will be generated by calculating the sum of the squared differences between each of the relative fatty acid concentrations of two zooplankton samples. With 16 samples, a total of 128 unique differences can be observed in this manner. The difference between each fish and the mean fatty acid profile for the zooplankton will be calculated as the sum of the squared differences for each of their fatty acids, and compared to the empirically derived distribution of differences. A fish will be considered different if the difference between it and the mean fatty acid composition is greater than 95% of the randomly selected differences in the empirical distribution. We recognize that significant differences exist between the composition of the prey field and the stomach contents of herring and sandlance, thus the absence of differences under this analysis coupled with detectable differences in prey and predator fatty acid profiles over longer distances provides a robust basis for examining trophic relationships between zooplankton and their predators.

Consequences of Low and High Fat Diets for Fatty Acid Profiles and TAG Availability in Sea Lions (Objectives 3 and 4)

The sea lion feeding study proposed here supports the proposed "*Pinniped Muscle Response To Diet*" project designed to take place at the Sea Life Center in Seward, Alaska and depends on that project for sea lion feeding, sample collection and shipping. Sea lions diets will be alternated between high (herring) and low fat (pollock) fish on 15 week cycle. Sea lions and their food will be sampled for lipid analysis once every 5 weeks for three cycles. Full depth blubber cores will be drawn from near the pelvic region of three sea lions using sterile biopsy punches. The resulting core will be placed in labeled airtight jars, and immediately frozen at -20°C. At the same time, a 50 ml blood sample will be withdrawn by syringe, placed in a heparinized tube, centrifuged in salt solutions to isolate the fraction containing chylomicrons which will be decanted and frozen. Food samples will be collected weekly, so that a total of 15 representative samples will be collected during each cycle. The 50 g food samples will be placed into separate airtight containers and frozen immediately. Frozen sea lion tissues and food will be maintained at -20°C, and shipped frozen to Auke Bay for extraction and further analysis.

Samples received from the Sea Life Center will be extracted within 200 days of collection. Blubber cores will be divided into three sections, and each section will be analyzed for lipid class composition, and the concentrations of all the fatty acids in the neutral lipid component will be measured following the analytical procedures described below. Food samples will be homogenized, and the concentrations of all the fatty acids in the entire sample will be measured as well as the lipid class composition.

The fatty acid profiles observed in sea lion food will be compared to the profiles obtained in each of the blubber sections and blood through a randomization procedure. Fatty acid concentrations will be transformed into relative concentrations by dividing the concentration of each fatty acid by the sum of all the fatty acid concentrations. Differences between the fatty acid profiles of a sea lion tissue and their food will be examined by calculating sum of the squared differences between the tissue and food for each of the relative concentrations of fatty acids. This sum will be compared to an empirical distribution of differences generated by comparing two food observations of the same type and measuring the sum of the squared differences in their relative concentrations of fatty acids for each food type. A distribution for both the low and high fat foods will be generated, by calculating the 125 unique differences that will be possible out of each type's 15 observations. If the sum of the squared differences between the sea lion tissue and the food is larger than 95% of the differences in the empirical distribution then the profiles will be considered different. This analysis should be considered conservative with respect to identifying similarities in fatty acid profiles since it assumes that the relative frequency of fatty acids in the food is not modified by the sea lions.

Lipid Class/Fatty Acid Analysis

Samples will be extracted by methods developed by Folch (1957) and modified by Iverson (1988). Lipid classification will employ high performance liquid chromatography (HPLC) and evaporative light scattering detection (ELSD) equipped with a stream splitter and an automated integration system. The lipid classes will be separated on a silica based HPLC column; as they elute from the column, each lipid class will be split with one portion being directed to the detector and the other portion being collected for fatty acid (FA) analysis. The portion going to the detector will be integrated and the chromatographic data for each lipid class will be quantified by standard calibration curves established by analyzing standards with lipid compositions similar to the sample.

After separation from the other lipid classes the neutral lipid portion of the sample extracts will undergo acid catalyzed transesterification as outlined in Christie (1982). The resulting fatty acid methyl esters (FAME) will be determined using a gas chromatograph coupled with a mass selective detector (MSD). The FAME will be identified by comparison of the chromatographic peaks with those of known laboratory standards. Peaks not identified by direct comparison to standards will be identified from the fragmentation pattern resolved by the MSD. Fatty acids will be reported as a percentage of the total amount of FA and named according to IUPAC nomenclature.

These methods will give results directly comparable to that of the conventional methods using TLC/Iatroscan for lipid class determination and gas chromatography-flame ionization detection (GC-FID) for FAME analysis. The ELSD will allow for simultaneous detection and separation of lipid classes without developing rods or TLC plates and without extracting lipids from the TLC media for FA analysis. Likewise, analysis of FAME mixtures by MSD will forego the need for silver nitrate augmentation to identify of peaks that are not components of standard mixtures. Since each compound has a unique fragmentation pattern the identity of unknown peaks can be determined from the mass spectral data.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The experiments described in this proposal are designed to 1) initiate development of these techniques for examining broad scale trophic relationships 2) supplement other Trustee Projects and 3) complement ongoing Stellar sea lion diet studies initiated under the NMFS *Stellar Sea Lion Recovery Plan*. The forage fish experiment depends on the sampling protocol of APEX study 97163A. Using the this study plan, we can obtain samples for processing at the beginning of FY 98. APEX investigators will be responsible for collecting, labeling and storing samples until they return to Auke Bay. APEX 97163A will benefit from our analysis by relating our measures of dietary differences and their energetic consequences to their coarser indices of nutritional condition. The examination of the spatial scale of variability in herring fatty acid profiles will be of direct benefit to Restoration Study 97064, which examines the fatty acid profiles of harbor seals. The sea lion feeding study is designed to complement a project proposed for FY 98 entitled *"Pinniped Muscle Response To Diet"*. In this project investigators will examine the effect of the different diets on mitochondria production in sea lions. The energetic information provided by our analysis of lipid class composition will directly benefit their work. Information on the fatty acid composition of sea lions obtained under our project coupled with data provided by Restoration Study 97064 provide a basis for developing this technique with Killer Whales, as well as provide a basis for extending the stable isotope based research of upper trophic level changes proposed by the National Marine Mammal Lab to be funded by GLOBEC.

SCHEDULE

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

Oct 1997	Purchase Evaporative Light Scattering Detector
Jan 1998	Begin analysis of herring, sandlance, zooplankton
Jul 1998	Complete analysis of herring, sandlance, zooplankton
Oct 1998	Begin Sea Lion Feeding Project

B. Project Milestones and Endpoints

	FY98
Oct 1997	Purchase ELSD
Jan 1998	Begin analyzing herring, sandlance and zooplankton samples.
July 1998	Analysis of herring, sandlance, and zooplankton complete
	FY99
Oct. 1998	Begin sampling of sea lions (time dependent on Sea Life Center opening)
Jan. 1999	Report for forage fish experiment completed.
Aug 1999	Complete sampling of sea lions
	FY00
Jan 2000	Analysis of sea lion samples complete
Oct 2000	Report on sea lion experiment completed, Final Report submitted

C. Completion Date

This project will occur in FY98, and FY99, FY00. Synthesis of herring, sandlance, and zooplankton data will be complete in the middle of FY99. Synthesis of sea lion data will be complete at the end of FY00.

PUBLICATIONS AND REPORTS

April 1998: Annual Report containing update on sample processing for the forage fish experiment.

Jan 1999 Submit forage fish report to journal:

Heintz, R , M. Larsen, S. D. Rice, and APEX investigator. 1999. Spatial Variation of Fatty Acid Profiles and Lipid Class Compositions in Herring, Sandlance and Their Prey in Prince William Sound, Alaska. Journal uncertain.

April 1999: Annual Report containing final data on the forage fish experiment, update on sea lion experiment.

April 2000: Annual Report containing update on sea lion sample processing.

Oct. 2000: Final report submitted for of this proposal. Submit final sea lion report to journal:

Larsen, M, R. Heintz, S. D. Rice, R. Merrick and D. Duffy. 2001. Fatty Acid Deposition in the Lipids of Captive Sea Lions. Journal uncertain.

PROFESSIONAL CONFERENCES

Report on forage fish results at National Meeting of the American Fisheries Society in September 1998.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

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

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This section is not applicable to this project.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

Ron Heintz obtained his BS in Ecology from the University of Illinois in 1979 and his MS Fisheries Science from the University of Alaska in 1986. He has worked for the National Marine Fisheries Service, Auke Bay Laboratory since 1985 and been actively involved with Trustee sponsored research since 1992. He is a co-investigator in two pink salmon studies, the first examines the effects of incubating in oiled gravel on reproductive capacity, and the other examines the effects on homing fidelity. The first of these projects established the plausibility of effects on pink salmon fry observed in the Sound after the EVOS, including the existence of long-term effects on growth, marine survival and reproductive ability. He was also a co-author of the final report for Subtidal 8, which examined all of the Trustee Hydrocarbon data for the presence of EVO. This work is of substantial importance to the trustees, by providing evidence for the presence of oil on the beaches of PWS. His efforts in this project led to a detailed understanding of the utility of multivariate methods for analyzing GC/MS data.

OTHER PERSONNEL

Stanley D. Rice, GM-14 Physiologist
Education:
BA in biology (1966) from Chico State University
MA in biology (1968) from Chico State University
Ph.D. in comparative physiology (1971) from Kent State University

Experience:
1986 - present: Habitat Program Manager. Managed NOAA/NMFS/Auke Bay Laboratory's *Exxon Valdez* damage assessment and restoration studies. Conducted and managed cooperative projects interactive with other agencies, provided critical reviews and input in agency decisions.
1971 - 1986: Research Physiologist/Task Leader. Researched and managed studies investigating oil effects encompassing a wide variety of organisms and conditions.

Marie Larsen, GS-11 Research Chemist

Education:
BA in chemistry (1983) from The College of St. Benedict

Experience:
1990 - present: Research Chemist. Managed daily activities and schedules in the hydrocarbon analysis lab at the Auke Bay Laboratory. Primary operator of mass spectrometer.
1983- 1990: Contracted chemist services to the U.S. EPA Environmental Research Laboratory-Duluth as part of the National Dioxin Study. Responsibilities included sample processing and operation/maintenance of mass spectrometry systems.

Richard L. Merrick, Zoologist
Education:

1988-95:	Ph.D. Fisheries, University of Washington, Seattle, WA
1980-85:	Master of Marine Resource Management and MS Biological Oceanography, Oregon State University, Corvallis, OR
1970-73:	Master of City and Regional Planning, Clemson University, Clemson, SC
1965-70:	B.S., Building Sciences, Clemson University, Clemson, SC

Experience:
1989-present Steller sea lion Task Leader, Alaska Ecosystem Program, National Marine Mammal Laboratory, NMFS/AFSC, Seattle,WA.
Direct program to assess Alaska Steller sea lion populations and determine causes of past two decades of population declines. Research program involves aerial surveys for monitoring abundance; telemetry, behavioral, and physiological studies of sea lion ecology; and vessel studies of prey availability. Staff includes 3 full time research biologists, three contract employees, and additional seasonal staff. Coordinate sea lion related studies and issues with NMFS divisions, ADF&G, USF&WS, and various Universities. Represent marine mammal interests on various fishery groups, including North Pacific Fisheries Management Council.

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1998 EXXON VALDEZ TRUST OUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FFY 1997	Proposed FFY 1998					
Personnel		$61.3					
Travel		$4.1					
Contractual		$0.0					
Commodities		$20.0					
Equipment		$16.0	LONG RANGE FUNDING REQUIREMENTS				
Subtotal		$101.4	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	Estimated FFY 2003
General Administration		$9.2					
Project Total		$110.6	$92.6	$35.3	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)		0.9					
	Dollar amounts are shown in thousands of dollars.						
Other Resources		$34.4	$35.0	$10.0			

Comments:

NOAA Contribution:
Habitat Investigation Program Manager, S. Rice,.5 mo = $5.8K
Co-PI: Senior Research Chemist , Marie Larsen 2mo = $10K
Larry Holland, Research Chemist 2 mo @ 10K

For a total NOAA Contribution of $34.4 K

1998

Prepared: 4/11/97

Project Number: 98-347
Project Title: Fatty Acid & Lipid Class Analysis for Estimating Diet Composition and Quality in Seal Lions and their Prey
Agency: National Oceanic and Atmospheric Administration

FORM 3A
TRUSTEE
AGENCY
SUMMARY

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
R Heintz	Fishery Research Biologist	11/5	1.5	6.3	0.0	9.5
M Larsen	Research Chemist	11/6	2.0	5.6	0.0	11.2
L Holland	Research Chemist	11/6	2.0	5.6	0.0	11.2
J Lunasin	Chemist	9/3	5.0	4.8	0.0	24.0
S Rice	Physiologist	14/	0.5	10.8		5.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		11.0	33.1	0.0	
					Personnel Total	$61.3

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
Anchorage, January Workshop/coordination mtgs., 2	0.4	1	4	0.2	1.2
Miscellaneous					0.3
					0.0
National Americal Fisheries Society Meeting	1.6	1	4	0.2	2.4
Miscellaneous (Carrental, telephong, POV mileage etc)					0.2
					0.0
Seward, visit SeaLife Center					0.0
Cost is ca. $1800 paid for by Merrick @ NMML					0.0
Miscellaneous					
					0.0
					0.0
				Travel Total	$4.1

1998

Prepared: 4/11/97

Project Number: 98---
Project Title: Fatty Acid & Lipid Class Analysis for Estimating Diet Composition and Quality in Seal Lions and their Prey
Agency: National Oceanic and Atmospheric Administration

FORM 3B
Personnel
& Travel
DETAIL

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
Sample Analysis: standards, solvents, reagents, glassware, columns	20.0
Commodities Total	$20.0

1998

Prepared:
4/11/97

Project Number: 98---
Project Title: Fatty Acid & Lipid Class Analysis for Estimating Diet Composition and Quality in Seal Lions and their Prey
Agency: National Oceanic and Atmospheric Administration

FORM 3B
Contractual &
Commodities
DETAIL

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

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
Evaporative Light Scanning Detector	1	16.0	16.0
			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**	$16.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
High Performance Liquid Chromatograph	1	NOAA
Gase Chromatograph/Mass Selective Detector	1	NOAA

1998

Prepared: 4/11/97

Project Number: 98---
Project Title: Fatty Acid & Lipid Class Analysis for Estimating Diet Composition and Quality in Seal Lions and their Prey
Agency: National Oceanic and Atmospheric Administration

FORM 3B
Equipment
DETAIL

Responses of river otters to oil contamination: a controlled study of biological stress markers and foraging success

Project Number:	98348
Restoration category:	Research
Lead Trustee Agency:	University of Alaska Fairbanks
Cooperating Agencies:	Alaska Department of Fish and Game; Purdue University, Indiana.
Alaska SeaLife Center:	Yes
Duration:	1st year, 2-year project
Cost FY98:	$220,628.
Cost FY99:	$164,721.
Cost FY00:	none.
Geographic Area:	Seward, Alaska.

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EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT
This project is designed to explore the effects of oil contamination on physiological and behavioral responses in river otters (*Lutra canadensis*) experimentally. Fifteen captive otters will be exposed to two levels of oil contamination under controlled conditions in captivity. Samples of blood, tissues and feces will be collected for analysis of biomarkers, and immunological examinations. In addition, behavioral observations on foraging behavior will be conducted to explore the effects of oil contamination on foraging success.

98348

INTRODUCTION

This proposal originates from the need to better understand the effects of contamination by crude oil on biological stress markers and foraging success in river otters (*Lutra canadensis*). Previous studies demonstrated elevated levels of biological stress markers (bioindicators) in river otters from oiled areas compared with those from nonoiled areas throughout Prince William Sound, Alaska, shortly following the *Exxon Valdez Oil Spill* (*EVOS*). In addition, elevated values of bioindicators have been documented in river otters as part of the *EVOS* - Nearshore Vertebrate Predator Project (NVP) 7 years after the spill.

Although the data collected to date strongly indicate a correlation between oil contamination and physiological stress in river otters, this circumstantial evidence requires verification through controlled experiments as identified by the *EVOS* Trustees Council review process (1997). Also, it is difficult to assess from the evidence collected to date whether the physiological stress is a direct result of oiling or a secondary response to food limitation (Fig. 1). The documented injury to the prey base of river otters, however, is not sufficient to explain the observed pattern of physiological stress. This generated the hypothesis that exposure to oil may have an affect on the diving ability of otters and therefore their foraging success.

In this study, we propose to investigate the effects of exposure to oil on physiology and behavior of river otters under controlled conditions. We will address the following hypotheses:

1. Exposure to oil will result in elevated levels of bioindicators in river otters.
2. Exposure to oil will affect foraging behavior and foraging success of river otters.

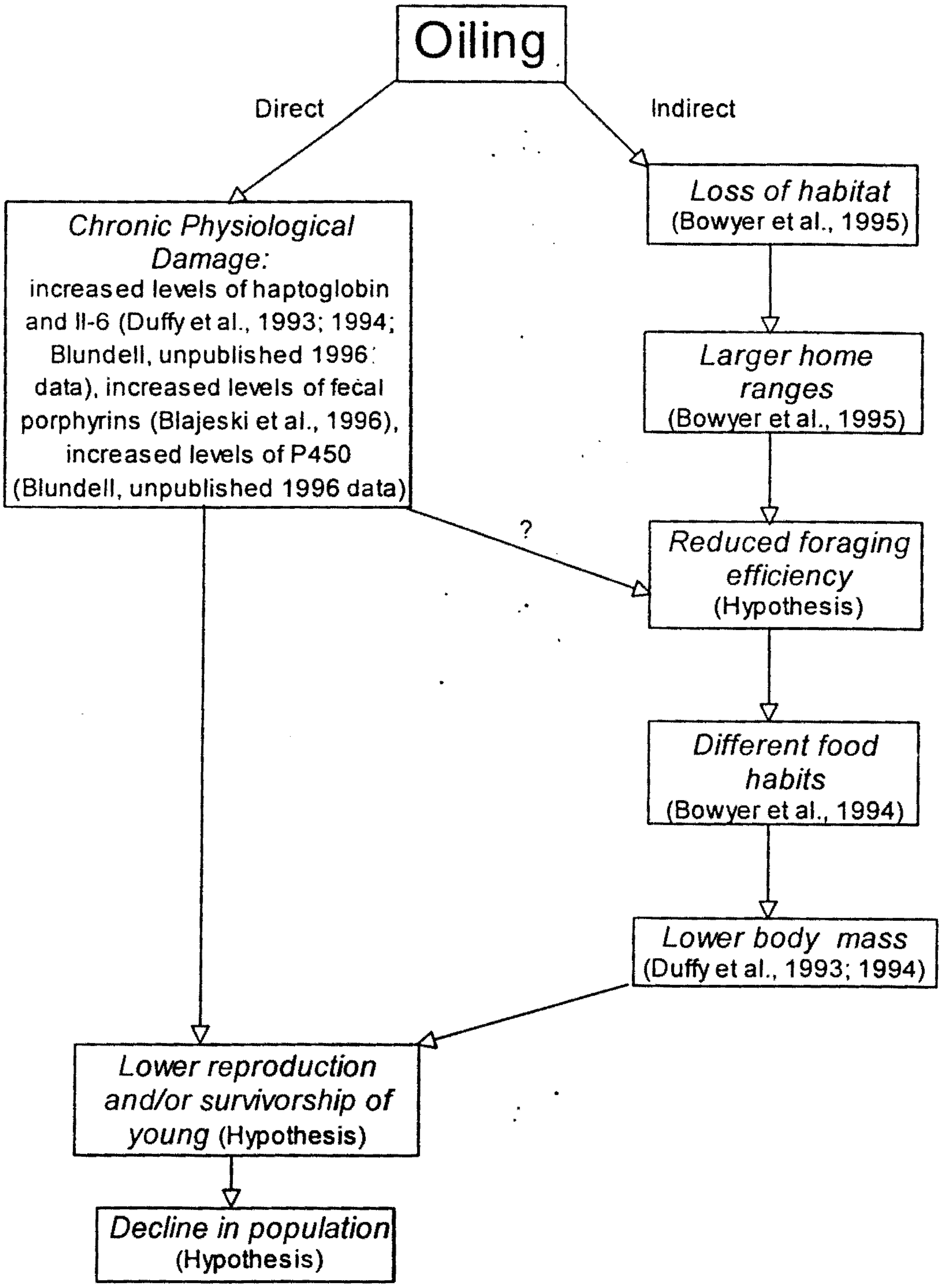

Fig. 1 - Possible pathways for the effect of oiling on river otters in Prince William Sound, Alaska

Background

General

Investigations in Prince William Sound following the *Exxon Valdez* oil spill revealed that river otters (*Lutra canadensis*) on oiled shores had lower body mass and elevated levels of bioindicators, than did otters living on nonoiled shores (Blajeski et al., 1996; Duffy et al. 1993; 1994a; 1994b; 1996). In addition, otters from oiled areas selected different habitat characters, had larger home ranges, and less diverse diets than those in nonoiled areas (Bowyer et al. 1994; Bowyer et al. 1995). These observed differences between river otters from oiled shores and those from nonoiled areas strongly suggest that oil contamination had an effect on physiological and behavioral processes in otters. Moreover, these effects have a potential to become chronic and may impede recovery of populations of river otter as hydrocarbon exposure continues. Between 8-16% of the 10.8 million gallons of crude oil spilled by the *T/V Exxon Valdez* remains buried in marine sediments (Wolfe et al., 1994). Such oil is not subject to degradation by marine organisms and remains in a form that is toxic to many vertebrates (Braddock et al., 1996). Moreover, microbial analyses indicates that oil in sediments along oiled shorelines is still several orders of magnitude more common than in unoiled areas (Braddock et al., 1996), suggesting oil may still be available for biological transport from benthic invertebrates through the food chain.

Biomarkers

Studies initiated following the *EVOS* suggest that several mammalian and avian predators display physiological stress related to oil toxicity. Sea otters from oiled regions had greater antigenic stimulation than animals from unoiled areas (Rebar et al., 1994). Pigeon guillemots had elevated levels of haptoglobins and blood proteins in specific locations and years, although dosing experiments in the field failed to demonstrate the connection between oiling and those parameters (Prichard et al., in press). More specifically, river otters live captured in oiled areas had higher haptoglobin, Interleukin - 6 (Il-6), and fecal porphyrin levels than otters from nonoiled regions post spill (Blajeski et al., 1996; Duffy et al., 1994; 1994). In addition, river otters showed elevated haptoglobin and P450 values in 1996 (G. M. Blundell, pers. comm.). Similar changes in plasma proteins, abnormalities in white blood cells (leukocytes), reduction in the number of red blood cells (erythrocytes), and electrolyte imbalance, were observed in mink (*Mustela vison*) and polar bears (*Ursus maritimus*) following exposure to hydrocarbons (Mohn and Nordstoga, 1975; Oristsland et al., 1981).

Cytochrome P450 are a group of enzymes that metabolize a wide variety of xenobiotic compounds. P450-1A is specifically induced by planar aromatic or chlorinated hydrocarbons, and thus its presence serves as a bioindicator of hydrocarbon exposure. Haptoglobin and Il-6 indicate increase liver activity in synthesizing acute-phase proteins in response to tissue injury (Duffy et al., 1993; 1994). Porphyrins are tetrapyrrolic pigments that are involved in biosynthesis of the heam molecule. Chemical-induced changes in patterns of porphyrins have been observed in several avian species following an exposure to aromatic hydrocarbons (Miranda et al., 1987) Other physiological responses such as those of the immune system have been used recently in the *EVOS* - NVP project as assays to toxic damage of oil.

Although the data collected to date strongly indicate a relationship between oil contamination and physiological stress in river otters, this circumstantial evidence requires verification through controlled experiments. The *EVOS* Trustees Council review process (1997) identified the need for such controlled experiments: "....For river otters captive laboratory exposures to petroleum ...is needed to solidify the cause for P450-induced individuals in western PWS......captive experiments that examine the relationship between oil dose and biochemical responses in the species where such responses appear to be related to spill effects should be done.........To obtain a better basis for interpretation of the field haptoglobin and fecal porphyrin data, controlled oil exposures of river otters are highly recommended."

Foraging success

Diet of river otters from oiled shores was significantly different than that of otters from unoiled areas (Bowyer et al., 1994). Surveys of intertidal organisms in Prince William Sound. suggested that species composition and biomass of subtidal fishes did not differ between oiled and nonoiled areas (Thomas Dean, Pers. Comm.). In addition, diets of otters along oiled shores were more similar to the species composition of subtidal fish than that of otters from nonoiled shores (Bowyer et al. 1994; Thomas Dean, Pers. Comm.) suggesting that otters on oiled shores differed in their foraging strategies from otters on nonoiled areas.

Kruuk et al. (1990) demonstrated that foraging success of European river otters (*Lutra lutra*) in marine environments in Shetland, was determined largely by behavior of both prey and predators. Foraging behavior of semi-aquatic mammals such as river otters will be partially determined by their diving ability. For mink (*Mustela vison*), several studies have shown that the relatively small surface of their feet, their anterior propulsion, and their low storage capacity for O_2 make them an inefficient swimmer compared with other diving mammals (Ben-David et al., 1996; Dunstone and O'Connor 1979*a*; 1979*b*; Stephenson et al. 1988; Williams 1983; 1989; Williams and Kooyman 1985). Although river otters have a higher surface-area of feet, higher storage capacity for O_2, and better propulsion capabilities (Fish, 1994; Tarasoff et al., 1972), these limitation on swimming and diving efficiency could affect the duration and depth of dives especially in sea water, which has higher density and viscosity than does fresh water (Vogel 1981). Exposure to oil, associated chronic physiological stress, and reduction in numbers of red blood cells (i.e. lowered O_2 storage capacity; Oritsland et al., 1981) could have an affect on the diving ability of otters (see Fig. 1). The diet of otters in oiled areas in PWS was largely composed of sessile subtidal fish that are easier to catch. Therefore, the physiological stress imposed on oiled otters may have resulted in the observed differences in diet between otters in oiled and nonoiled areas (Bowyer et al. 1994).

Diving behavior, energetics, foraging success and recovery times of European river otter have been studied extensively in captivity (Kruuk, 1995). Based on these observations the relationships between foraging efficiency and prey abundance was modeled for the European otters (Kruuk, 1995). Repeating these experiments on river otters in relation to oil contamination will provide useful information on the mechanisms by which exposure to oil affects river otters.

River otters in Prince William Sound frequently occur and forage in social groups (Rock et al., 1994). Group living could improve foraging success of predators if hunting is coordinated among members of the group (Kruuk. 1975). Although foraging behavior of wild otters is poorly documented. it is possible that foraging efficiency changes with group size. The controlled experiment described below will provide a good opportunity to investigate the hypothesis that foraging efficiency of otters increases with group size. The observed differences in diets of otters between oiled and nonoiled areas coupled with the observation that many otters foraged in large groups (Testa et al., 1994; Ben-David pers. obs.) suggest that exposure to oil may affect foraging of groups of otters. Therefore, we intend to explore the effects of oil contamination on groups of foraging otters and address the hypothesis that exposure to oil affects foraging behavior of groups of otters.

NEED FOR THE PROJECT

A. Statement of Problem

The 1997 review process of the NVP Project funded by the *EVOS* Trustees Council identified the need to verify the effects of oil contamination on physiological stress responses in river otters. Data collected in summer 1996 revealed that coastal river otters in the western Prince William Sound are still exposed to oil contamination (P450) and show high levels of haptoglobins. These results may indicate that restoration of river otter populations may be impeded by the continued exposure to hydrocarbons. Nonetheless, as long as the connection between exposure to oil and bioindicators is not demonstrated under controlled conditions. the interpretation of the results is limited because of the correlational nature of these data.

In addition, it is difficult to assess from the evidence collected to date whether the physiological stress is a direct result of oiling or a secondary response to food limitation (Fig. 1). The documented injury to the prey base of river otters, however, is not sufficient to explain the observed physiological stress. This generated the hypothesis that exposure to oil may have an affect on the diving ability of otters and therefore their foraging success.

This study will investigate the effects of exposure to oil on bioindicator levels in river otter tissues as well as the effect of such exposure on foraging behavior and success of individual and groups of river otters under controlled captive conditions. Using the behavioral data on foraging behavior, capture success, and the energetic models developed to date for diving semi-aquatic mammals (Kruuk, 1995), we intend to evaluate the differences in foraging efficiency of river otters exposed to oiling.

B. Rationale/Link to Restoration

Effective implementation of the *EVOS* Trustee Council's policy that "Restoration should contribute to a healthy, productive and biologically diverse ecosystem...", is complicated by the diversity and trophic interdependence of the numerous injured resources within the nearshore system. The existing evidence of chronic physiological stress in a wide variety of nearshore vertebrate predators (see NVP project) requires verification under controlled experiments, before the mechanisms that constraint recovery can be understood.

C. Location

River otters will be captured in the western PWS and transported via air to the Alaska Sealife Center in Seward, where the controlled experiments will be conducted.

COMMUNITY INVOLVEMENT

This project will involve intensive data collection both in the Sealife Center as well as in the different laboratories. We will recruit high school and undergraduate students to assist in the data collection. Preference will be given to students from local communities. In addition, supply of live-fish prey will be crucial for the behavioral experiments. It is our intention to contract local fishermen to provide us with these prey.

The captive river otters in the Sealife Center will be available for public viewing and education. We will participate in the development of the educational materials associated with the river otter display. We will also welcome opportunities to interact with local communities to present and discuss our findings.

PROJECT DESIGN

A. Objectives

The objective of this study is to document the effects of exposure to oil on physiology and behavior of river otters under controlled conditions. We will address the following hypotheses:

1. Exposure to oil will result in elevated levels of bioindicators in river otters.
2. Exposure to oil will affect foraging behavior and foraging success of river otters.

B. Methods

General

Fifteen wild male river otters will be live captured from the wild in unoiled areas in western PWS using No. 11 Sleepy Creek leg-hold traps (Blundell et al., in review) under permit from the Alaska Department of Fish and Game (requested 4/9/97). Traps will be placed on trails at latrine sites and monitored by means of trap transmitters (Telonics, Mesa, Arizona, USA) that signal when a trap has been sprung. Processing of otters will begin within 1 - 2 hours. Otters will be anesthetized with Telazol (9mg/kg; A. H. Robins, Richmond, Virginia, USA) administered using Telinject darts and a blowgun.

Once anesthetized, otters will be weighed (to the nearest 0.1 kg), and measured (to the nearest 1 mm). These measurements will include body length, tail length, and total length; total skull length and width of zygomatic arch; length from hock to toe of the right hind foot; canine length and diameter, and distance between canines. Age of otters will be determined by removing an upper premolar 1 for cementum annuli aging. We will insert a PIT tag under the skin between the scapulae of each individual to allow for individual identification. In addition, colored tags in unique combinations will be inserted in the animals ears to allow for visual identification.

The fifteen wild-caught male river otters will be transferred under sedation via air to the Alaska Sealife Center in Seward, Alaska. Otters will be housed in two large enclosures with a large saltwater pool and a small freshwater pool. Each otter will be provided with an individual solid sleeping box. Otters will be fed live fish on a daily basis in the large saltwater pool, and diet will be supplemented with prepared food mixture (mink chow), vitamins, and minerals (Robbins, 1993).

After an acclimation period of 1 month, otters will be randomly assigned to five experimental groups of three individuals each:

- Group 1 - control
- Group 2 - single exposure to low levels of oil (1000 ppm)
- Group 3 - triple exposure to low levels of oil at 3 week interval
- Group 4 - single exposure to high levels of oil (10,000 ppm)
- Group 5 - triple exposure to high levels of oil at 3 week interval

Prior to the exposure to oil a series of tissue sampling and behavioral observations on foraging behavior and success will be conducted on each individual otter. The day of sampling (tissues and behavior) prior to oil administration will be termed day 0 of the experiments for each otter (the actual date of this day may differ slightly between individuals and will depend on the number of individuals personnel will be able to handle in one day). Table 1 describes the schedule of oil administration and sampling.

Oil will be administered to otters mixed with prepared food (mink chow). Weathered (comparable to 2 weeks weathering) Prudhoe Bay Crude oil will be dissolved in salmon oil and than mixed with the food.

Table 1. Schedule of experiments for captive river otters to examine the effects of crude oil, Seward Sealife Center.

Treatment	Day	Group 1 control	Group 2 low	Group 3 low	Group 4 high	Group 5 high
Behavioral observations	0	x	x	x	x	x
Tissue sampling	1	x	x	x	x	x
Oil administration	2		x	x	x	x
Behavioral observations	8	x	x	x	x	x
Tissue samples	9	x	x	x	x	x
Oil administration	22			x		x
Behavioral observations	29	x	x	x	x	x
Tissue samples	30	x	x	x	x	x
Oil administration	43			x		x
Behavioral observations	50	x	x	x	x	x
Tissue samples	51	x	x	x	x	x
Behavioral observations	150	x	x	x	x	x
Tissue samples	151	x	x	x	x	x

Following completion of the experiments river otters will be released back into the wild at the site of their original capture. These animals will be implanted with radiotransmitters following the surgical protocol described below and monitored using aerial telemetry for the next 6 months.

Otters will be anaesthetized to a surgical plane with a combination of Ketamine Hydrochloride (100 mg/ml, Ketaset, Aveco Co., Fort Dodge, Iowa, 50501, USA) at a dose of 10 mg/kg, and Midazolam Hydrochloride (5 mg/ml, Versed, Hoffman-LaRoche, Nutley, New Jersey 07110, USA) at a dose of 0.25 mg/kg mixed in the same syringe (Spelman et al., 1993). The surgery site will be shaved and surgically scrubbed with Nolvasan soap and a final iodine prep. Once the site is prepared and prior to making the incision, the otter will be checked to ascertain depth of anesthesia and proper analgesia. The surgeries will be performed by a veterinary technician with specialized training in the procedure, using methods outlined in Testa et al. (1994). All surgeries will be done adhering to sterile technique. We will use a side entry, posterior to the last rib to introduce a hermetically sealed radiotransmitter (IMP/400/L; Telonics, Mesa, Arizona) into the peritoneal cavity. Each muscle layer will be closed separately with simple interrupted sutures, the skin will be closed with a continuous subcuticular suture line to prevent the otter from accessing any sutures. As a final precaution, the skin incision will be sealed with surgical glue. We have performed this surgery successfully many times on wild river otters.

Animals that will suffer minor but noticeable damage due to oil administration that will threaten their survival in the wild will be kept at the Sealife Center for public viewing and education. In instances where oil damage will cause pain and major suffering, animals will be humanely euthanized using inter vinous injection of 0.5cc/kg body mass. Any carcasses will be used for full pathological screening. All methods used in this research will be approved by an independent Animal Care and Use Committee at the University of Alaska Fairbanks, Fairbanks, Alaska (proposal submitted 4/9/97), in compliance with policies recommended by the National Institutes of Health (NIH), the National Science Foundation (NSF), and the Scientists Center for Animal Welfare (SCAW).

Tissue sampling

Collection of tissue samples will follow the same operating protocol as used in the NVP project to assure that results will be comparable. The assays performed on the tissue samples will include: haptoglobin, Il-6, P450-1A (in epithelial cells and WBC), CBC, WBC, and serum chemistry, lymphocyte blastogenesis, serum protein electrophoresis, immunoglubolin quantitation, delayed type hypersensitivity reactions, DNA adduct analysis.

A total of 22 milliliters of blood will be drawn from the jugular vein of each otter with care to keep samples sterile. Ten milliliters will be preserved with heparin (40u/ml or 0.4ml/10ml of blood) and stored in a red top vacutainer. An additional 2 ml will be preserved with EDTA (purple top vacutainer), and 10 ml of blood will be collected in a red top vacutainer and allowed to clot. Two blood smears will be made for each river otter on site, at the time of blood draw. A tissue sample from the medial surface of the left front limb in the triceps area will be collected from each river otter using a 3mm disposable skin biopsy punch. The specimen will be preserved in 10% neutral buffered formalin immediately after collection.

In the laboratory, red-top tubes will be centrifuged at low speed (800 x g,) for 20 minutes. Serum will be drawn from the clot of the centrifuged sample and frozen separately. All serum samples, and the clot, will be frozen within 12 hours of obtaining the samples. The plasma will be drawn off of the heparinized sample with care so as not to disturb the buffy-coat layer. One milliliter of the plasma will be mixed with 0.2 ml of DMSO (tissue culture grade) and placed on ice. The buffy-coat will be removed from the erythrocyte layer and placed in a snap top tube along with 1 ml of plasma. The plasma/DMSO will then be added slowly (one drop at a time) to the mixture. The mixture will be aliquoted into two cryovials (approx. 1 ml each), placed into a prechilled Nalgene freezing unit and placed into the freezer for 12 hours. The buffy-coat samples will be transferred to a liquid nitrogen dewar for storage and eventual transport to the Purdue University laboratory. Any remaining plasma will be frozen. EDTA samples and one blood smear from each otter will be flown to a laboratory in Anchorage (Quest Lab c/o Laurie Rubin, 562-2551) for a complete blood count within 72 hours of the blood draw. All serum and plasma will stay frozen and sent, periodically, to Fairbanks for analysis. Serum samples will be sent to Quest Lab for Serum Chemistry Panels and other tests as needed.

Assays Biological Stress Markers and Immunology

Haptoglobins

Haptoglobins (Hp) are alpha$_2$ glycoproteins that stoichiometrically bind free hemoglobin (Hb) in a haptoglobin-hemoglobin complex. Excess hemoglobin will be added to the serum sample in a 1 part of a 10% hemoglobin suspension to 20 parts of undiluted serum, and allowed to mix for 5 min. Two microliters of the sample mixture will then be electrophoresed on agarose gels at 100 volts for 1 hr. After fixing the protein complex with 7.5% trichloroacetic acid, gels will be stained for hemoglobin using o-dianisidine, as described by the manufacturer. The Hp-Hb complex, which migrates in a different region from hemoglobin, is quantitated by densitometry and results are expressed as mg of hemoglobin binding capacity per 100 ml of serum as described by the manufacturer.

Interleukin - 6

Samples received from the captive otters will be analyzed for IL-6 levels using an immunochemical assay . Samples, run in duplicate, will be added to a microliter plate coated with a monoclonal antibody for IL-6. After washing away any unbound proteins, an enzyme-linked polyclonal antibody for IL-6 will be added to the wells and incubated to allow for any IL-6 binding. After a final wash, a substrate solution will be added to the wells. After color develops, sample concentrations will be determined from a standard curve. IL-1ß will be measured similarly.

Cytochrome P450 assays

Two approaches will be taken to evaluate cytochrome P450 levels:

1) Immunohistochemistry: The induction of-cytochrome P4501A (CYP1A) in tissues of the river otters will be evaluated by immunohistochemistry. Candidate tissues to be used include skin punches. Tissue samples will be preserved in 10% neutral buffered formalin immediately after collection and shipped to Woods Hole Oceanographic Institute for analysis (by Dr. J. Stegman).

Analytical SDS-PAGE will be done using a modified procedure of Laemmli[31]. The test and control media will be removed from the 12 well plate, and each well will be rinsed twice with 2 ml cold wash buffer (62.5 mM Tris-HCI, pH 6.8). Sample buffer (2.35% [w/v] SDS, 10% [v/v] glycerol, 5% [v/v] ß-mercaptoethanol, and 62.5 mM Tris-HCI; pH 6.8) will be added to each well (200 µl per well) to solubilize the cells. Cell lysates will be collected from individual wells and stored at -20°C. Test samples will be heated to 90°C for several minutes and equal volumes loaded in 9 or 10% (w/v) acrylamide: 0.27% (w/v) bis-acrylamide slab gels (approximately 12 x 16 cm, 0.75 mm thick) and run at 20 mA constant current per gel for approximately 4 h to resolve individual bands.

The gels will be fixed and stained using a Sigma Chemical Co. AG-25 silver staining kit procedure. Analytical gels will be prepared as above and electrobloted onto nitrocellulose membranes using 25mM Trisma base, 192 mM glycine, and 20% (v/v) methanol for 3 h at 100 V. The membranes will be then blocked in 5% nonfat dried milk in CMF-PBS, washed four times in CMF-PBS, and incubated with antibody to hsp 70 and 141 which recognizes a conserved epitope present in most members of these families. The blots will be washed as before and incubated with an HRP-conjugated goat antirat IgG antibody (Sigma, A-9037) as the secondary antibody. For the color development, the blot will be washed as before and stained using 3,3'-diaminobenzidine tetrahydrochloride (DAB) as the HRP substrate (Sigma Fast® DABkit D-4418).

2) Quantitative RT-PCR to measure cytochrome P450: The purpose of this approach is to use an alternate method (quantitative polymerase chain reaction) to measure cytochrome P450 expression in peripheral blood lymphocytes. The lymphocytes will be isolated from blood samples drawn from animals captured from oiled and non-oiled areas. The method to be used will be adapted from Vanden Heuvel et al. (1993). Total RNA will be extracted from isolated peripheral blood lymphocytes and a reverse transcriptase-polymerase chain reaction (RT-PCR) assay will be used to quantify cytochrome P450 levels. Advantages of this technique are: (1) the use of peripheral blood samples for analysis; (2) the small sample size required for detection and (3) potentially increased sensitivity as compared to other methods (by Dr. P. Snyder).

Hematology and serum chemistry

For CBC (complete blood cell counts), WBC (white blood cell counts), and serum chemistry samples will be submitted to commercial clinical laboratories. The serum samples from the captive river otters will be batch tested at Purdue University for serum electrophoresis (SEP) and immunoglobulin quantitation using standard methodologies. Serum protein electrophoresis offers information on relative protein distribution and allows for the calculation of absolute values (Melvin 1987). Many disease states may alter the electrophoretic pattern (Turnwald and Barta 1989). Acute phase, complement, immunoglobulin and coagulation proteins can all be assayed using SEP.

Immune function assays

A total of 10 ml of blood collected with 40u of preservative-free heparin/ml as the anticoagulant will be used to isolate buffy coat leukocytes. Blood samples will be processed using a technique modified from Truax et. al. (1993) on cryopreservation of buffy coat cells, stored in liquid nitrogen, and shipped to Purdue University. For analysis, frozen cells will be thawed rapidly in a 37°C water bath and immediately placed on ice.

The sample will then be transferred to a 15 ml centrifuge tube and diluted to 10 ml with Hank's balanced salt solution (HBSS) containing 40u of heparin/ml. The sample will then be layered over 4 ml of a ficoll gradient and centrifuged at 1600 x g for 30 minutes. The cells at the interface will be collected and washed 3 times in HBSS. Following the final wash the cells will be resuspended in RPMI 1640 medium supplemented with 10% (v/v) fetal clone, 2 mM L-glutamine, 25 mM 2-mercaptoethanol and antibiotics. Enumeration and viability will be assessed using trypan blue dye-exclusion. Lymphocyte proliferation assays will be performed using the mitogens PHA, Con A and PWM in 5 day cultures. All assays will be done in triplicate. Proliferation will be assayed by adding tritiated thymidine to the cultures at 16 hours prior to harvesting. Results will be recorded as counts per minute (cpm).. Control wells will contain medium only.

Assays of Fecal Porphyrins

Feces will be collected from individual otters following the schedule of tissue sampling (Table 1).

Oil Measurement in Feces

A sample of 2.5 ml or g of feces will be placed into an extraction tube containing 4 mL isopropyl alcohol. The extraction tube will then be shaken for 1 minute to extract the PAH components. The extract will be filtered using a piston filter and then diluted 10-fold. This first dilution allows detection of 0.7 to 15 ppm PAH from the gauze saturated with isopropyl alcohol. If necessary a second dilution will be made to increase the detectable range to 140 ppm. The alkaline phosphatase hapten-enzyme conjuate will be added to the diluted sample and to a negative reference solution. The analyte detector used has a discrete sample reaction zone (sample zone) as well as a negative control reference reaction zone (reference zone), each of which contain latex particles that are coated with affinity-purified antibody. Five drops of prepared test sample will be added to the sample zone, and 5 drops of negative reference solution will be added to the reference zone of the detector. After 3 minutes, each solution will pass through the immobilized antibody and will be absorbed into the detector by capillary action. PAH in the sample will compete with the hapten-enzyme conjugate for sites on the immobilized antibodies. To remove any unbound hapten conjugate, 2 drops of rinse solution will be added to each reaction zone. To produce a color endpoint for the immunoassay, 2 drops of alkaline phosphatase color forming substrate will be added to each reaction zone which then reacted with the antibody bound hapten conjugate. As the concentration of PAH in the sample increases, the color endpoint decreases in intensity. A hand-held dual-beam reflectometer will be used to compare color intensity of the sample zone to the reference zone. The concentration of PAH in the isopropyl alcohol saturated gauze will be calculated from a preprogrammed standard curve and displayed by the reflectometer. The sensitivity, specificity, and predictive values of the test will be calculated by standard methods.

Fecal Extraction

The protocol used for extraction of fecal porphyrins is a modification of that developed by Lockwood et al. (1995). Five milliliters of 12N HCL will be added to approximately 1.0 g of dry (lyophilized) feces. This mixture will be vortexed, allowed to sit for 5 minutes, and vortexed again. Fifteen milliliters of both diethyl ether and distilled H_2O will be added, and the mixture will be vortexed after each addition. To ensure that the porphyrins will be not denatured, the time elapsed between the addition of HC1 and H_2O will not exceed 10 minutes. This mixture will be then centrifuged at 3,000 RPM for 10 minutes. The aqueous phase will be centrifuged again at 4,000 RPM for 5 minutes, and the supernatant refrigerated in the dark until time of analysis. The aqueous phase, which contains all porphyrins, will be approximately 20 ml, and exact volumes will be recorded.

Diode-array Spectrophotometry

One milliliter of each fecal extraction will be measured spectrophotometrically using Perkins-Elmer diode-array spectrophotometer. Porphyrins have a characteristic absorbency in the Soret banc, between 390-440 nm. The high noise created by the dark color of aqueous phases complicates the spectra so the second derivative spectra (350-450 nm) will be obtained for all samples and standards. The relative concentration of total porphyrins will be obtained by relating the trough depth (as measured from the baseline) of a standard porphyrin kit (Porphyrin Products, Logan, UT) to the trough depth of each sample. Porphyrin could be detected in every sample with 0.76 nmoles being the lowest level detected in the 201 samples analyzed. The concentration of total porphyrins in each sample will be calculated from the equation:
Total Porphyrins (nmole/g dry feces) = TD*(6/stdTD)*20ml/(DW*VU)
where: TD=trough depth of sample, measured from baselines; 6/std TD=trough depth of standard kit (6nmole); DW=dry weight of sample initially used for extraction; VU=volume of sample used for diode array analysis.

HPLC Analysis

Two milliliters of the initial aqueous phase will be concentrated to approximately 1 ml using a SpeedVac concentrator. One-hundred fifty micorliters (µl) of each sample, which will be selected arbitrarily from the 201 extracted samples, will be injected into a Waters HPLC system to determine porphyrin profiles. A Waters 441 UV detector with a 405 nm filter will be used for sample analysis. A silica-C1 column with 5 µm packing will be obtained from Phenomenex, Inc. (Torrance, CA). The gradient solvent system for the HPLC used will be a modification of the procedure outlined by Lim and Peters (1984). Solvents for gradient elution will be 10% (v/v) acetonitrile in 1 M ammonium acetate (Solvent A) and 10% (v/v) acetonitrile in methanol (Solvent B). All solvents will be HPLC grade (Fischer Scientific, Inc.). Porphyrins will be separated for 40 minutes with a linear gradient elution from 100% A to 100% B, followed by isocratic elution at 100% B for 20 minutes, then returning to 100% A over a 5 minute period. The flow rate will be 1 ml/minute at room temperature.

Behavioral Observations

Observations on foraging behavior and success will be conducted in two forms: 1. direct observations; 2. frame by frame analysis of video tapes recorded during the experimental sessions (Ben-David et al., 1991).

Otters will be individually marked with observable ear tags and will be allowed to forage alone for 90 minutes in each session. In each session river otters will be offered one type of the four possible prey in equal biomass:

1. Large schooling fish (Dolly varden; *Salvelinus malma*).
2. Large nonschooling fish (Cottidae).
3. Small schooling fish (herring; *Clupea pallasii*).
4. Small nonschooling fish (Cottidae).

These prey types represent the types of fish prey available to river otters in PWS.

Nonschooling fish are most commonly occur in the intertidal and subtidal sections of the coast. These prey are slow moving and are easy for river otters to catch (Kruuk, 1995). On the other hand, these fish may be difficult to locate and may require longer dive duration than schooling fish. Schooling fish represent more pelagic prey and may require high energy expenditure in chase (Kruuk, 1995). We chose 2 different sizes of fish to investigate the role of energy returns from prey on diving behavior of otters.

During each session the following data will be collected by direct observations:

1. Active time spent foraging
2. Number of dives
3. Duration of dives.
4. Number of capture attempts.
5. Number of capture successes.
6. Giving-up time.
7. Recovery time

Additional evaluation of foraging behavior will be conducted from video films recorded by 3 video cameras positioned in the enclosures. Data will be transcribed from films using Eshckol-Wachman Movement Notation (Ben-David et al., 1991). Eshckol-Wachman Movement Notation is a mathematical representation of animal movements that allows quantitative evaluation of behavior. This method is being used extensively in studies of predatory, play, and drug-induced behavior (Ben-David et al., 1991; Pellis, 1981; Pellis and Officer, 1987). Data collected from video films will include the following categories:

1. Propulsion mode (Fish, 1994).
2. Dive depth.
3. Duration of dive at each depth.
4. Attack behavior.
5. Prey responses to attack.

Observations will be conducted on single otters following the schedule described previously (Table 1), as well as on groups of 3 otters to assess the differences in foraging efficiency of individual otters compared with those of otters in groups under conditions of oil contamination.

Statistical Analysis

After examination of blood profiles and immunological assays of otters (by Dr. A. Rebar), animals will be classified to their appropriate clinical state (effected, uncertain, not effected). We will use a Chi-Square analysis for tests of homogeneity of proportions among groups (Guenther 1973). For bioindicators we will use a repeated measures MANOVA (Johnson and Wichern, 1992) with haptoglobin, IL-6, P450, and total fecal porphyrins as dependent variables and before exposure and after exposure (n = 12) oil treatments as main effects. We will examine chronic effects by extending the comparison of repeated measurements into a period of time demeaned necessary to detect chronic effects, examining a full model with dosage as an effect. In addition to statistical analyses we will follow the groups of 3 otters (Table 1) as a case-study for signs of clinical effects from oiling.

Behavior will be analyzed using observation bouts as the unit of sampling with repeated measures analysis, i.e., blocking by individual to control for lack of independence among bouts. Percentage of time spent in the different behaviors will be modeled as dependent variables with sampling period, dosage and group size as main effects.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This project is a collaborative research project of scientists from a variety of State (ADFG), university, and private research centers. University of Alaska Fairbanks will be responsible for the research work order, and contracts to Purdue University and Woods Hole Oceanographic Institute to assess health and oil exposure parameters.
Various transport aircraft and vessels will be chartered from the private sector. Local fishermen will be contracted to provide live prey.

Professional services contracts and Research Work Order mechanisms will be used to transfer funds from Trustee Agencies to university and private cooperators on this project. These will include contracts to Purdue University, Western Ecosystems Technology, Woods Hole Oceanographic Institute and others.

SCHEDULE

A. Measurable Tasks for FY98 and FY99

This project will begin in FY98 and will be completed in 1999.

Nov 1997:	Development and refinement of study design and integration (Fairbanks, Alaska).
Jan 1998:	Attend Annual Restoration. Workshop (Anchorage)
Feb - Mar 1998:	Arrange logistics (boats, equipment, Sealife Center enclosures)
Apr - May 1998:	Live - trapping of otters and transport to Sealife Center (PWS)
Jun - Dec 1998:	Conduct experiments at Sealife Center (Seward)
Jan 1999:	1. Release animals to the wild 2. Attend Annual Restoration Workshop (Anchorage)
Jan - Sep 1999:	Data entry, analysis, and write up (Fairbanks and Seward)

B. Project milestones and endpoints.

FY 98: Data collection
FY 99: Data collection and report submission

C. Completion Date

The work will be completed by Sept. 1999.

PUBLICATIONS AND REPORTS

No publications are expected in FY 98. All reports will be published in FY 99. We have an excellent record of publishing results from our research.

PROFESSIONAL CONFERENCES

The senior scientists on this project will likely present project results at various forums in 1999. However, other than the annual *EVOS* meeting in January in Anchorage, presentations at professional conferences have not been identified or scheduled at this point. We propose to notify the Trustees of presentations and forums as they are scheduled.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The project is closely linked with the river otter section of the NVP project and with the Sealife Center in Seward. We have discussed the project with Dr. Leslie Holland Barttles, Chief Scientist for NVP.

PRINCIPAL INVESTIGATORS

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Merav Ben-David, Ph.D. is a research associate with the institute of Arctic Biology University of Alaska Fairbanks. She has extensive experience in studying behavior of mammals and birds under captive conditions. Her research concentrates on mustelids and predatory behavior. She is currently funded for three projects one of which involves developing new DNA techniques to estimate population levels of river otters (ASTF). She is an active member of the IUCN/SSC otter specialist group. Her responsibilities in this project include the foraging behavior and project coordination.

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Dr. R. Terry Bowyer, Professor of Wildlife Ecology, University of Alaska Fairbanks. Dr. Bowyer has an extensive publication record (70). He has conducted extensive research on river otters and impacts of *EVOS* on this species (10 publications), and has experience conducting behavioral research.

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Dr. Lawrence Duffy, Professor of Chemistry and Biochemistry at the University of Alaska Fairbanks has been working in the area of toxicology for 15 years and is a member of the International Society of Toxicology. He has studied various bacterial and mammalian toxins. Since the *Exxon Valdez* oil spill, he has published six papers related to developing biomonitors. He is currently funded for two major environmental studies in Alaska. At the University, he teaches "Environmental Biochemistry and Biotechnology" and is a member of the Environmental Chemistry Program and Mammal Group. His responsibilities in this project will be to conduct the biomarkers analysis.

OTHER KEY PERSONNEL

Dr. Lyman McDonald
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Dr. Lyman MacDonald, B.S., M.S. Oklahoma State University, PhD. Colorado State University, is a biometrician with 25 years of comprehensive experience in the application of statistical methods to design, conduct, and analyze environmental and laboratory studies. He has designed and managed both large and small environmental impact assessment and monitoring programs. His responsibilities will include providing advice on project design and statistical analysis.

Dr. Alan Rebar
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Dr. Alan Rebar is Dean of the School of Veterinary Medicine and Professor of Veterinary Clinical Pathology at Purdue University. He is internationally recognized as an expert in the field of clinical pathology and toxicology. He has been involved in EVOS studies of sea and river otters since 1991. His responsibilities will include conducting the physiological, pathological and immunological investigations.

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Dr. Paul W. Snyder is an Assistant Professor of Pathology and Immunotoxicology and Director of the Clinical Immunology laboratory of the Department of Veterinary Pathobiology, Purdue University. He is also a Diplomate of the American College of Veterinary Pathologists. His research interests are in the area of mechanism based studies on the pathology and immunology of xenobiotics on biological systems. He has an NIH-funded project related to the immunobiology of environmental contaminants. His responsibilities will include conducting the physiological, pathological and immunological investigations.

Dr. Hans Kruuk
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Dr. Hans Kruuk is a leading researcher in carnivore ecology with international reputation. In recent years he has conducted extensive research on the European river otter as well as on other otter species worldwide. His publication record on river otters is the most extensive to date. He has successfully maintained river otters in captivity and conducted experiments on diving physiology of captive river otters. He will serve as an advisor to the project.

Dr. Michael Castellini
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Dr. Michael Castellini is an associate professor in the Institute of Marine Sciences University of Alaska Fairbanks. He is the coordinator of the Sealife Center Facility in Seward Alaska. He will be assisting with acclimating the river otters to the captive conditions and conducting the captive experiments.

Mr. Howard Golden
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Mr. Howard Golden is a researcher with the Alaska Dept. of Fish and Game, Division of Wildlife Conservation. His specialty is studying furbearers including river otters. He has extensive experience in live-trapping river otters as well as other furbearers. He will be involved in the trapping, transporting and release of the river otters.

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Captive River Otter Project

		FY 98
Salaries		
	M. Ben-David $16.46/hr x 9.5 mo	27099
	R.T. Bowyer $36.88/hr x 1 mo	6391
	L.K. Duffy $39.39/hr x 0 mo	0
	Technician $12.08/hr x 1386 hrs	16473
Leave Benefits		
	M. Ben-David 18.9%	5122
	R.T. Bowyer 19.9%	1272
	L.K. Duffy 19.9%	0
	Technician	0
Staff Benefits		
	M. Ben-David 29.8%	9602
	R.T. Bowyer 26.0%	1992
	L.K. Duffy 26%	0
	Technician 7.4%	1219
	SUBTOTAL	**69170**
Services		
	Air Charter	
	Boat Charter	
	Contract fishermen	
	Statistical consultation	
	Duplication and computer fees	
	Telephone	
	SUBTOTAL	**65300**
Commodities		
	Food - mink chow	
	Blood collection/ storage supplies	
	Videos and diskettes	
	SUBTOTAL	**11500**
Equipment		
	Video cameras	
	Frame by Frame VCR analyzer	
	Computer	
	Disposable equipment	
	Traps (NVP)	
	Trap-transmitters (ADFG)	
	SUBTOTAL	**16000**
Travel		
	Airfare	
	Car rentals	
	Per Diem	
	SUBTOTAL	**17732**
Subtotal project costs		**179702**
INDIRECT COSTS		
	25% on total direct costs (less equip)	40926
TOTAL COSTS		**220628**

MPH
4/14/97

Captive River Otter Project

		FY 99
Salaries		
	M. Ben-David $16.46/hr x 9 mo	25678
	R.T. Bowyer $36.88/hr x 0 mo	0
	L.K. Duffy $39.39/hr x 1mo	6826
	Technician $12.08/hr x 347 hrs	4192
	Lab Tech $23.11/hr x 300	6933
Leave Benefits		
	M. Ben-David 18.9%	4853
	R.T. Bowyer 19.9%	0
	L.K. Duffy 19.9%	1358
	Technician	0
	Lab Tech 20.8%	1442
Staff Benefits		
	M. Ben-David 29.8%	9098
	R.T. Bowyer 26.0%	0
	L.K. Duffy 26.0%	2128
	Technician 7.4%	310
	Lab Tech 39%	3266
	SUBTOTAL	**66084**
Services		
	Lab - blood panel	
	P450 - Woodshole	
	Immunological assays - Purdue	
	Statistical cosultation	
	Behavioral consultation	
	Charter boat for release	
	Telemetry flights after release	
	Duplication and computer fees	
	Publication costs	
	Telephone	
	SUBTOTAL	**46320**
Commodities		
	Haptoglobin	
	Interleukin 6	
	Radiotransmitters	
	SUBTOTAL	**7175**
Equipment		
	SUBTOTAL	**0**
Travel		
	Airfare	
	Car rentals	
	Per diem	
	SUBTOTAL	**12198**
Subtotal project		**131777**
INDIRECT COSTS		
	25% on total direct	32944
TOTAL COSTS		164721

MPH
4/10/98

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$69.3						
Travel		$17.8						
Contractual		$65.3						
Commodities		$11.5						
Equipment		$16.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$179.9		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect		$40.9						
Project Total	$0.0	$220.8		$165.0	$0.0	$0.0	$0.0	
Full-time Equivalents (FTE)		18.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:
1. Indirect at 25% of direct costs as agreed with the University of Alaska Fairbanks. Equipment was excluded from indirect cost.
2. 30% of direct costs will be spent on community involvement.
3. 4% of direct costs will be spent on attending workshops.
4. Bench fees for housing otters in the Sealife Center will be negotiated directly between Trustees council and Sealife cooredinator at a later date.

1998

Prepared: April 8, 1997

Project Number: 98348
Project Title: Responses of river otters to oil contamination: a controlled study of biological stress markers and foraging success
Name: Institute of Arctic Biology - UAF

FORM 4A
Non-Trustee
SUMMARY

4/14/97

MM 4/14/97

1998 EXXON VALDEZ TRUSTEI JNCIL PROJECT BUDGET
October 1, 1997 - September 30, 1998

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
M. Ben-David	Principle investigator - coordinator and be[redacted]	[redacted]	9.5	4.5		42.8
R. T. Bowyer	Principle investigator - behavior		1.0	9.7		9.7
L. K. Duffy	Principle investigator - lab analyses		0.0	10.2		0.0
Vacant	Technician - assist in data collection		8.0	2.1		16.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		18.5	26.5	0.0	[redacted]
					Personnel Total	$69.3

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
Travel to Fairbanks from lower 48	0.8	3	15	0.1	3.9
Travel to Fairbanks from Europe	2.5	1	5	0.1	3.0
Travel to Seward	0.3	8	44	0.1	6.8
Travel to Anchorage	0.3	2	10	0.2	2.6
Travel to PWS	0.3	5	150	0.0	1.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$17.8

1998

Prepared: April 8, 1997

Project Number:
Project Title: Responses of river otters to oil contamination: a controlled study of biological stress markers and foraging success
Name: Institute of Arctic Biology - UAF

FORM 4B
Personnel
& Travel
DETAIL

4/14/97

4/11/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Contractual Costs: Description	Proposed FY 1998
Charter plane for otter transport @ $800 x8	6.4
Charter a boat for trapping @ $950 x30	28.50
Contract fishermen to obtain live prey	20.00
Statistical consultation	4.80
Duplication and computer fees	5.00
Telephone	0.6
Contractual Total	$65.3

Commodities Costs: Description	Proposed FY 1998
Food - mink chow	5.0
Blood collection/ storage supplies	3.5
Videos and diskettes	3.0
Commodities Total	$11.5

1998

Project Number:
Project Title: Responses of river otters to oil contamination: a controlled study of biological stress markers and foraging success
Name: Institute of Arctic Biology - UAF

FORM 4B
Contractual & Commodities
DETAIL

Prepared: April 8, 1997

4/14/97

M.J.
4/14/97

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

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 1998
2 Video cameras 8mm. Price estimate was obtained from Cannon	2	3000.0	6.0
Frame by Frame VCR analyzer. Price estimate was obtained from Cannon	1	5000.0	5.0
IBM compatable Computer. Price obtained from Gateway	1	5000.0	5.0
			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**	$16.0

Existing Equipment Usage:	Number	
Description	of Units	
No 11 Sleepy Creek leghold traps	50	
Telonics trap monitoring transmitters	30	

1998

Prepared: April 8, 1997

Project Number:
Project Title: Responses of river otters to oil contamination: a controlled study of biological stress markers and foraging success
Name: Institute of Arctic Biology - UAF

FORM 4B
Equipment
DETAIL

4/14/97 4/14/97

Curriculum Vitae

Merav Ben-David
Wildlife Ecologist

Date of Birth: 17 Jan. 1959

Current Address:
211 Irving Bldg. (IAB)
University of Alaska, Fairbanks
Fairbanks, Alaska 99775
USA

Tel: 907 - 474 - 1195
907 - 474 - 4890
Fax: 907 - 474 - 6967
E-mail: ftmb1@aurora.alaska.edu
http://www.uafbio.alaska.edu/faculty/merav

Education

- Doctor of Philosophy, May 1996. Department of Biology and Wildlife, University of Alaska, Fairbanks, USA.
- Master of Science, Aug. 1988. Department of Zoology - Faculty of Life Sciences, Tel-Aviv University, Israel. Graduated Cum Laude.
- Bachelor of Science, Aug. 1984. Biology - Faculty of Life Sciences, Tel - Aviv University, Israel.

Employment

- January 1, 1997 - May 31, 1997. Lecturer of " Patterns of Evolution". Dept. of Biology and Wildlife, University of Alaska Fairbanks, Fairbanks, Alaska.
- September 15, 1996 - December 31, 1997. Post-Doctoral position with the Institute of Arctic Biology. University of Alaska Fairbanks. Fairbanks, Alaska.
- March 15, 1996 - September 15, 1996. Post- Doctoral position with the Alaska Dept. of Fish and game. Douglas, Alaska.

Research Experience

Investigator

- June 1996 - present. "Diet composition of collared pikas along an environmental gradient: the role of song birds and Nunataks" in collaboration with Dr. D. Hik. University of Toronto, Canada.
- Mar. 1996 - present. "Incorporation of marine-derived nutrients into beach- fringe forest: responses of vegetation to marking behavior of river-otters". In collaboration with Drs. R. T. Bowyer and L. Duffy, University of Alaska, Fairbanks, USA.

- Mar. 1996 - present. Post-Doctoral Research "Use of salmon by Southeast Alaskan brown bears: a longitudinal study." in collaboration with Dr. K. Titus, Alaska Dept. of Fish and game. Douglas, Alaska USA.
- Sept. 1990 - Mar. 1996. Ph. D. Thesis Research "Seasonal diets of mink and martens: effects of spatial and temporal changes in resource abundance", with Dr. D. R. Klein, University of Alaska, Fairbanks, USA.
- May 1991 - Aug. 1991. "Feeding site selection and food composition of mink (*Mustela vison*) in Prince William Sound, Alaska".
- Jan. 1989 - July 1989. "Population monitoring of Dorcas gazzelles (*Gazella dorcas*) in the Shezaf Nature Reserve".
- Sept. 1984 - Aug. 1988. M. Sc. Thesis Research "The biology and ecology of the Marbled Polecat (*Vormela peregusna syriaca*) in Israel", with Prof. H. Mendelssohn and Dr. S. Hellwing, Dept. of Zoology, Tel-Aviv University, Israel.
- 1983 - 1984 "Nesting behavior of the common Bee-eater (*Merops apiaster*) in Israel", with Prof. H. Mendelssohn, Dept. of Zoology, Tel-Aviv University.
- 1982 - 1986. "Maternal behavior and infant development in captive squirrel monkeys (*Saimiri sciureus*)", with Prof. H. Mendelssohn, and Dr. I. Genur, Dept. of Zoology, Tel-Aviv University.
- 1975 - 1977. "The influence of testosterone on the Thymus and Bursa Glands in domesticated chickens (*Gallus domesticus*)", with Prof. N. Snapir, Faculty of Agriculture, Hebrew University, Rehovot.

Research Assistant

- Sept. 1996. Alaska Cooperative Fish and Wildlife Research Unit - Small mammals monitoring program - Denali National Park. With Dr. E. Rexstad.
- Sept. 1991 - Sept. 1995. Alaska Cooperative Fish and Wildlife Research Unit, University of Alaska, Fairbanks.
- May 1991 - Aug. 1991. Alaska Department of Fish and Game, 333 Raspberry RD., Anchorage, Alaska. Research Assistant in oil spill River-otter (*Lutra canadensis*) project, Prince William Sound, Alaska. With Drs. R. T. Bowyer, W. Testa, and Mr. J. B. Faro.
- August 1989. National Museum of Kenya. African hunting dog (*Lycaon pictus*) project in Masai Mara Nature Reserve, Kenya. With Drs. T. Fuller and P. Kat.
- Mar. 1983 - July 1985. Department of Zoology, Tel-Aviv University. Radio-tracking of marked hedgehogs (*Eriaceus europaeus, Hemiechinus auritus*), and porcupines (*Hystrix indica*). With Drs. S. Sever and Y. Yom-Tov.

Teaching Experience

Instructor

- Jan. 1, 1997 - May 31, 1997. Lecturer of " Patterns of Evolution". Dept. of Biology and Wildlife, University of Alaska Fairbanks, Fairbanks, Alaska. An upper division course including lecture and lab sessions.
- Sept. 1995 - Dec. 1995. An upper division undergraduate course " Wildlife Management Techniques" with full course responsibilities. Course includes lecture

and laboratory sections. Dept. of Biology and Wildlife, University of Alaska Fairbanks, Fairbanks, Alaska.

- Oct. 1989 - May 1990. Elementary school teacher. "Haviv" Elementary school, Rishon Le - Zion, Israel. Teacher of a mammalogy course in a special science education project.
- Sept. 1982 - June 1984. Society for Protection of Nature in Israel, Hashfela 4, Tel-Aviv, Israel. Instruction of high-school students in environmental studies.
- Aug. 1977 - Aug. 1979. Computer Instructor. Israeli Defense Forces, Rank of Sergeant at time of discharge.

Teaching Assistant

- Sept. 1990 - May 1991. Department of Biology and Wildlife University of Alaska, Fairbanks, Alaska, USA. Teaching assistant in lower division undergraduate course "Fundamentals of Biology". Course instructor: Dr. S, Smiley.
- Nov. 1984 - June 1987. Department of Zoology, Tel-Aviv University. Teaching assistant in the following courses: Faunistics (mammals, birds, reptiles, and amphibians); Ecology; Sociobiology; Animal behavior; Captive breeding; Primatology; Conservation biology. Courses instructors: Prof. H. Mendelssohn, Prof. A. Zehavi. Prof. I. Golani, Prof. Y. Yom-Tov, and Dr. D. Simon.

Other work Experience

- Sept. 1995 - present. Developing and testing a miniature sensor and data logger to monitor parturition in medium to large mammals, with Advanced Telemetry Systems Inc. Isanti MN 55040. Engineer: S. Struthers.
- Sept. 1989 - Oct. 1989. Scientific advisor for a BBC television production "The Velvet Claw". Filming carnivores in Israel. Head scientific advisor of production: Dr. D. Macdonald.
- Jan. 1989 - July 1989. Biologist of Nature Reserve. Shezaf Nature Reserve (Rift Valley) Field Study Center, Hatzeva, Israel.
- Sept. 1987 - Aug. 1990. Tour Guide and Lecturer. Safari trips in Kenya. Geographical Tours Ltd. 8 Tveria St., Tel-Aviv, Israel.
- Sept. 1986 - June 1988. Veterinary Assistant. Dairy cows. Kibbutz Yaqum, Israel.
- Mar. 1982 - June 1988. Zookeeper. Canadian Center for Ecological Zoology, Tel-Aviv University, Israel.
- Sept. 1981 - Apr. 1982. Zookeeper. Zoological Center Tel-Aviv / Ramat-Gan, Safari Park, Ramat-Gan, Israel.

Peer-Reviewed Publications

Published

- **Ben-David, M.,** Pellis, S., and Pellis V. 1991. Feeding habits and predatory behaviour in the Marbled polecat, *Vormela peregusna syriaca*: 1. Killing methods with relation to prey size and prey behaviour. Behaviour, 118: 127 - 143.

- **Ben-David, M.,** Bowyer, R. T., and Faro, J. B. 1996. Niche separation by mink (*Mustela vison*) and river-otters (*Lutra canadensis*): co-existence in a marine environment. Oikos 75: 41 - 48.
- **Ben-David, M.** 1997. Timing of reproduction in wild mink: the influence of spawning Pacific salmon. Canadian Journal of Zoology 75: 376 - 382.

In Press

- **Ben-David, M.,** T. A. Hanley, D. R. Klein, and D. M. Schell. (*in press*). Seasonal changes in diets of coastal and riverine mink: the role of spawning Pacific salmon. Canadian Journal of Zoology.
- **Ben-David, M.,** Flynn, R. W. and Schell, D. M. (*in press*) Annual and seasonal changes in diets of martens: evidence from stable isotope analysis. Oecologia.
- Rosing, M. N., **M., Ben-David**, and R. Barry (*in press*). Analysis of stable isotope data: a K nearest-neighbor randomization test. The Journal of Wildlife Management.

In review

- **Ben-David, M.,** (*in review*). Delayed implantation in the marbled polecat (*Vormela peregusna syriaca*): evidence from mating, parturition, and post-natal growth. Mammalia.

Submitted

- **Ben-David, M.,** R. T. Bowyer, L. K. Duffy, D. Roby, and D. M. Schell. (*Submitted*). Social Behavior and Ecosystem Processes: Effects of River Otters Latrine Sites on Nutrient Dynamics of Terrestrial Vegetation. Ecology.

In preparation

- **Ben-David, M.,** and Flynn, R. W. (*in prep*). Diet, body condition, and reproduction in American martens: the role of alternative foods.
- **Ben-David, M.,** R. T. Bowyer, and R. W. Flynn. (*in prep*). Diet assessment of *Martes americana*: Sex, Age or Individuality?
- **Ben-David, M.,** T. V. Schumacher, and R. W. Flynn. (*in prep*). Stable isotopes, scats, and guts: what can be learned from each technique about marten diets?
- **Ben-David, M.,** M. W. Oswood, D. R. Klein, and D. M. Schell. (*in prep*). Dietary niche separation and seasonal changes in diets of fresh-water fish in Southeast Alaska: stable isotope analysis vs. stomach contents.
- **Ben-David, M.,** and T. A. Hanley. (*in prep*). Seasonal changes in diets of *Peromyscus keeni* in Southeast Alaska: comparing stable isotope analysis and stomach contents.
- **Ben-David, M.,** J. A. Blake, and D. M. Schell. (*in prep*). Isotopic fractionation and response curves of carbon and nitrogen in mink.

- **Ben-David, M.** (*in prep*). Incorporation of marine derived nutrients into terrestrial vegetation: spawning pacific salmon and stable isotope analysis.
- **Ben-David, M.,** and J. A. Blake (*in prep*). Blood progesterone levels of pregnant and lactating female mink.
- **Ben-David, M.,** and C. Swingley (*in prep*). Converting a deterministic multi-source mixing-model to a stochastic one: which is better predicting marten diets?
- **Ben-David, M.,** S. Struthers, D. Mall and M. Vaughan (*in prep*). The birth archive tag: a new approach to determine timing of parturition.

Theses

- **Ben-David, M.** 1996. Seasonal diets of mink and martens: effects of spatial and temporal changes in resource abundance. Ph. D. Thesis, University of Alaska, Fairbanks, Alaska, USA. 208 pp.
- **Ben-David, M.** 1988. The biology and ecology of the Marbled polecat, *Vormela peregusna syriaca*, in Israel. M. Sc. Thesis, Tel-Aviv University, Israel. 167 pp. (in Hebrew - English summary).

Other Publications

- **Ben-David, M.** 1990. Phototrapping Honey badgers. Mustelid and Viverrid Conservation 3: 14 - 15.
- **Ben-David, M.,** and Sobol, M. 1989. Peeking into a bee-eater nest. Torgos 8/1 (16): 39 - 41. (in Hebrew - English summary).
- Levi, N., and **Ben-David, M.** 1991. Honey badgers: ecology and behaviour. Land and Nature, 246: 23 - 26. (in Hebrew).

Professional Presentations

- **Ben-David, M.** 1995. Seasonal diets of coastal and riverine mink in Southeast Alaska.. 46th Arctic Science Conference. American Association of Advancement of Science - Sept. 1995, Fairbanks, Alaska, USA. (**Abstract published**).
- **Ben-David, M.,** and Flynn, R. 1995. Diet selection by *Martes americana*: evidence from stable isotope analysis.. 75th Annual Meeting. American Society of Mammalogists. June 1995, Burlington, Vermont, USA. (**Abstract published**).
- **Ben-David, M.,** Bowyer, R. T., and Faro, J. B: 1995. Niche separation by mink (*Mustela vison*) and river-otters (*Lutra canadensis*): co-existence in a marine environment. Sixth International Fur-bearers Conference. May 1995, Anchorage, Alaska, USA.
- **Ben-David, M.,** and Klein, D. R. 1994. Marine vs. Terrestrial derived nutrients in diets of mink and marten in Southeast Alaska. Forth International Congress of Ecology. Aug. 1994, Manchester, UK. (**Abstract published**).
- **Ben-David, M.** and Flynn, R. 1994. Assessment of diet in *Martes americana*: Sex, age or individuality? Fifth International Behavioral Ecology Congress. Aug. 1994, Nottingham, UK. (**Abstract published**).

- **Ben-David, M.** 1994. Seasonal dietary shifts of mink and marten in a riparian ecosystem. 59th North American Wildlife and Natural Resources Conference. Mar. 1994, Anchorage, Alaska, USA.
- **Ben-David, M.** 1993. The use of stable isotope analysis in determining diets of mink and marten. 44th Arctic Science Conference. American Association of Advancement of Science - Sept. 1993, Whitehorse, Yukon, Canada.
- **Ben-David, M.**, Mendelssohn, H., and Hellwing, S. 1989. Social hierarchy in a solitary carnivore: the Marbled polecat, *Vormela peregusna syriaca*. Fifth International Theriological Congress, Aug. 1989, Rome, Italy. (**Abstract published**).
- **Ben-David, M.**, Mendelssohn, H., and Hellwing, S. 1988. Home range and spacing patterns of the Marbled polecat, *Vormela peregusna syriaca*, in Israel. Deutche Gessellschaft fur Saugetierkunde - 62 Hauptversammlung, Oct. 1988, Munster, Germany. (**Abstract published**).
- **Ben-David, M.** 1988. The biology and ecology of the Marbled polecat, *Vormela peregusna syriaca*, in Israel. Marder Colloquium - Annual Conference, Sept. 1988, Viena, Austria.
- Mendelssohn, H., **Ben-David, M.**, and Hellwing, S. 1988. Reproduction and growth of the Marbled polecat, *Vormela peregusna syriaca*, in Israel. Society of Fertility - Annual Conference, July 1988, Edinburgh, Scotland. (**Abstract published**).
- **Ben-David, M.**, Hellwing, S., Pellis, S., and Pellis V. 1987. Feeding habits and predatory behaviour in the Marbled polecat, *Vormela peregusna syriaca*, (Mustelidae), in Israel. Deutche Gessellschaft fur Saugetierkunde - 61 Hauptversammlung, Oct. 1987, Berlin, Germany. (**Abstract published**).

Other Professional Meetings

- July 1995. 10th International Bear Symposium. Fairbanks, Alaska, USA.
- Aug. 1992. Fourth International Behavioral Ecology Congress. Princeton, New Jersey, USA.
- Sept. 1989. IUCN/SSC - Otter Specialist Group Meeting, Hankensbuttel, Germany.
- Aug. 1989. IUCN/SSC - Annual meeting, Rome, Italy.

Guest Lectures

- Jan. 1992. The use of logistic regression in analyzing habitat selection of mink (*Mustela vison*) in Prince William Sound, Alaska. Dept. of Zoology, Special Seminar. Tel-Aviv University, Israel.
- Jan. 1994. The use of stable isotope analysis in studying seasonal and annual dietary changes of mink and marten in Southeast Alaska. Dept. of Zoology, Special Seminar. Tel-Aviv University, Israel.
- Feb. 1995. The use of stable isotope analysis in studying seasonal and annual dietary changes of mink and marten in Southeast Alaska. Institute of marine Sciences, Faculty Seminar. University of Alaska, Fairbanks, Alaska, USA.
- Jan. 1996. Annual and seasonal changes in diets of martens: evidence from stable isotope analysis. Blaustein Institute for Desert Research, Mitrani Center for Desert Ecology, Faculty Seminar. Ben-Gurion University of the Negev, Israel.

- Feb. 1996. Annual and seasonal changes in diets of martens: evidence from stable isotope analysis. Water Research Center, Faculty Seminar. University of Alaska, Fairbanks, Alaska, USA.
- Jan. 1997. From ecosystems to individuals and back: flowing with the heavy isotopes. Dept. of Zoology, Special Seminar. Tel-Aviv University, Israel.
- Jan. 1997. From ecosystems to individuals and back: flowing with the heavy isotopes. Dept. of Fisheries and Wildlife, Oregon State University, Corvallis, Oregon, USA.

Other Academic Activities

- 1993 - present. Reviewer for the Journal of Mammalogy.
- Aug. 1995 - May 1995. Member on a search committee for new faculty position.
- Oct. 1995 - June 1995. Student representative in departmental faculty meetings.
- Jan. 1997 - present. Member on Ph.D. Committee of Gail M. Blundell. Committee Chair: R. T. Bowyer.
- Jan 1997 - present. Reviewer of proposals for the Center of Global Change, University of Alaska Fairbanks.

Funded Proposals

- 1997. Estimating wildlife populations with DNA microsattelites: a new mark re-capture approach using river otters as a model. Alaska Science and Technology Foundation. $20,000. With Dr. P. Groves.
- 1996 - 1997. Diet, body condition, and reproduction in American martens: the role of alternative foods. Alaska Department of Fish and Game. $8,934.
- 1996 - 1997. Stable isotopes in riparian food webs. USDA Forest Service, Pacific Northwest Research Station. $31,058.
- 1996 - present. Estimating population levels of river otters using DNA microsattelites: a new mark re-capture approach. University of Alaska, President Special Fund. $2,905. With Dr. P. Groves.
- 1996 - present. Use of salmon by Southeast Alaskan brown bears: a longitudinal study. Alaska Dept. of Fish and Game. $8,000.
- 1992 -1995. Seasonal dietary changes of mink and marten in Southeast Alaska. USDA Forest Service, Pacific Northwest Station. $50,000.
- 1990 - 1991. Feeding site selection and food composition of mink (*Mustela vison*) in Prince William Sound, Alaska. USDA Forest Service, Pacific Northwest Research Station, and Alaska Department of Fish and Game. $12,500.

Pending Proposals

- Body condition and timing of parturition in the polar bear (*Ursus maritimus*). Canadian Wildlife Service, US Fish and Wildlife Service, Lindburgh Foundation $97,500. With Dr. M. Ramsay.
- Diet composition of collared pikas along an environmental gradient: the role of song birds and Nunataks. University of Alaska, President Special Fund. $2,670. With Dr. D. Hik.

- Responses of river otters to oil contamination: a controlled study of biological stress markers and foraging efficiency. *Exxon Valdez* Oil Spill Trustees Council. $56,800. With Dr. T. Bowyer.
- Social behavior and ecosystem processes: effects of river otters latrine sites on nutrient dynamics of terrestrial vegetation. NSF - SGER Ecology. $30,000. With Dr. T. Bowyer.

Awards and Honors

- 1995. Conference award for best student presentation. 75th Annual Meeting. American Society of Mammalogists., Burlington, Vermont, USA.
- 1988. Conference award for best student presentation. Deutche Gessellschaft fur Saugetierkunde - 62 Hauptversammlung, Munster, Germany.
- 1986. R. Levin scholarship awarded by the Department of Zoology of Tel-Aviv University for superior academic achievements and field work.

Professional Affiliations

- 1982 - present. The Society for protection of Nature in Israel, 4 Hashfela St. Tel-Aviv, Israel.
- 1988 - present. IUCN/SSC, Mustelid, Viverrid, and Procyonid Specialist Group. Chairman: Roland Wirth, Franz-Senn Strasse 14, 8000 Munich 70, Germany.
- 1989 - present. IUCN/SSC, Otter Specialist Group - African Region. Chairman: David Rowe-Rowe, Natal Parks, P. O. Box 662, 3200 Pietmaritzburg, Rep. of South Africa.
- 1990 - present. Wildlife Society, Alaska Chapter, University of Alaska, Fairbanks, AK 99775, USA.

Knowledge of Languages: Hebrew, English, French.

Computer Languages: FORTRAN 4.

Permanent Archiving of Specimens Collected in Intertidal and Nearshore Habitats

Project Number: 98349

Restoration Category:

Proposer: University of Alaska Museum

Lead Trustee Agency:

Alaska Sea Life Center:

Duration: 1st year, 3-year project

Cost FY 98: $ 147,347

Cost FY 99: $ 142,800

Cost FY 00: $ 145,600

RECEIVED
APR 15 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Geographic Area:

Injured Resource: Intertidal communities

Subtidal communities

ABSTRACT

The large zoological and botanical collections resulting from various oil spill-related surveys in the Gulf of Alaska are a unique scientific resource, but no provision has been made for their final deposition. If this project is funded, these specimens will be incorporated into the Aquatic Collection of the University of Alaska Museum, so that they will be available for further biological studies.

INTRODUCTION

The oil spill from the *Exxon Valdez* mandated a monumental reconnaissance of the biota of Prince William Sound and adjacent parts of the Gulf of Alaska. Between 1989 and 1995, the intertidal zone and, subtidal communities from over 50 sites throughout Prince William Sound were systematically sampled [see appendix 1 for list of localities and archived material]. As in most good biological surveys, tremendous numbers of specimens have been collected, in this case, at tremendous expense (>$17 million).

This project is intended to support acquisition and permanent archiving of these specimens at the University of Alaska Museum Aquatic Collection.

In FY 98 specimens and associated locality data will be brought into the UA Museum, protocols for their incorporation into the Aquatic Collection will be developed, and accessioning and cataloging will begin. In subsequent fiscal years, catalogs, including ~~on-line catalogs accessible through the UA Museum's~~ website will be developed. Additional and funds for continued maintenance of these specimens will be applied for.

NEED FOR THE PROJECT

A. Statement of the problem

Collections from the *Exxon Valdez* oil-spill represent an extensive survey of the coastal biota from the Gulf of Alaska region, and they represent a huge investment of scientific resources that will not be repeated. Unless collections are brought into the Museum, and maintained as part of an active research collection, they could be lost, neglected or ruined, or they could end up in major museum collections outside of Alaska. The latter scenario would represent a setback both to the Museum and to the academic heritage of Alaska.

The number of specimens lots (mostly fluid-preserved animal specimens in vials) to be handled is on the order of 64,000. At least 200 species have been identified, including several range extensions. The number of species and presence of new species in certainly under-detected.

These specimens will enhance the UA Museum's existing collections which document pre-oil-spill conditions in the area, e.g. Collections for BLM-sponsored intertidal sampling in the northern Gulf of Alaska from Yakutat to Spectacle Island, surveys of epifauna in the northeastern Gulf of Alaska, and benthic samples from Port Valdez.

B. Rationale/Link to Restoration

At the University of Alaska Museum, our research collections serve three basic functions:

1) Specimens are vouchers for work that has been done. Specifically, they verify identifications and descriptions made in the study of biodiversity, distribution, and evolutionary relationships. Often, later studies require evaluation of original descriptions or identifications. This function is basic scientific bookkeeping and analogous to the publication of scientific findings.

This function is closely linked to both the research and the monitoring needs of restoration. Because these specimens are the physical documentation of resources present in Prince William Sound, Cook Inlet, Kodiak Island, and the adjacent Gulf of Alaska, they are essential to assessment and monitoring studies in which accurate identifications are needed.

2) Museum collections typically contain the only primary evidence of historically-altered biota. Concern about declining biodiversity, impending global climate change, the possibility of a future oil spill, and the possible introduction of aquatic nuisance species into Port Valdez and Prince William Sound make these collections invaluable.

3) Well-documented specimens are used in independent collection-based science. For example, a scientist studying variation in a wide-spread species, or group of species, may visit or request loans from several regional collections. Such work would be prohibitively expensive if all locations represented by a museum collection had to be re-sampled.

Thus natural history collections make past work verifiable and much future work feasible. Our museum is analogous to a library; our collections are the physical documentation on which understanding of regional natural history is based.

C. Location

This work will take place at the University of Alaska Fairbanks. The project should benefit scientists, the lay public, educators, and subsistence users working in the Sound and Gulf coast areas.

PROJECT DESIGN

A. Objectives

The project's overall objectives are to:

1. Keep specimens and associated locality data collected as part of oil spill studies from being lost.
2. Make information based on the specimens (that is, species composition and distribution of Prince William Sound and Gulf of Alaska marine biota) available to scientists, teachers, students, managers, and the general public as needed.
3. To preserve a baseline from which further environmental change can be measured.
4. To promote and encourage further research on the natural history of Prince William Sound.

B. Methods

The space needs for adding new material will be assessed by comparing storage space now occupied by oil spill voucher specimens with the space occupied by similar taxa in the UA Museum Aquatic Collection.

The data management needs for accessioning and developing a database of localities will be made by obtaining or copying records and reports and determining their compatibility with systems in use in the UAM Aquatic Collection. This will require hiring a data processing technician.

Incorporating the collections into the UA Museum Collection involves three tasks: accessioning, in which permanent records are created for assemblages of specimens to which the museum has title; arranging the specimens on the shelves; and cataloging, in which individual specimens are assigned numbers and entered as records in an electronic catalog. These tasks require a biological technician with a thorough familiarity with the classification of marine invertebrate animals.

Museum collections require constant maintenance, and this is especially true for fluid-preserved invertebrates, which can be destroyed by evaporation. Funding to support the long-term curation and development of this collection will be sought from a variety of sources, both government and private.

SCHEDULE

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

Oct. 1 - Oct. 15: Identify and locate collections
Oct. 1 - Oct. 15: Purchase and install computer and software
Oct. 15 - Oct. 31: Assess space needs for collection and workers
Oct. 15 - Oct. 31: Order supplies

Oct. 15 - Oct. 31: Hire biological and data entry technicians
Nov. 1- Dec. 31: Develop protocol for accessioning, labeling, sorting, storage, and data entry
Jan. 1-Feb 1: Re-organize existing collection to accommodate new material
Jan. 15-24 (3 of these days) Attend Restoration Workshop
Feb. 1 - March 1: Bring specimens into collection
March 1 - Sep. 30: Accession and incorporate specimens

B. Project Milestones and Endpoints

Objective 1. Will be addressed within the fiscal year.
By the end of FY 98, specimens and associated data will be housed in the Museum, and accession numbers will be assigned. To help meet objectives 2, 3, and 4, grant proposals for ongoing support for the Aquatic Collection will be written.
Objectives 2 and 3 will be addressed in the next two fiscal years.
By the end of FY 99, mollusk, bryozoan, algae, and decapod crustacean specimens will be cataloged.
By the end of FY 00, new databases will be developed for small crustacea, echinoderms, and annelids.

C. Completion Date

All objectives of this proposal will be met by the end of FY 00.

PUBLICATIONS AND REPORTS

Annual and final reports will be prepared and submitted as required.

NORMAL AGENCY MANAGEMENT

This project is directly related to the oil spill. It is highly unlikely that a biological collecting effort on a similar scale would have been conducted except in response to an oil spill or similar environmental event.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is an extension of projects conducted by the University of Alaska School of Fisheries and Ocean Sciences, including Coastal Habitat Assessment studies lead by Dr. Ray Highsmith, and Restoration Project 93047, *The Effects of the* Exxon Valdez *Oil Spill on Shallow Subtidal Communities in Prince William Sound, Alaska*, and Restoration Project 95106, *The Effects* *of the* Exxon Valdez *Oil Spill on Eelgrass Communities in Prince William Sound. Alaska*, conducted by the UAF School of Fisheries in 1989-1995. Specimens and data from these projects will be shared. [see appended letters of support]

A closely linked proposal, *Biological Invasions of Cold-Water Coastal Ecosystems: Ballast Mediated Introductions in Port Valdez/Prince William Sound* has been submitted to SeaGrant. The proposal calls for a team of scientists. from the Smithsonian Environmental Research Center (SERC), Alyeska Pipeline Service Company, Willams College, the University of Oregon, and the University of Alaska Museum to conduct research on the possible presence nonindigenous species and ways to prevent introductions. A major part of the proposed research will draw upon EVOS specimens and records for evidence of species from biogeographical provinces outside Prince William Sound, and especially for nuisance species.

PROPOSED PRINCIPAL INVESTIGATOR

Nora R. Foster
Aquatic Collection
University of Alaska Museum
907 Yukon Drive
Fairbanks. Alaska 99775
(907) 474-7994
(907) 474-5469 fax
fyaqua@aurora.alaska.edu

PRINCIPAL INVESTIGATOR
Nora R. Foster

Education:

University of Alaska B.S.. 1969 Biological Sciences
University of Alaska M.S.. 1979 Biological Oceanography

Current Position:

Coordinator, Aquatic Collection
University of Alaska Museum

Experience and Interests:
Taxonomy, ecology, and biogeography of marine invertebrates of the north Pacific and Arctic; conservation of invertebrate collections; environmental interpretation

Selected Publications

Foster, Nora R. 1981. A Synopsis of the marine prosobranch gastropod and bivalve mollusks in Alaskan waters. Institute of Marine Science University of Alaska Report IMS R81-3. 479 p.

Foster, N. R. 1991. *Intertidal bivalves: A guide to the common marine bivalves of Alaska.* Fairbanks, University of Alaska Press. 152 p.

Feder, H. M., Foster, N. R., Jewett, S. C., Weingartner, T. J., and Baxter, R. 1994. Distribution of mollusks in the northeastern Chukchi Sea. *Arctic* 47(2):145-163.

Prozorova, L. A. and Foster, N. R. 1996. Terrestrial mollusks of Beringia [extended abstract]. *Western Society of Malacologists Annual Report* for 1995.

Prozorova, L. A. and Foster, N. R. 1996. Freshwater mollusks of Alaska and eastern Asia: Some research in progress [extended abstract]. *Western Society of Malacologists Annual Report* for 1995.

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		113.4						
Travel		.5						
Contractual		.3						
Commodities		2.0						
Equipment		2.8	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	119.0		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
Indirect		21.9						
Project Total	$0.0	148.1		142.8	145.6			
Full-time Equivalents (FTE)								
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: indirect rate is 25%
.5 is inclused for workshop attendance
.3 is included for phone/fax and copying
FY1999 and FY2000 estimates include 2%pay increase each year

1998

Prepared: 1 of 4

Project Number: 98349
Project Title:
Name:

FORM 4A
Non-Trustee
SUMMARY

3/3/97

1998 EXXON VALDEZ TRI E COUNCIL PROJECT BUDGET
October 1, 19 September 30, 1998

Personnel Costs: Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FY 1998
Nora R. Foster	Coordinator, Aquatic Collecti project supervision, taxonomic expertise		6.0	3.7		22.2
						0.0
						0.0
vacant	data entry technician develop database for accession and locality records		12.0	3.8		45.6
						0.0
						0.0
vacant	biological technician organize specimens by taxon, check identifications, screen specinems for quality		12.0	3.8		45.6
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal			0.0	
					Personnel Total	113.4

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1998
Fairbanks to Anchorage and return to attend the Restoration Workshop	.17	1	3	.12	.5
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	.5

1998

Prepared: 2 of 4

Project Number:
Project Title: Permanent Archiving of Specimens Collected in Intertidal and Subtidal Habitats
Name Nora R. Foster

FORM 4B
Personnel
& Travel
DETAIL

3/3/97

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

Contractual Costs:	Proposed
Description	FY 1998
Phone/fax,copying	3.0
Contractual Total	3.0

Commodities Costs:	Proposed
Description	FY 1998
project supplies	2.0
see following page for explaination	
Commodities Total	2.0

1998

Project Number:
Project Title: Permanent Archiving of Specimens Collected in Intertidal and Subtidal Habitats
Name: Nora R. Foster

FORM 4B
Contractual &
Commodities
DETAIL

Prepared: 3 of 4

3/3/97

UNIVERSITY OF ALASKA BUDGET INFORMATION

The University of Alaska accounting system accumulates data according to an established system of accounts codes. This differs from the level or category of detail required on this proposal. Per the new Cost Accounting Standards Board (CASB) guidelines, costs are to be listed in a proposal only to the level of detail at which the subsequent expenditures may be tracked. Therefore, please note that supplies itemized on the budget form may be tracked to UA accounting system categories such as the following examples: 1) project supplies; 2) professional, technical and scientific supplies; 3) field camp supplies; and 4) hazardous materials. Service listings are also broad, but include specific categories such as duplicating, postage, toll charges, and software licensing. A complete list of University of Alaska Accounts Codes is available upon request.

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1998
Gateway 2000 G-6 computer this will be used to develop a database for accession, specimens, and locality records; to generate labels, tables, and reports; for fax and e-mail communication (see attatched quote for detailed speceifcations)	1	2.8	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	2.8

Existing Equipment Usage: Description	Number of Units	

1998	Project Number: Project Title: Permanent Archiving of Specimens Collected in Intertidal and Sibtidal Habitats Name: Nora R. Foster	FORM 4B Equipment DETAIL

Prepared: 4 of 4

GATEWAY2000

"You've got a friend in the business."

G6-200

Processor: Intel 200MHz Pentium Pro processor
Memory: 32MB EDO DRAM expandable to 128MB
Cache: Internal 256K L2 secondary write-back cache
Monitor: Vivitron700 color monitor (15.9" viewable area)
Graphics Accelerator: STB ViRGE[TM] VX. 8MB, 3D 64-bit Graphics (Limited Time Only)
Hard Drive: 3.8GB EIDE drive
Floppy Drive: 3.5" 1.44MB diskette drive
CD-ROM: 12X min./16X max. CD-ROM drive
Multimedia Package: Ensoniq wavetable sound card & Altec ACS-41 speakers added: US$90
Fax/Modem: TelePath 33.6 fax/modem for Windows w/speakerphone (Windows 95 only) added: US$79

Case: New Look Mini Tower Case
Network Card: 3COM ISA Ethernet TP added: US$59
Keyboard: 104- Keyboard
Mouse: MS IntelliPoint Mouse; Gateway mouse pad
Operating System: Microsoft Windows 95
Application Software: MS Office 97, Small Business Edition
Service Program: Gateway Gold Service and Support
Onsite system installation: Not Included
Printer: Not Included
IOMEGA Drive: IOMEGA Internal ZIP Drive w/1 Zip Disk
Scanner: Not Included
Pilot: Not Included
Tape Backup Unit: Not Included
Joystick: Not Included
APC uninterrupted power supply: Not Included

Base Price: US $2549
Configured Price: US $2777
Quantity: 1
Total Price: US $2777
Date: 03/27/97 18:22
Prices and specifications are subject to change without notice or obligation. These prices do not include shipping or sales tax if applicable. After your system has been built (lead times may vary), it may be shipped via 2nd day shipping in the continental US. 2nd day shipping within the continental USA is US $95 for desktops and US $25 for portables. Skyway 5 day shipping for Destination™ Big Screen PCs is US $149. All prices are quoted in U.S. dollars.

If you want to contact us by phone, please call , fax

Appended material

Lists of localities and samples

Letters of support

The Effects of the Exxon Valdez oil spill on Shallow Subtidal Communities in Prince William Sound, Alaska

1989-91, 1993 and 1995

1989-Fall

Site	Stations	Transcets	Quads	Location	Date	Samples	Processed	Habitat
2953	3	3	1	Culross Bay	10/9-10/89	9	yes	
3598	3	3	1	McClure Bay	10/12-13/89	9	yes	
453	3	3	1	Foul Passage	10/14-19/89	9	yes	
601	5	3	1	Herring Bay	10/22-23/89	15	yes	Silled Fjord
1522	3	3	1	Herring Bay	10/23-24/89	9	yes	

1990-Summer

Site	Stations	Transcets	Quads	Location	Date	Samples	Processed	Habitat
1	3	2	2	Cabin Bay	5/23-24/90	11	yes	Island Bay
no sample ST2 TR2 QD2								
2	3	2	2	NW Bay	5/26-27/90	12	yes	Island Bay
601	3	0	2	Herring Bay	5/29-30/90	6	yes	Silled Fjord
3	3	2	2	SW Herring Bay	5/30-31/90	12	yes	Island Bay
4	3	2	2	L. Herring Bay	6/3-4/90	12	yes	Island Bay
27	4	0	2	Outer Lucky Bay	6/6/90	8	yes	Silled Fjord
29	1	0	2	Inner Lucky Bay	6/6/90	2	yes	Silled Fjord
5	3	2	2	Mummy Bay	6/7-8/90	12	yes	Island Bay
30	2	0	2	Inner Bay of Isles, W. Arm	6/10/90	4	yes	Silled Fjord
6	3	2	2	Bay of Isles	6/11-13/90	12	yes	Island Bay
7	3	2	2	LaTouche Point	6/16/17/90	15 jars	archived	Nereocystis
8	3	2	2	Procession Rocks	6/19-20/90	12 jars	archived	Nereocystis
9	3	2	2	Zaikof Point	6/22-23/90	13 jars	archived	Nereocystis

12	5	1	2	Little Smith Isld.	6/28-29/90	15 jars	archived	Nereocystis
11	3	2	2	Naked Island	7/1-2/90	16 jars	archived	Nereocystis
13	3	3	2	Bay of Isles	7/4-5/90	18	yes	Eelgrass
14	3	3	2	Drier Bay	7/6-7/90	18	yes	Eelgrass
17	3	3	2	Sleepy Bay	7/8/90	18	yes	Eelgrass
18	3	3	2	Moose Lips Bay	7/11-12/90	18	yes	Eelgrass
15	3	3	2	L. Herring Bay	7/13-14/90	18	yes	Eelgrass
16	3	3	2	Herring Bay	7/15-16/90	18	yes	Eelgrass
20	3	2	2	Lucky Point	7/18-19/90	27 jars	archived	Island Point
19	3	2	2	Discovery Point	7/22-23/90	24 jars	archived	Island Point
24	3	2	2	Peak Point	7/29-30/90	17 jars	archived	Island Point
23	3	2	2	Ingot Point	8/3/90	41 jars	archived	Island Point
22	3	2	2	Outer Herring Bay	8/5-6/90	23 jars	archived	Island Point
21	3	2	2	Outer L. Herring Bay	8/7-8/90	21 jars	archived	Island Point
25	3	3	2	Clammy Bay	8/9-10/90	18	yes	Eelgrass
26	3	3	2	Puffin Bay	8/11/90	18	yes	Eelgrass
1990-Fall								
Site	Stations	Transcets	Quads	Location	Date	Samples	Processed	Habitat
32	3	0	2	Disc Lagoon	9/26/90	8	yes	Silled Fjord
27	3	0	2	Outer Lucky Bay	9/28/90	6	yes	Silled Fjord
29	2	0	2	Inner Lucky Bay	9/28/90	4	yes	Silled Fjord
30	4	0	2	Outer Bay of Islea	9/29/90	8	yes	Silled Fjord
31	2	0	2	Inner Bay of Isles	9/29/90	4	yes	Silled Fjord
33	4	0	2	Humpback Bay	9/30/90	8	yes	Silled Fjord
601(28)	3	0	2	Herring Bay	10/1/90	6	yes	Silled Fjord

1991- Summer								
Site	Stations	Transcets	Quads	Location	Date	Samples	Processed	Habitat
26	3	2	2	Puffin Bay	7/11/91	12	yes	Eelgrass
25	3	2	2	Clammy Bay	7/12-13/91	12	yes	Eelgrass
14	3	2	2	Drier Bay	7/14/90	12	yes	Eelgrass
34	3	2	2	Mallard Bay	7/15/91	12	yes	Eelgrass
13	3	2	2	Bay of Isles	7/17/91	12	yes	Eelgrass
35	3	2	2	Bay of Isles Short Arm	7/17/91	6	yes	Eelgrass
16	3	2	2	Herring Bay	7/18/91	12	yes	Eelgrass
15	3	2	2	L. Herring Bay	7/23-24/91	12	yes	Eelgrass
17	3	2	2	Sleepy Bay	7/25/91	12	yes	Eelgrass
18	3	2	2	Moose Lips Bay	7/28/91	12	yes	Eelgrass
27	4	0	2	Outer Lucky Bay	8/13/91	8	yes	Silled Fjord
29	2	0	2	Inner Lucky Bay	8/13/91	4	yes	Silled Fjord
601(28)	3	0	2	Herring Bay	8/14/91	6	yes	Silled Fjord
6	3	2	2	Bay of Isles	7/29/91	12	yes	Laminaria
5	3	2	2	Mummy Bay	7/30-31/91	12	yes	Laminaria
4	3	2	2	L. Herring Bay	8/1/91	12	yes	Laminaria
3	3	2	2	Herring Bay	8/2/91	12	yes	Laminaria
2	3	2	2	NW Bay	8/3/91	12	yes	Laminaria
1	3	2	2	Cabin Bay	8/4-5/91	12	yes	Laminaria
1993-Summer								
Site	Stations	Transcets	Quads	Location	Date	Samples	Processed	Habitat
17	3	2	2	Sleepy Bay	7/13-14/93	12	yes	Eelgrass
18	3	2	2	Moose Lips Bay	7/15/93	12	yes	Eelgrass
16	3	2	2	Herring Bay	7/16/93	12	yes	Eelgrass
13	3	2	2	Bay of Isles	7/21/93	12	yes	Eelgrass
14	3	2	2	Drier Bay	7/23/93	12	yes	Eelgrass
15	3	2	2	L. Herring Bay	7/24/93	12	yes	Eelgrass
601(28)	3	0	2	Herring Bay	9/25/93	6	yes	Eelgrass

1995-Summer								
Site	Stations	Transcets	Quads	Location	Date	Samples	Processed	Habitat
18	3	2	2	Moose Lips Bay	7/7/95	12	yes	Eelgrass
17	3	2	2	Sleepy Bay	7/9/95	12	yes	Eelgrass
13	3	2	2	Bay of Isles	7/13/95	12	yes	Eelgrass
14	3	2	2	Drier Bay	7/17/95	12	yes	Eelgrass
14	3	2	2	L. Herring Bay	7/19/95	12	yes	Eelgrass
15	3	2	2	Herring Bay	7/20/95	12	yes	Eelgrass
26	3	2	2	Puffin Bay	7/22/95	12	yes	Eelgrass
25	3	2	2	Clammy Bay	7/23/95	12	yes	Eelgrass

INSTITUTE OF MARINE SCIENCE

SCHOOL OF FISHERIES & OCEAN SCIENCES

UNIVERSITY OF ALASKA FAIRBANKS
FAIRBANKS, ALASKA 99775-1080

April 8, 1997

Exxon Valdez Oil Spill Trustees Council
645 G Street, Suite 401
Anchorage, AK 99501-3451

Dear Council Members:

This letter is in support of the proposal "Permanent Archiving of Specimens Collected in Intertidal and Nearshore Habitats" submitted by Nora R. Foster of the University of Alaska Museum. Her plan to incorporate organisms collected under EVOSTC-sponsored research into the Museum's voucher collection will be beneficial to the Museum, the scientific community, and the public. I was a Principal Investigator and Co-PI on studies that examined the shallow subtidal communities of western Prince William Sound. All of our invertebrate samples have been processed, reported on, and temporarily stored. These samples undoubtedly will be disposed in the near future as storage space becomes critical. Therefore, Ms. Foster's plan to incorporate my samples, along with other subtidal and intertidal samples, into the Museum's voucher collection is admirable and worthy of funding.

Respectfully,

Stephen C. Jewett

Stephen C. Jewett
Research Associate

Harbor Seal Recovery: Fate of Pups

Project Number:	98351
Restoration Category:	Research
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	
Cooperating Agencies:	None
Alaska SeaLife Center:	Yes
Duration:	1st year, 4-year project
Cost FY 98:	$120,116
Cost FY 99:	$109,800
Cost FY 00:	$117,800
Cost FY 01:	$89,000
Geographic area:	Prince William Sound; Kenai Peninsula, Seward
Injured Resource:	Harbor seal

RECEIVED
APR 15 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

ABSTRACT

All previous work on the recovery of harbor seals after the EVOS event focused on adult animals. Predictions of population decline, ecological relationships, health and body condition in those adults suggest that a key factor in the poor recovery of the species is the fate of pups. This project begins a field and laboratory based examination on the biology of harbor seal pups. Field work will determine whether pups are born compromised and laboratory work at the Alaska SeaLife Center will focus on detailed health and survivorship studies.

INTRODUCTION

On the strength of several years of field-based surveys on adult seals, the two principal investigators of Trustee Council funded projects on harbor seal recovery (Castellini: /001 and Frost: /064) informally proposed in late 1996 that future work be moved from adults to pups (Appendix 1). Our rationale was that our data indicated adult seals were essentially healthy and that survivorship of young animals may influence the entire harbor seal population more than survivorship of adults. This is possibly similar to the now verified problem with the decline of Steller sea lions in Alaska, where it has been shown that sea lion pups are not recruiting into the adult population (1). When confronted with this problem, the Steller sea lion Recovery Team supported work on the fate of pups in an effort to understand the mechanisms that would compromise recruitment. Working on this model, Frost received permission from the Council to begin capturing pups in the last season of project 97064 and Castellini (97001) received permission to work on the health and body condition of those animals. Castellini and Trumble (Ph.D. student) have also recently proposed to ADF&G to work on pup fate at Tugidak Island (south of Kodiak), once the largest harbor seal haulout in the world. Recent data from that island also suggest that pup survivorship may be poor (2).

The Castellini laboratory has worked on the fate of pinniped pups in several different species. There are ongoing health and survivorship studies of Weddell seal pups in the Antarctic (3), projects on the fasting and starvation chemistry of northern elephant seal pups (4) and work on the biology of Steller sea lion pups (5). In all these cases, one of the primary goals has been to establish health status and body condition of the young animals. For the Steller sea lions and Weddell pups, the projects were designed to correlate those indices with survivorship. Frost will propose field based studies to examine the fate of newborn pups in Prince William Sound by following them with satellite tags and we will provide the body condition indices to categorize those animals. In addition, this proposal has a unique model of harbor seal survivorship to consider: At the Alaska SeaLife Center (ASLC), about 10–12 harbor seal pups per year are predicted to be treated at the facility due to medical problems, abandonment, stranding, etc. These pups represent the animals that fell off the survivorship curve. They presumably would not have survived in the wild and thus give us a window to the truly compromised animals. By quantifying the medical and body condition status of these orphaned pups, we can "see" what a non-survivor looks like from a health status point of view. The field component will provide studies of a random group, but the ASLC animals will be the animals that are truly in trouble.

In this project we propose to collaborate on the random pups from the wild population, to quantify the health and body condition of the ASLC orphan pups and to follow the fate of those pups, once released, through the use of inexpensive satellite location tags. The movement of pups from the ASLC into the Kenai Fjords region will be compared to the movement of random pups from the PWS study by Frost. This comparative approach will be extremely powerful in understanding the fate of harbor seal pups.

NEED FOR THE PROJECT

A. Statement of Problem

Almost all of the body condition markers, health indices, movement patterns, blubber chemistry, diving patterns and ecological relationships documented in PWS harbor seals come from adult animals (6, 7). Consequently, none of the findings suggesting whether or not these animals are food limited, or if they are healthy, can be applied to pups. Unfortunately, if pups are not recruiting into the adult population (as is the case with Steller sea lions), the data from all past studies can not be used to quantify the problem. Trustee Council supported work has shown the nature of the adult harbor seal population. Now the work on pups must begin.

Working on pups, however, is logistically difficult in the field. The net capture methods perfected by Frost were designed and tested on adults. By shifting the capture dates to when more pups are available, more pups will probably be caught, but predicting the success rate is difficult (Appendix 1). We can provide all the field teams necessary to work on any pups that are captured.

Based on informal data from the last few years, almost all the stranded and abandoned animals that show up in the Seward area are harbor seal pups. As noted above, these are animals that are truly compromised and they constitute a critical point on the survivorship line of questioning. We predict that the many health and body condition indices we use in the field will be off our standard curves for these pups. In Steller sea lions, Weddell seals and elephant seals, abandoned, orphaned and diseased pups were all clearly distinguished by many of our indicators.

The essence of the problem is that we do not know if harbor seal pup health and survivorship is compromised in this population. The Frost proposal will focus on the field determinations of these issues, while this proposal is to collaborate on the field component and conduct the detailed laboratory studies on pup fate.

B. Rationale

The rationale of this project is that if harbor seal pups are not recruiting at a level high enough to sustain the population of harbor seals in the spill area, then we must shift our work from adults to pups in order to determine pup survivorship and health. If we do not attempt this work, we will be able to provide a careful studied model of adult health, but will not be able to answer the simple question: are enough pups becoming adults?

C. Location

The laboratory experiments for this work will be conducted at the Alaska SeaLife Center in Seward. Field work will be conducted in PWS in conjunction with the Frost project.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The field work on harbor seals has had integral collaboration with Native communities throughout the Gulf region in conjunction with the BIOSAMPLING program(Project 96244) and we anticipate Native collaboration to continue. Given that the Alaska SeaLife Center, the EVOS Trustee Council, the Alaska Native Science Commission and the Alaska Native Harbor Seal Commission are all currently working on joint scientific collaboration, we expect this project to include involvement with Native communities. However, at this time we cannot predict what form this involvement will take. Since harbor seals are food items for these communities, it is likely that the results of this work will be of interest to the Alaska Native Harbor Seal Commission.

PROJECT DESIGN

A. Objectives

The primary goal of this project is to determine what is happening to harbor seal pups after they are weaned. This will occur by working with animals caught in the wild, which presumably reflect a random selection of pups, and by working with animals that are known to be compromised.

1. Quantify the health status of the wild population of harbor seal pups in PWS.

2. Assess the health status of orphaned and abandoned pups at the ASLC.

3. Track the movement of rehabilitated pups as they rejoin the wild community.

B. Methods

Field efforts will be tied closely to the logistical methods developed by Frost for capturing and handling seals at haulout sites in PWS. These capture methods will have to be modified to collect a greater number of pups. Once the pups are caught, using all the same methods as developed and tested on adult animals (7), we can assess body condition and health status of these young seals. We have used these techniques on other pinniped pups hundreds of times with no known problems (4).

The current suite of health assessment markers we employ includes blood samples taken for standard clinical and veterinary panels, markers for fat, protein and carbohydrate metabolism (fatty acid patterns, blood urea nitrogen, ketone bodies, glucose), water balance (plasma and whole blood water), blubber quality (energetic density, lipid distribution, histology) and total body fat. Other markers address more health or contaminant related issues such as indicators of whole body inflammatory response (haptoglobin), or metal contamination (metallothionein, plasma metals). Extensive measurements of body morphometrics are also collected.

into quarantine, its health assessed and then placed on a recovery program. Those initial health assessments will be critical to this project for they will presumably reflect the status of the pup at its worst case in the wild. We predict that the health indicators we use in the field will be able to distinguish these pups. We also predict that those indicators will show the eventual return to health under constant medical care. This "experiment" is vital to the successful interpretation of our field data for harbor seals. We have developed an enormous data set on reference ranges for health parameters in pinnipeds (7), but we need to test those parameters against animals that are known to be sick or compromised.

Finally, on animals that are successfully reared back to health and released to the wild, we propose to follow their movements with satellite based locators glued to their fur. These pups will not molt again until the next spring, so they could carry these monitors for as long as a year. Frost will propose the same procedure to be used on the wild caught pups.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This project will collaborate with ADF&G through the Frost program.

SCHEDULE

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

October - May 1998:	Obtain satellite tags, test at ASLC
May - August :	Field collaboration on wild pups, rehab animals at ASLC
August - October:	Release rehab animals with satellite tags from Seward

B. Project Milestones and Endpoints

Each year will have its own milestones as the current year of pups are captured in the wild and others released from the ASLC. Project tasks for FY 99 through FY 01 are listed below.

FY 99:	Blood work and modeling of animals handled in 1998 and second full year of field and ASLC work.
FY 00:	Blood work and modeling of animals handled in 1999 and third full year of field and ASLC work.
FY 01:	Close out, report and manuscripts.

C. Completion Date

This project will finish on September 30, 2001.

PUBLICATIONS AND REPORTS

We do not predict any major manuscripts during FY 98, but by FY 99 there should be enough data for the completion of short papers.

PROFESSIONAL CONFERENCES

Travel is requested for the PI and a student to attend the annual EVOS workshops and, in November of 1999, to attend the International Marine Mammal Society meeting. Smaller conferences and workshops will be attended throughout the life of the project.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project coordinates with ADF&G (Frost) for the field component and with animal care staff at the ASLC for laboratory work.

PROPOSED PRINCIPAL INVESTIGATOR

Dr. Michael Castellini
Institute of Marine Science
University of Alaska Fairbanks
Fairbanks, AK 99775-7220
Phone: (907) 474-6825
FAX: (907) 474-7204
e-mail: mikec@ims.alaska.edu

PRINCIPAL INVESTIGATOR

Michael Castellini, Ph.D., specializes in metabolic chemistry problems associated with marine mammals. He is a tenured Associate Professor of Marine Science at UAF and has worked in this field for over 20 years.

Publications by Dr. Castellini since 1990 relevant to the proposal include:

Castellini, M.A. and G.L. Kooyman. Length, girth, and mass relationships in Weddell seals (*Leptonychotes weddellii*). Marine Mammal Science. 6(1): 75-77. 1990.

Castellini, J.M., M.A. Castellini and M.B. Kretzmann. Circulatory water balance in suckling and fasting northern elephant seal pups. Journal of Comparative Physiology B. 160(5): 537-542. 1990.

Castellini, M.A. and D.P. Costa. Relationships between plasma ketones and fasting duration in neonatal elephant seals. American Journal of Physiology. 259: R1089-R1090. 1990.

Castellini, M.A., J.M. Castellini and V.L. Kirby. Blood glucose handling methods can compromise analytical results: Evidence from marine mammals. Journal of the American Veterinary Association. 201(1): 145-148. 1992.

Castellini, M.A., D.P. Costa and J.M. Castellini. Blood glucose distribution, brain size and diving in small odontocetes. Marine Mammal Science. 8(3): 294-298. 1992.

Castellini, M.A. and L.D. Rea. The biochemistry of natural fasting at its limits. Experientia. 48: 575-582. 1992.

Castellini, M. and D. Calkins. Mass estimates using body morphology in Steller sea lions. Marine Mammal Science. 9: 48-54. 1993.

Castellini, M.A., R.W. Davis, T.R. Loughlin and T.M. Williams. Blood chemistries and body condition of Steller sea lion pups at Marmot Island, Alaska. Marine Mammal Science. 2: 202-208. 1993.

Castellini, J.M., H.J. Meiselman and M.A. Castellini. Understanding and interpreting hematocrit measurements in pinnipeds. Marine Mammal Science. 12: 251-264. 1996.

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

Rea, L.D., R. Groscolas, E. Mioskowski and M. Castellini. Changes in the fatty acid composition of plasma lipids indicate nutritional status in developing Weddell seal pups. Polar Biology. Submitted September 1996.

Rea. L.D., M.A. Castellini and B.S. Fadely. Health status of young Alaska Steller sea lions (*Eumetopias jubatus*) as indicated by blood chemistry and body condition. Canadian Journal of Zoology. Submitted December 1996.

Zenteno-Savin, T. and M.A. Castellini. Plasma angiotensin II. arginine vasopressin and atrial natriuretic peptide in free ranging and captive seals and sea lions. Comparative Biochemistry and Physiology. Submitted February 1997.

OTHER KEY PERSONNEL

J.M. Castellini, M.Sc., is a UAF Research Associate and has worked on marine mammal biochemistry/physiology projects since 1986. She is currently the laboratory director and provides daily project monitoring. Her role will include blood chemistry analysis, quality control, computer analysis and publication preparation.

Students (TBA). There are several new students (Ph.D. and M.S.) in the Castellini laboratory who will use this project as a base for their thesis research.

LITERATURE CITED

1. York, A.E. 1994. The population dynamics of Northern sea lions, 1965-1985. Mar. Mamm. Sci. 10: 38-51

2. Jemison, L.A. and B.P. Kelly. 1996. Harbor seal productivity and first-year survival in the Gulf of Alaska. IN: Harbor seal investigations in Alaska. NOAA Grant NA57X0367. Annual Report. Alaska Department of Fish and Game, Douglas, Alaska.

3. Castellini, M.A., J.W. Testa, L.D. Rea, J.M. Moss and K.K. Hastings. 1994. Diving development and survivorship in Weddell seals pups. Antarctic Journal of the United States. XXIX (5): 171-172.

4. Rea, L.D. 1995. Prolonged fasting in pinnipeds. Ph.D. thesis. University of Alaska Fairbanks. 135pp.

5. Rea, L.D., M.A. Castellini and B.S. Fadely. Health status of young Alaska Steller sea lions (*Eumetopias jubatus*) as indicated by blood chemistry and body condition. Canadian Journal of Zoology. Submitted December 1996.

6. Fadely, B.S., J.M. Castellini and M.A. Castellini. 1997. Recovery of harbor seals from EVOS: Condition and health status, *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 96001). University of Alaska Fairbanks.

7. Fadely, B.S and M.A. Castellini. 1996. Recovery of harbor seals from EVOS: Condition and health status. *Exxon Valdez* Oil Spill Restoration Project Annual Report (Restoration Project 95001), University of Alaska Fairbanks.

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$49.7						
Travel		$14.5						
Contractual		$19.1						
Commodities		$12.8						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$96.1	Estimated	Estimated	Estimated	Estimated	Estimated	Estimated
Indirect		$24.0	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004
Project Total		$120.1	$109.8	$117.8	$89.0			
Full-time Equivalents (FTE)		2.2						
	Dollar amounts are shown in thousands of dollars.							
Other Funds								

Comments:

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

Student salaries include $5544 in tuition each.

FY 98

Prepared: 04/10/97

Project Number: 98351
Project Title: Harbor seal recovery: Fate of pups
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

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

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 1998
M. Castellini	Associate Professor – P.I.		0.9	7.6		6.8
J. Castellini	Research Associate		1.4	3.9		5.4
Vacant	Ph.D. Student		12.0	1.7		19.9
Vacant	M.S. Student		12.0	1.5		17.6
	Subtotal		26.3	14.7	0.0	
					Personnel Total	$49.7

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
6 R/T Fairbanks–Seward	200	6	87	138	13.2
2 R/T Fairbanks–Anchorage, EVOS Workshop	150	2	8	120	1.3
				Travel Total	$14.5

FY 98

Prepared: 04/10/97

Project Number:
Project Title: Harbor seal recovery: Fate of pups
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

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

Contractual Costs: Description	Proposed FY 1998
Chemical analysis of blood samples @ $35	10.5
Long distance phone and communication	0.6
Service ARGOS – satellite telemetry	8.0
Contractual Total	$19.1

Commodities Costs: Description	Proposed FY 1998
Blood collection supplies	1.0
Laboratory expendables	2.2
Satellite tags	9.6
Commodities Total	$12.8

FY 98

Prepared: 04/10/97

Project Number:
Project Title: Harbor seal recovery: Fate of pups
Name: University of Alaska Fairbanks

FORM 4B
Contractual &
Commodities
DETAIL

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

Existing Equipment Usage: Description	Number of Units	

FY 98

Prepared: 04/10/97

Project Number:
Project Title: Harbor seal recovery: Fate of pups
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Appendix 1: Memoranda Concerning Modification of DPDs 97064 and 97001

A. Modification to DPD for 97064, Harbor Seals
B. Modification to DPD for 97001, Harbor Seals

STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

DIVISION OF WILDLIFE CONSERVATION

TONY KNOWLES, GOVERNOR

1300 College Road
Fairbanks, AK 99701-1599
PHONE: (907) 459-7213
FAX: (907) 452-6410

MEMORANDUM

TO: Molly McCammon
Exxon Valdez Restoration Office
Anchorage

FROM: Kathy Frost
Fairbanks

DATE: 9 May 1996

SUBJECT: Modification to DPD for 97064, Harbor Seals

Since we prepared and submitted the 1997 DPD for EVRO project 97064 (Monitoring, Habitat Use, and Trophic Interactions of Harbor Seals in Prince William Sound, Alaska.) we have completed the annual report for project 95064 and our spring 1995 field trip. After reviewing the data obtained and analyzed to date from our satellite tagging studies, and after discussing the data with Dr. Mike Castellini who conducts harbor seal physiology studies in conjunction with our project, we would like to recommend some changes to the field program described in the 1997 DPD.

Sensitivity analyses and simulations developed as part of the harbor seal population model showed that survival of age classes 0-4 has a large impact on the dynamics of the harbor seal population. The population is far more sensitive to changes in survival of these age classes than to changes in adult survival. Also, it seems likely that younger seals would be more sensitive to changes in food availability. Therefore, we think it is important to increase our understanding of these age classes during the remaining two years of this study.

When we began this project, it was not possible to instrument small, subadult seals with satellite-linked depth recorders (SDRs) because the tags were too large. In fall 1994, we first obtained SDRs that could be used on small seals. Including this most recent field trip in April, we have instrumented 25 adults and 18 subadults. An additional 4-6 subadults will be tagged in September, giving us an almost equal number of adults and subadults. To date only two of the young seals we tagged were thought to be pups. That is because even the small 0.5 -watt SDRs may be too large to be carried by pups for an extended period. However, recent developments in the design of satellite tags will mean that by summer 1997 a reliable 0.25-watt tag, small enough to be easily carried by a pup, should be available. We tested an early version of the 0.25 watt SDR in September 1995, and more testing will occur throughout the 1996 field season by projects around the world.

We propose the following modifications to the 1997 DPD for project 97064:

1) Reschedule the sampling and tagging of seals which would have occurred during April-May or September 1997 to late June or July 1997.

2) Tag pups of the year (instead of adults and subadults older than pups) with 0.25-watt SDRs.

3) Conduct standard sampling of all seals caught during our efforts to catch and tag pups in summer. This will expand the seasonal coverage for studies of fatty acids, stable isotopes, health and condition indices, etc. Project 97001, which coordinates field work with 97064, will also emphasize studies of pups.

These proposed modifications should provide us with a more well-rounded picture of what harbor seals in Prince William Sound are doing. It is clear from the tagging studies conducted to date that movement patterns of subadults and adults are different, and that subadults are more likely to range over a wider area. Since pups are thought to be an especially vulnerable age class, and also less flexible in the range of prey they can consume, it will be extremely valuable to obtain information on their movements and diving behavior.

I have reviewed the proposed budget for 97064 and looked for ways to save money. The proposed modifications to the field work, in addition to economizing in some other ways, will result in a budget reduction of $33,700, or almost 10%. This is due to the elimination of one field trip during 1997 and the associated costs for vessel charter, transportation of field crews, etc.

Please let us know whether these changes are acceptable. I am enclosing a revised version of the Excel budget showing the new dollar amounts. I have also sent a copy of this to Joe Sullivan at ADF&G.

cc: Joe Sullivan
Mike Castellini

May 10, 1996

TO: Molly McCammon
Exxon Valdez Restoration Office
Anchorage

FROM: Dr. Michael Castellini
University of Alaska, Fairbanks.

SUBJECT: Modification to DPD for 97001, Harbor seals

Recently, you should have received a memo from Kathy Frost at ADF&G in Fairbanks requesting a change in the scope to her DPD 97064 on harbor seals. As noted by Kathy, we have recently returned from our 1996 spring harbor seal field sampling in PWS. During that trip, we reviewed our respective 1995 reports and started to plan the details for our future commitments to this work. It that discussion, we agreed to request a change in scope in our collaborative harbor seal projects.

After reviewing our data, we agreed that work on pups should be emphasized. Kathy has provided you information on the population biology of the species and her rationale on why the survival and health of pups is a critical component in future studies. In this memo, I add our reasoning behind the request for change in the physiological studies.

Our laboratory has recognized that the health of pups as a vital component of understanding pinniped populations. To that end, we have been funded by the National Science Foundation to study population health indices in Weddell seal pups in the Antarctic and by the National Marine Mammal Laboratory to study the health of Steller sea lion pups here in Alaska. We also have National Institute of Health funding to look at the development of diving physiology in northern elephant seal pups and American Heart Association funding to examine cardiac function in seal pups. In addition, as you know, the Alaska SeaLife Center will be a major rehabilitation and research site for Alaska harbor seal pups. We are working on general development issues in pinnipeds that directly address their health and survival. One of the MS students in our laboratory is completing a thesis project on the survival of Weddell seal pups and has a paper in press dealing with survival up to weaning. Finally, we have published several recent papers in international physiological journals dealing with development of seal pups. Thus, we have a long standing interest in the biology of pinniped pups and have ongoing projects that can interface with work on harbor seal pups.

We propose to carry out our health status studies on harbor seal pups using both the adult protocols and techniques we have used on pups from many other species. This would include veterinary clinical blood sampling, length, girth and mass measurements, blubber thickness, water chemistry, contaminant testing and blood metabolite monitoring. In addition, we would seek additional non-EVOS support to monitor basic physiology of the pups while they are on-board the ship (heart rate, respiration, body temperature). I have accepted a Ph.D. student for the fall who already has a MS in harbor seal biology and has extensive training in pup handling. He would become the lead person for our harbor seal pup component.

As Kathy noted, a change in the field season protocols would significantly decrease the logistical costs associated with our collaborative grants. However, because almost all of those field costs are borne by 97064, there would be little change in the cost basis of 97001. There would be fewer samples for analysis and this could lead to some costs savings. Unfortunately, I cannot estimate that at this time since it depends on how many pups are captured. Our 1997 DPD budget was about 2-3% below what we had originally requested and this change in scope could drop that to about 5% below.

Please let me know your opinion of this request for a change in scope to begin work on harbor seal pups.

cc: Joe Sullivan
Kathy Frost

UNIVERSITY OF ALASKA BUDGET INFORMATION

The University of Alaska accounting system accumulates data according to an established system of accounts codes. This differs from the level or category of detail required on this proposal. Per the new Cost Accounting Standards Board (CASB) guidelines, costs are to be listed in a proposal only to the level of detail at which the subsequent expenditures may be tracked. Therefore, please note that supplies itemized on the budget form may be tracked to UA accounting system categories such as the following examples: 1) project supplies; 2) professional, technical and scientific supplies; 3) field camp supplies; and 4) hazardous materials. Service listings are also broad, but include specific categories such as duplicating, postage, toll charges, and software licensing. A complete list of University of Alaska Accounts Codes is available upon request.

EVOS RESTORATION PUBLIC ACCESS AND EDUCATION PROGRAM

Project Number: 98353

RECEIVED
APR 15 1997
EXXON VALDEZ OIL SPILL
TRUSTEE COUNCIL

Restoration Category: General restoration, research and monitoring.

Proposer: Ocean Explorers,

Lead Agency:
Cooperating Agencies:

Alaska Sealife Center: yes

Duration: Year I FY98 successive years funded to coincide with existing funded restoration projects.

10% increase in funding for the participation restoration programs to facilitate this program to include traditional knowledge holders and communities into the EVOS research projects.

Cost FY 97 : 250.0

Cost FY 98 : 300.0

Cost FY 99 : 350.0

Cost FY 00 : 400.0

Cost FY 01 : 450.0

Cost FY 02 : 500.0

Geographic Area: All AreaInjured Resource/service: All resources and services. Project will enhance current EVOS funded projects.

ABSTRACT

Project will provide a feasible, manageable, marine science research operations and input program for traditional knowledge holders, educators, coastal communities, administrators and the development of an educational coastal environmental awareness program.

Prepared 4/9/96 Project 97

INTRODUCTION

This proposal is intended to provide a simple and direct access means for traditional knowledge holders, coastal communities, students, researchers and administrators to access the real EVOS research programs. Many of the current funded research projects have facilities (i.e. research vessels) which can be utilized to provide direct access to the projects themselves. This proposal is intended to, not only provide access to the projects, but also to improve the logistical management of these projects and facilities. the use of these already funded facilities in which principal
investigators and researchers on site is invaluable. By allowing access to traditional knowledge holders, students and research administrators. The long term benefit to coastal communities in understanding the complicated decisions they may have to make in the future is considerable.

NEED FOR THE PROJECT

A. Statement of Problem

The most common criticism of the EVOS program over the years has been lack of community input. The theme of the 1996 workshop was to increase the input of traditional knowledge holders to assist in the restoration program. The need has been identified by the EVOS Restoration Council.

B. Rationale/link to Restoration

Enhancing the research with traditional knowledge and providing a program for field assistants, education on restoration is a positive addition to all the existing projects. This project has the potential to go far beyond the current scope.

C. LOCATION

The project will take place in every community. When a research project is taking place near a community the community will be advised and activities coordinated under this program.

COMMUNITY INVOLVEMENT

Research logistics program will be coordinated with the local community facilitators. Also existing youth watch programs and other community programs will be able to access the real research projects underway. This will also provide an opportunity for the Sea Life Center, PWSSC and others to coordinate their field logistics as well. Traditional knowledge holders and others would become members of the vessel crew as assistant researchers and would operate under the vessel safety training, insurance and payroll. This system was successfully used with the community of Chenega for oiled mussel bed research under the ADEC in 1994 on board the vessel Pacific Star. A similar project was instituted by this proposer with the Chugach School District.

PROJECT DESIGN

A. Objectives

1. Improved logistics and coordination between research projects.

2.Substantial opportunity for community involvement

3.Direct program for getting traditional knowledge holders to interact with the principal researchers in the field.

4. A basis for a long term mentor & education program facilitating access to the specific field projects and to enhance the operations of the PWSSC, the Seward Sea Life Center and include other coastal communities into their operations. For example; a logistics base in Whittier for PWSSC and Seward Sea Life Center cruises.

5.A basis for the marine research centers to have direct field access and coordination with all coastal projects. The Seward Sea Life Center would provide an orientation and coastal awareness, training program in some respects similar to Woods Hole and Schipps program.

6.A coordinated basis for developing a sea education component.

7. A coastal community design and implementation of an environmental vehicle which would be operated by the individual community.

B. METHODS.

Current logistics and management required for existing research projects would be increased to include the communities and traditional knowledge holders' involvement. The design and implementation of a community environmental vehicle.

C. COOPERATING AGENCIES, CONTRACTS, AND OTHER AGENCY ASSISTANCE.

This project requests participation of all the Trustee Agencies as part of this proposal. The opportunity level would be determined by the agency and the scope of the individual project.

Current proposer contracts to provide field support services for research projects go into the 1999 research project years. The logistics and cruise planning technical requirements to successfully operate this program have been developed over the past 7 years. Working closely with all the project principal investigators over these 7 years, attending the EVOS workshops has developed the knowledge of particular projects, community perspectives and logistics required to coordinate this project.

Schedule

A. Oct. 1 - Dec. 31 : Prepare NEPA compliance documents. Meet with facilitators. Coordinate objectives.

Jan 22 - 25 : Attend Annual Restoration Workshop and meet with principal investigators.

Feb 1 - Mar 1 : Logistics management and coordination . First cruise date approx. Mar. 7 1997

Mar 1 - Oct 98 : 1997 EVOS coordinated cruise programs.

B. Project Milestones and Endpoints.
A pilot program with the Chugach School District was designed and implemented in 1996. This project consisted of bringing students fromt the existing programs and allowing them access to the research projects on board the Pacific Star, March 12 & 113 1996.
The inclusion of each community and individual would not only be the milestones of this project but would be the gauge of its success. Accurate project logs (records) would be available for review at any time.

The project will publish a newsletter of each cruise, along with data and access information to the traditional knowledge holders, students and interested community leaders.

C. Completion Date
This project is not expected to have a completion date. The EVOS basis provided is expected to develop and grow into a long term self sustaining Marine Science Education and Coastal Coordinating Program that is focused on the coastal communities and their involvement in all of the coastal activities. The proposer is aware of the current programs in existence at this time. This program complements those programs by providing the method for their interaction.

PUBLICATION AND REPORTS.

This project will publish (for reprint) an access information and cruise plan, information for traditional knowledge holders, researchers, administrators, educators and the coastal communities which can be included in the various professional newsletters and coastal publications.

PROFESSIONAL CONFERENCES

The availability of this information to the traditional knowledge holders and to the professional researchers will require attendance at meetings and conferences of both parties. It is intended that a professional paper will be produced showing the coordinated program as funded by EVOS and the positive aspects of this program to future researchers. (1999)

PROPOSED PRINCIPAL INVESTIGATOR

Henry Tomingas, Pres,
Fairweather Marine/Ocean Explorers
BOX III32I,
Anchorage, Alaska 99511
Phone/fax 907 345 6126

EVOS RESTORATION PUBLIC ACCESS & EDUCATION PROGRAM

PUBLIC ACCESS AND EDUCATION BOARD.

Function of board representative for information flow and coordination.

Stan Senner	-	EVOS
Henry Tomingas	-	Ocean Explorers
Pet Kompkoff	-	Community Facilitator PWS
Member	-	Port Graham facilitator
Dr. Mike Castellini	-	Seward Sea Life Center.
Member	-	Kodiak Facilitator
Member	-	UAF
Member	-	NOAA
Member	-	ADFG
Member	-	USFWS
Member	-	USFS
Member	-	DEC
Member	-	DNR
Dr. Todd Miner	-	UAA Alaska Wilderness Studies
Member	-	Chugach School District
Member	-	Education School District at Large.

OPERATIONS MANAGEMENT

Henry Tomingas	-	Director
Pete Kompkoff	-	Director
Stan Senner	-	Director
Dr. Mike Castellini	-	Director
Joe Broom	-	Lt. Commander USCG Ret. MS Education.

Project Title: Bivalve Clam Literature Review, Clam Habitat Association Model and Field Investigation

Project Number:	[illegible]
Restoration Category:	Research
Proposer:	Peter J. Armato, Coastal Resource Specialist Kenai Fjords National Park P.O. Box 1727, Seward, Alaska 99664-1727 907/224-2166 (phone), 907/224-2144 (fax) Peter_Armato@nps.gov (e-mail)
Lead Trustee Agency: Cooperating Agencies:	DOI/NPS
Alaska SeaLife Center:	Yes
Duration:	0 Year, Proposed 2-year Project
Cost FY 98:	$ 28,500
Cost FY 99:	$ 25,000[1]
Cost FY 00	$ 5,000
Geographic Area:	*Exxon Valdez* Oil Spill Region, Kenai Peninsula, Nuka Bay, Beauty Bay, North Arm Bay
Injured Resource/Service:	Clams

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EXXON VALDEZ OIL SPILL
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ABSTRACT

The paucity of *Exxon Valdez* Oil Spill Trustee Council sponsored studies documenting the extent and persistence of injury to bivalve clams throughout the *Exxon Valdez* oil spill (*EVOS*) zone suggests that researchers may have: 1) overlooked the importance of documenting the injury to clams; 2) lacked the expertise to conduct such studies; or 3) had little interest in studying this area of injury and recovery. Because little work has been conducted in the area of clam injury and recovery, conducting a literature review, constructing a clam injury and recovery model and conducting field studies are crucial for developing and understanding of *EVOS* related clam injury and recovery in the spill zone.

[1] Does not include cost for Alaska SeaLife Center. See budget for explanation.

INTRODUCTION

The March 24, 1989 grounding of the supertanker *Exxon Valdez* and subsequent release of approximately 42 million liters of crude oil into the nearshore marine environment adversely impacted almost 1,500 miles of coastline from Prince William Sound (PWS) to the Katmai coast. Now, eight years post-*EVOS*, concern about the effects of the *Exxon Valdez* oil spill (*EVOS*) on clams and the status of clam recovery throughout the *EVOS* zone remains high (*EVOS* Trustee Council, 1996; 1997). Unless clams are studied, virtually no data will be available for Trustees to assess how the spill affected the structure and habitat associations of clam assemblages in the *EVOS* zone. Nor will the Trustees be able to accurately estimate the impact of this injury to the marine and nearshore terrestrial food webs.

The structure of clam assemblages and their habitat associations are poorly known through much of the *EVOS* zone. Developing and understanding of pre- and post-*EVOS* bivalve clam community structure and habitat associations may be critical for interpreting data from other *EVOS* studies (i.e. APEX), assessing recovery status of injured clam predators, prescribing further restoration activities and assessing impacts to subsistence clam species in the *EVOS* spill zone. The sheltered and highly productive embayments and tidal flats at Beauty Bay and North Arm Bay are ideal locations to study clam assemblage structure, habitat associations and predator prey relationships in both oiled (Beauty Bay) and unoiled (North Arm Bay) sites.

Work will consist of: 1) conducting an indepth literature review, comprised of a synthesis and summary of the occurrence, distribution, life habits, food web linkage, subsistence value and effects of oil on clams; 2) constructing a clam injury and recovery model; and 3) conducting a field investigation to evaluate the clam injury and recovery model. A team consisting of the principal investigator and two graduate students will be assembled to conduct the proposed work.

The literature review will involve collecting, reviewing, abstracting and categorizing molluscan literature describing the effects of North Slope crude on clams inhabiting Arctic to sub-Arctic habitats. This work will lead to the production of an annotated bibliography on the subject. The literature review will entail both an in-depth computerized search of databases of the published literature and a thorough examination of government and industry reports and documents. Personal interviews will be conducted with agency personnel and researchers who have studied the effects of oiling on intertidal bivalve assemblages.

Once the literature and interviews have been abstracted and reviewed, the body of data will be analyzed and a model developed that will include:

> 1) assessing the effects of oiling and of the disturbance associated with oil spill cleanup to *EVOS* zone intertidal clam assemblages; and,
>
> 2) assessing the recoverability of the clam assemblages after the 1989 oil spill.

Once a model has been produced it will be field tested in Beauty Bay, an expansive tidal flat and estuarine system that was lightly to moderately oiled during the *EVOS*. North Arm Bay tidal flats, unoiled during the 1989 spill, located to the northeast of Beauty Bay, will serve as a control site for the field portion of this study. Work at these sites will include conducting physical and biological field investigations to check the validity of the model.

Products of this study will include: 1) an abstracted literature review; 2) a field checked clam injury and recovery model; 3) a report to Native subsistence boards and regulatory agencies; 4) submittal(s) to peer reviewed journals; and 5) *EVOS* workshop presentations.

NEED FOR THE PROJECT

A. Statement of Problem

There is ample evidence that oil spills can perturb entire invertebrate populations. The broad range of effects that oil or its components elicit can be seen from studies done with the soft-shell clam *Mya arenaria*. They include mortality due to smothering (M.L.H. Thomas, 1973, 1977); long term mortality M.L.H. Thomas, 1977); altered population composition (Gilfillan and Vandermeulen, 1978); altered metabolic and feeding rates (J.W. Anderson et al., 1974; Avolizi and Nuwayhid, 1974; Stainken, 1978); reduced survival (Roesijadi and Anderson, 1979) and alteration in shell formation (Gilfillan and Vandermeulen, 1978). These and other adverse effects occur in invertebrates exposed to oil or oil fractions. Included are long term perturbations at the population and community levels (e.g., Elmgren et al., 1981).

Sublethal effects of oil exposure are seen in all phyla and range from alterations in respiration, growth, reproduction, and behavior to alterations in the more specific processes of calcification, molting, ion transport, and enzyme function. Often, effects of exposure last for years after the oil spill. For example, 6 years after the Arrow spill, *Mya arenaria* populations in Chedabucto Bay continued to experience recruitment problems (M.L.H. Thomas, 1978; Gilfillan and Vandermeulen, 1978). However, an apparent enigma observed at some spill sites and in experimental studies is the puzzling survival of some macroinvertebrates in highly oiled sediments. For example, several studies have noted the lack of significant mortality during exposures to concentrations of oil in sediments in excess of 1,000 $\mu g/g$ (Wells and Sprague, 1976; J.W. Anderson et al., 1977; Roesijadi et al., 1978; Vandermeulen and Gordon, 1976; Gordon et al., 1978). Shaw and Cheek (1976) discussed survival of the clam *Macoma balthica* in sediments containing 640-3,890 $\mu g/g$ (dry weight) hydrocarbons.

The 1989 grounding of the T/V *Exxon Valdez* and subsequent oil spill severely perturbed the nearshore environment from Prince William Sound (PWS) to the Katmai coast. Impacts occurred at all tidal levels and in all types of coastal habitats. Here, the nearshore ecosystem served as a repository for much of the oil spilled. The oil that collected and concentrated on and in the substrate caused acute mortalities in benthic invertebrate populations. Some of the affected benthic populations include mussels, clams, and crabs. It is suggested that the magnitude of impacts on bivalve mollusc (clam) populations varied with the species of clam, degree of oiling, and location. Data from the lower intertidal zone on sheltered beaches suggest that little-neck clams (*Protothaca staminea*) and, to a lesser extent, butter clams (*Saxidomus giganteus*) were killed or suffered slower growth rates as a result of the oil spill and clean-up activities (*EVOS* Trustee Council, 1996). At this time, however, the effects of the *EVOS* on clam populations throughout the spill zone and clam recovery remains unclear and uncertain. Initial changes in the composition and structure of clam assemblages can be attributed to acute mortalities due to habitat perturbations caused by oiling and massive cleanup efforts.

Approximately 25,000 bags of oil, oil soaked sediment and debris were removed from the Beauty Bay tidal flats. It can easily be predicted that the disturbance from oiling and cleanup prompted a rapid initial population shift in clam assemblages. In fact, the initial impact and/or residual weathered oil may continue to modify important structuring processes in Beauty Bay intertidal clam populations (i.e. competition, predation and recruitment). As such, sediment will be collected at each quadrate location and inspected for oil. If oil is present then sediment and clam tissue samples will be collected and stored until funds for fingerprinting and analysis are available.

Although the Trustees are currently funding one project to restore clams (*Chugach Region Clam Restoration* (\131)) virtually no data has been collected, analyzed and presented that describes the impact of the *EVOS* spill on clam population dynamics.

B. Rational/Link to Restoration

Clams are an important linkage in many marine and terrestrial food webs including human subsistence. Despite a growing amount of descriptive information about ecosystem perturbations resulting from oil pollution, there are big gaps in the data and uncertainties about data interpretation. Such is the case with *EVOS* clam data. In light of the fact that clams are a critical link in the nearshore food web for *EVOS* injured top vertebrate species whose recovery is uncertain (e.g. harlequin ducks, sea otters), it is unfortunate that the nature and extent of injury to clams is unknown and their recovery status uncertain. As such, it is no surprise that concern about the effects of the *Exxon Valdez* oil spill on clams and clam recovery status remains high.

Now, eight years post-*EVOS*, as many Trustee funded ecosystem studies are beginning to wind down, uncertainty about the impact and recovery of clam populations injured during the oil spill remains high. Unfortunately, investigators and Trustees are hampered in assessing the extent and persistence of the injury to clams, and *EVOS* injured species who prey on clams, by lack of adequate knowledge of natural, unstressed ecosystems and associated clam assemblages as well as knowledge about stressed ecosystems and clams impacted by *EVOS*. Virtually no surveys have been conducted or continued long enough to provide a standard for comparing long-term variability, injury or recovery in these stressed environments. As such, the injury to clams and their recovery and the recovery of their predators in the *EVOS* zone remains unclear.

C. Location

This project will be conducted in Beauty Bay and North Arm Bay on the Kenai Peninsula. Beauty Bay is a northwest trending marine embayment situated approximately between North Arm and West Arm of Nuka Bay. Air photo analysis suggests that Beauty Bay is an inlet formed by Holocene marine submergence of a valley in low-lying glaciated rocky terrain. Beauty Bay is flanked to the northeast and southwest by steep, rugged mountains. Locally, topographic relief ranges from sea level to 3,793 feet at Storm Mountain. The principal stream entering Beauty Bay is the Nuka River. Sediment from the large braided glacial river catchment has accumulated in the embayment resulting in the formation of a prograding delta and associated sand, mud and pebble tidal flats. Air photos of the Beauty Bay delta and tidal flats depict numerous distributary channels and adjacent sediment lobes.

North Arm Bay, located to the east of Beauty Bay, is a northeast trending marine embayment. The mouth of North Arm Bay is situated approximately 3 kilometers to the east of the mouth of Beauty Bay. Air photo analysis suggests that North Arm Bay was also formed by Holocene marine submergence of a valley in low-lying glaciated rocky terrain. North Arm Bay is flanked to the northwest and northeast by steep, rugged mountains. Locally, topographic relief ranges from sea level to 3,793 feet at Storm Mountain. The principal stream entering North Arm Bay is an un-named braided outflow stream of Split Glacier. Sediment from the braided glacial stream catchment has accumulated in the embayment resulting in the formation of sand, mud and pebble tidal flats.

COMMUNITY INVOLVEMENT

There is a strong linkage between Alaska Native subsistence groups and clams. Alaska Department of Fish and Game (ADF&G) records indicate that many species of clams are harvested by Alaska Native subsistence groups and local residents. Nanwelek villagers, for example, harvest butter clams (*Saxidomus giganteus*), razor clams (*Siliqua patula*), Pacific littleneck/steamer clams (*Protothaca staminea*) and cockles (*Clinocarduim nutallii*) as did their ancestors. ADF&G clam harvest records for 1993 indicated that Nanwelek took approximately 12 pounds (edible weight) of clams per person from March through June.

Technological disasters, such as the *EVOS*, result in rapid acute and chronic long-term degradation of clam beds. Oil accumulating in the intertidal immediately after a spill, results in rapid mortality in clam populations with reduced tolerance to oil while those species with an increased tolerance to oil exposure persist. The accute and chronic effects of oiling of clam beds may result in long-term restructuring of clam population in the impacted area . due in part to the presence of residual oil, recolonization by less desirable, opportunistic species. due to shifting species composition of affected assemblages.

Information from this study will be presented at oil spill symposia, planning workshops, conferences, in published and unpublished literature. Clam species occurrence, abundance and distribution data will be provided to the University of Alaska Sea Grant program, ADF&G Division of Subsistence, English Bay subsistence harvesters, and any other interested groups and individuals.

Investigators will work closely with Nanwelek, and other interested Alaska Native subsistence harvest groups to: 1) inform groups of study being conducted; and 2) provide data and results of the study. Investigators will attend meetings as needed to present and discuss, research, methods and results. These data will help those involved in clam subsistence harvest make informed decisions about annual subsistence harvest of clams in Nuka Bay and adjacent areas. The principal investigator will be responsible for preparing progress reports of project findings for *EVOS* Trustees and for the distribution of information to community residents and other interested parties.

PROJECT DESIGN

A. Objectives

The objectives of this proposal are to:

1) develop a summary and synthesis in scientific terms of existing literature and research findings related to the impacts of oiling and the disturbance created by oil spill cleanup activities on soft sediment, infaunal bivalve clam communities inhabiting the sub-Arctic conditions found in Prince William Sound and the Gulf of Alaska;

2) develop a clam injury and recovery model; and

3) field test the model in Beauty Bay (oiled during *EVOS*) and North Arm Bay (unoiled during *EVOS*).

B. Methods

Task 1: Literature Review/Information Search.

The review of the scientific literature will be accomplished in a very cost-efficient manner. Two team members, graduate students in marine biological sciences at University of Alaska-Fairbanks, will conduct the literature search. Peer reviewed papers, published studies, unpublished agency or industry reports ("gray literature"), and a list of ongoing studies will be included to the extent it is feasible. Unpublished reports may be difficult to locate, so team members will conduct a "reasonable effort search" to obtain unpublished reports, primarily through the use of interviewing experts in the field and the use of the World Wide Web. Additional sources of information will include, but not be limited to, Environment Canada, U.S. Minerals Management Service, U.S. Coast Guard, National Park Service, U.S.G.S. Biological Resources Division, marine spill response organizations, the *Exxon Valdez* Trustees oil spill library, the International Oil Spill conference proceedings, the Arctic Marine Oil Pollution conference proceedings, on-line environmental, scientific databases and journals. Data and information will be also obtained from archives of local natural and historic museums and societies, news papers, local long-term families and keepers of traditional knowledge.

Key documents located through this search will be reviewed, and if an abstract is not provided by the author, a one to two paragraph abstract will be written which summarizes the scope and findings of the document. Information from these documents will be analyzed and compiled into a synthesis document, which will include both a discussion of the studies completed, the methodologies used, the conclusions drawn, and the recommendations made,

Task 2: Development of a Database.

Data and information obtained during the literature review will be assembled into a bibliographic software format utilizing Pro-Cite. This database can be sorted by author, title, date, any word contained in the abstract, species or matrix of concern, location of study and techniques used.

Task 3: Inventory/Synopsis of Ongoing Research in Sub-Arctic Regions.

In addition to the survey of previously existing literature, researchers will conduct an inventory of ongoing research within sub-Arctic conditions. This inventory will be developed based upon interviews with researchers at universities, research institutions and private companies. Information will also be gathered using the World Wide Web. Information gathered will include the name of the project, the agency conducting the project and any preliminary conclusions from the project.

Task 4: Listing of Potential Future Research.

After completion of the three tasks described above, project researchers will develop recommendations for future research needed to address the impact of the *EVOS* to clams and clam recovery.

Task 5: Develop A Tidal Flat Clam Habitat Association Predictive Model.

The co-occurrence of species as a community results from their common tolerance of a particular suite of biotic and abiotic ecological factors (Bailey and Tedesco, 1986). Changing these conditions prompts change in community composition and structure (Armato, 1993). Controversy concerning the role of physical, chemical and biological factors on the occurrence and distribution of marine invertebrates in the marine environment has stimulated much research on this subject. Peterson (1913) and Thorson (1957) examined the effects of ecological factors on diversity and species associations. Their studies helped better define community dynamics, species composition and dominance. Ecological factors controlling community composition include water temperature (Parker, 1956; Raup and Stanley, 1978; and Levinton, 1982) and water depth (Sanders, 1968; Raup and Stanley, 1978; Levinton, 1982).

After completion of Tasks 1, 2, and 3, data obtained from the carefully selected literature review will be used to construct a model, designed to predict molluscan (clam) habitat associations, quantitative species composition and clam distribution and abundance patterns in tidal flat assemblages. The model will be tested in the field and refined during year 02 of the study.

By applying this model, researchers may be able to: 1) predict, given measurable physical parameters, clam species occurrence, structure and habitat associations of tidal flat areas; 2) reconstruct the short term effects and assess long term effects of the *EVOS* on clam populations; and 3) determine injury and recovery status of clam assemblages. However, it must be recognized that the number of species present at any place or time, species diversity, appears to be regulated by ecological processes. Although many of the views presented are only hypotheses that are not yet proven, they should be considered to form a model for quantitative species patterns which can serve as a basis for explaining observed quantitative species patterns.

The key to this model is based on the premise that species that inhabit any part of the biospace are likely to be better adapted there than are other species in the same community but different biospace. The model of the occurrence and distribution of clam species inhabiting tidal flats will be based on the animals linkages to the physical environment. Physical environmental parameters that will be used to construct the model will include, but not be limited to, grain size distribution, water temperature, salinity, energy of the environment, resource and environmental fluctuations. The model will be tested by utilizing it to predict the occurrence and distribution of clam species in Beauty Bay and North Arm Bay tidal flat molluscan assemblages.

Upon completion of this phase and the field portion of the study, it is hoped that given measurable physical parameters, a scientist or technician would be able to use the model to predict the structure an habitat associations of molluscan assemblages throughout the *EVOS* zone. If this work is successful, additional funding will be requested to extend the scope of the work to Prince William Sound and the Katmai coast.

Task 6: Conduct Field Study.

Upon completion of the four tasks described above, project researchers will conduct field studies to test the model. Field study will test the following hypotheses:

1) The structure and habitat associations of molluscan assemblages inhabiting Beauty Bay (oiled) tidal flats exhibit predicted altered ranges and values.

2) The structure and habitat associations of molluscan assemblages inhabiting North Arm Bay (unoiled) tidal flats are within expected natural ranges and values.

3) There is no difference in the structure and habitat associations of molluscan assemblages inhabiting Beauty Bay (oiled) and North Arm Bay (unoiled) tidal flats. Both assemblages display similar structure and habitat associations and are within expected ranges and values for undisturbed clam assemblages.

4) Residual subsurface *EVOS* oil continues to impact Beauty Bay clam assemblages.

Biological data required to test the hypotheses:

1) Data describing living clam population dynamics including species abundance, diversity, age structure, life habits, predator prey relationships, spatial distribution and habitat associations will be collected and analyzed;

2) Data describing dead clam population dynamics including species abundance, diversity, age structure, life habits, predator prey relationships, spatial distribution, habitat associations, cause of mortality and post-mortem transport processes will be collected and analyzed.

Biological Sampling:

Specimens will be collected along multiple tide lines selected by random number generation, using the transition zone between beach and tidal flats as the zero point. Because of environmental changes which occur in the intertidal zone, including both rocky and sediment-covered substrates, stratified random sampling or sampling along line or belt transects through the intertidal zone is advisable (Michael et al., 1977). Permanent (iron rebar) locality monuments will be installed to allow accurate relocation and reoccupation of each tide line. Monuments will be placed far enough landward to prevent loss during erosion that accompanies large storm, high surf events and seasonal changes to beach profiles.

Along each tidal line, quadrates will be placed at distances determined by random number generation. Quadrates will measure 1/2 meter by 1/2 meter. Quadrates will be placed on the center of the tide line and sediment within each quadrate will be excavated to a depth of 1 foot. Living and dead clams collected from each excavation will be identified to the species level, counted and measured. The number of individual dead clams will be recorded as the number of articulated specimens and the larger number of identifiable left or right umbos of disarticulated or broken shells. When determinable, cause of death for clams will be noted. Molluscan predators (gastropods) will also be identified, measured and counted. However, if this methodology results in high numbers of excavations yielding no clams, the method will be amended to select those random numbers corresponding to locations with high potential for encountering bivalves.

Physical data required to test the hypotheses include:

1) Coastal morphology and morphological processes, habitat dynamics, substrate and grain size distribution data, presence and abundance of residual oil.

Aerial photos and field observations will be used to identify and interpret coastal morphological processes that may act to structure the bivalve assemblages. Substrate samples will be collected, analyzed and correlated to species abundance and distribution. Sediment will be examined for oil. If oil is present, funds will be sought for fingerprint analysis to determine if residual oil is from the *EVOS*.

Sample Processing:

Sediment and specimens from each quadrate sample will be carefully sieved using Newark standard testing sieves. Individual clam and sediment quadrate samples will be retained and preserved individually using buffered formalin. Quadrate numbers will be assigned to each samples to prevent mixing samples. Specimens will be stored until needed.

Species Identification and Life Habit Determination:

Individuals will be identified and life habit determined by using available literature. Abbott and Sandstrom (1968), Sabelli (1979), Rehder (1981), Abbott and Dance (1986), Abbott (1990) and other published references will prove to be useful for species identification and life habit determination.

Analytical Techniques:

After processing, identifying and counting all identifiable specimens, the clams will be ranked by abundance for each locality and the structure of the clam communities will be determined and compared to the model. Up to four measures of diversity may be used (species richness (Valentine, 1973; Peet, 1974; and Levinton, 1982), Shannon-Weaver Index (Shannon and Weaver, 1949), and dominance diversity (Whittaker, 1965). Several indices are being used because it is anticipated that the number of specimens recovered at each sampling locality probably will not be identical; and as the number of specimens collected increases, so too the number of species tend to increase. Because the number of specimens collected at each locality is not constant, species richness alone may not accurately reflect diversity. However, when used in conjunction with other measures of diversity, species richness can be useful in determining patterns of change in the marine environment.

To minimize the effect of unequal numbers of specimens per sample, Shannon-Weaver Index and dominance diversity curves will be used. The Shannon-Weaver diversity index is a measure of diversity that is sensitive to species richness and species equitability, the distribution of population sizes among the species (Valentine, 1973). The Shannon-Weaver index (H') will be used in this study because it is commonly used in marine studies and is relatively insensitive to the number of specimens found. The Shannon-Weaver index is

represented as

$$H' = -\Sigma\ (p_i) \ln (p_i)$$

where H' is the Shannon-Weaver diversity index, and p^i is the proportion of the i_{th} species in a sample.

Dominance diversity curves, which describe the distribution of species abundances, will be constructed for clam assemblages from each locality. The number of individuals of each species is plotted on the ordinate, and the species rank (its position in the sequence of from most to least abundant) on the abscissa. The form of the slope of the curve can be useful for interpreting the distribution of species and for making inferences about environmental stress and stability (Whittaker, 1965; Hooks et al., 1976). A linear, gently sloped curve suggests that the individuals are more or less evenly distributed among the species, while a nonlinear curve that is steeply sloped among the more abundant species suggests the presence of a few highly dominant species associated with many rare species. If numerous dominance-diversity curves are very similar in form, the dominance indices DI (McNaughton, 1967) and Dd (Berger and Parker, 1970) will be used to quantify the degree of dominance among the species. DI is given as

$$(P_1 + P_2) \times 100$$

where P_1 and P_2 are the proportions of the total number of individuals belonging to the first and second most abundant species in an assemblage. Dd is given as

$$P_1 \times 100$$

where P1 is the proportion of the total number of individuals in the first most abundant species.

Results of the literature review will be used to develop a normal species probability distribution model for *EVOS* zone sand and mud flat dwelling clam populations. Field data will then be compared to the model. Actual, mean and expected relative species occurrence, frequency and variance of probability distribution will analyzed.

Size:

Size is an important component in the ecological organization of animals (Stanley, 1973). Observed patterns of size-frequency distribution in living benthos across different environments have been attributed to the interaction of many biological and physical factors (Hansen, 1978). Jackson (1971) found that infaunal and hemi-faunal bivalves in stressed and low diversity environments have the largest average size, while epifaunal bivalves and gastropods display opposite trend of smaller size in these same environments. The most appropriate measure of species size would probably be the mean size of a species population in its most favorable environment or through its range. In this study, species size will be measured by taking the average of the longest dimension for the three largest specimens of a species in each quadrate. Because only the size relationships between species of the same family will be compared and because morphology within a family is reasonably constant, one linear measurement per specimen will be used. Every reasonable attempt to use the clams that have the greatest ecological distribution within the study quadrates will be used to determine if trends in size distribution are present throughout the study areas.

Sedimentologic Data:

Sediment will be collected for each quadrate location, marked with the quadrate identification number and stored for analyses. Work will include conducting a grain size analysis for each sample collected. Data will be used to help define changes in clam assemblage structure and habitat associations. Microscopes and grain size scales will be used to determine grain size distribution and angularity for each sample. Grain size will be reported using a Phi class (ϕ) scale. Grain angularity will be reported in accordance with American stratigraphic standards (angular, subangular, subrounded, rounded, well rounded).

Residual Oil:

The rate of uptake and depuration of oil ingested by benthic infauna and epifauna depends, in part, on their feeding habits and processes affecting the fate and persistence of oil in the environment. For example, since oil does not persist in the water column for long periods, it is taken up and depurated relatively quickly by filter feeders (Boehm et al., 1982, 1984). On the other hand, deposit/detrital feeders ingest oil present within benthic sediments (Roesijadi et al., 1978). These fauna may be chronically exposed to oil in benthic habitats. Because there is ample evidence that fresh and residual weathered oil can perturb entire benthic populations for long periods of time (M.L.H. Thomas, 1978; Gilfillan and Vandermeulen, 1978) sediment samples, collected for each quadrate locality, will be examined macroscopically and microscopically for residual oil. If oil is present: 1) samples will be collected from each oil bearing locality as a vertical integral of the surface sediment to a uniform depth; 2) more sample cores will be collected than may be feasible to analyze, thus allowing for achieving samples should they be needed for subsequent analysis; and 3) samples will be archived until funds are available for fingerprint analysis.

Task 7: Presentation of Results.

The principal investigator will prepare and deliver all written progress reports, the final written report and oral presentations as required or requested.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Only one Trustee agency (DOI) is requesting funds for this project. DOI assumes full responsibility for planning, coordinating and implementing this work.

SCHEDULE

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

October 1 - December 31:	Prepare compliance documents and obtain permits for FY 99
January 22 - 25:	Attend Annual Restoration Workshop
January 26 - March 15:	Train graduate students to conduct literature review
March 15 - April 15:	Conduct literature review
April 15:	Submit interim progress report
May 15 - June 1:	Continue literature review/abstracting
June 1 - June 15:	Complete literature review/dBase
June 15 - July 30:	Begin model construction
August 1 - September 30:	Analysis of model

B. Project Milestones and Endpoints

1. Conduct literature review and abstracting (March 15 - June 15, FY 98).
2. Complete clam occurrence and distribution model (June 15 - Sept. 30, FY 98)
3. Establish sampling localities (May 15 - June 1, FY 99).

4. Conduct field studies (May 15 - July 30, FY 99).
5. Determine bivalve population statistics (September 30, FY 99).
6. Prepare final report (April 15, FY 00)

C. Completion Date

This project will take place in three fiscal years. The literature review will be conducted during FY 01. Field work and data analyses will be conducted during FY 02 and FY 03. Final data analyses will be concluded and the final report prepared in FY 03. It is unlikely that, upon completion of this project, a new proposal will be submitted to continue or extend work beyond specified parameters.

PUBLICATIONS AND REPORTS

April 15, 1998:	Logistics progress report for 1998;
May 30, 1998:	Progress report of literature review activities;
October 30, 1998:	Progress report of field activities and surveys;
December 31, 1998:	Final report for 1998 non-field season;
April 15, 1999:	Annual report for 1998 studies and logistics progress report for 1999;
May 30, 1999:	Progress report of all project activities;
October 30, 1999:	Progress report of field activities;
December 31, 1999:	Final report for 1999 field season;
April 15, 2000:	Annual and final project report.

During FY 99 it is anticipated that at least one manuscript will be submitted for publication. It will be entitled "Structure and habitat associations in bivalve assemblages from Beauty Bay and North Arm Bay, Alaska" by the principle investigator, Peter Armato. This manuscript will present the results of the FY 99 field season. It is anticipated that this manuscript will be submitted to either *Marine Biology* or *Ecology*. It is also anticipated that manuscripts will be prepared describing molluscan predator prey relationships and the relationships between living molluscs and empty shells. The titles of these manuscripts have not been determined, nor have the journals to which they will be submitted. The senior author will be the principle investigator.

PROFESSIONAL CONFERENCES

Project investigators plan to attend the *EVOS* annual Restoration Workshop. As data becomes available and results publishable, project investigators will present results at applicable conferences and workshops.

NORMAL AGENCY MANAGEMENT

This project is funded entirely by the Trustee Council as a restoration project. Although clams have been identified as an injured species whose recovery is unknown and are integral components of many food webs, decreased NPS funding levels and declining staff preclude NPS from conducting this work. NPS conducts no other molluscan population dynamics studies in the project area. Because the clam populations to be studied occur below mean high tide line, NPS is not the regulating agency for clam subsistence harvest activities. However, NPS has a responsibility to provide all data gathered to the regulating agency(s) and to Native subsistence boards. Peter Armato (NPS) is conducting this research as principal investigator because of his many years of experience investigating molluscan population trends in cool temperate to sub-Arctic conditions. Without the results from this project, information defining the recovery status of clams in the study area, and possibly other portions of the spill area, will not be known.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is a multidisciplinary, inter-agency effort. Inclusion of interdisciplinary components will ensure that all data are shared and interpreted in an interdisciplinary manner. All data will be shared with regulating agencies, bivalve clam, APEX, and other interested researchers, English Bay Corporation, and other interested Alaska Native subsistence groups.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Not applicable, this is a new project proposal.

PROPOSED PRINCIPAL INVESTIGATOR IF KNOWN

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PERSONNEL

The DOI-NPS Principle Investigator/Project Leader (Armato) will be accountable for project administration and field operations including literature review, data management, quality control, permits, reports, publications, budget/fiscal management. His Seward office is located in close proximity to the study area. Technical expertise specific to the area and logistical knowledge of the local waters important to safety and efficient implementation of the field portion of the project also rests with the project leader. Specimen preservation and identification will be completed at the Alaska SeaLife Center (Armato). Data analysis will be conducted at Kenai Fjords National Park (Armato).

Peter Armato has conducted research on modern and fossil marine molluscs and their relationship to the marine hydroclimate since 1970 (Bodega Marine Laboratory; Bolinas Marine Laboratory; School of Oceanography, University of Washington; Western Washington University; and MacKay School of Mines, University of Nevada-Reno). His work with marine molluscan fossils includes studies of: 1) the paleoecology of molluscan assemblages of Fossil Hill, Nevada; 2) the structure and habitat associations in molluscan assemblages from the upper Eocene Pysht and lower Miocene Clallam Formations, northwestern Washington; 3) the paleoenvironment of Oligocene Alsea Formation, Oregon; 4) molluscan predator/prey relationships in the Green River Formation and the Lincoln Creek Formation, Washington. His work in modern marine environment includes: 1) the structure and habitat associations of invertebrate assemblages at Alkai Point, Washington; 2) predation by drilling gastropods on infaunal bivalves and the effects of size, species preference, density and tidal range at Double Bluffs Beach, Whidby Island, Washington; 3) the structure and habitat associations of infaunal bivalves at Limantour Spit, California; and 4) molluscan intertidal zonation at Bodega Head, California.

Related Presentations:

1995 Effects of disturbance on deep-sea macro-benthos. (Redwood National Park)

1994 Post disturbance colonization in deep-sea ecosystems. (Redwood National Park)

1993 Structure and habitat associations in molluscan assemblages from the Pysht and Clallam Formations, Olympic Peninsula, Washington. (Western Washington University)

1990 Biogenic sediment mounds, infaunal disturbance and bioturbation in the bathyal deep sea. (Western Washington University)

1988 The marine invertebrate paleoecology of Lone Mountain, Nevada. (Western Washington University)

1987 Paleothermometry in the oceans. (University of Washington)

1987 Paleoclimatology on the continents. (University of Washington)

Manuscripts in Preparation:

Armato, P.J., 1997. The occurrence and distribution of the bivalve Anadara in the lower Miocene Clallam Formation, northwestern Olympic Peninsula, Washington. (Canadian Journal of Geology)

Armato, P.J., 1997. Bivalve preservation and the recognition of rapid, episodic deposition in the lower Miocene Clallam Formation, northwestern Olympic Peninsula, Washington. (Canadian Journal of Geology)

Armato, P.J., 1997. Prey selection by drilling gastropods in the upper Oligocene Pysht Formation, northwestern Olympic Peninsula, Washington. (Canadian Journal of Geology)

Armato, P.J., 1997. Anadara, an indicator of cool marine hydroclimate in the lower Miocene Clallam Formation, Olympic Peninsula, Washington. (Palios)

Armato, P.J., 1997. Functions of shell architecture in the bivalve Anadara. (Paleobiology)

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Boehm, P.D., Steinhauer, W., Cobb, D., Duffy, S., and Brown, J., 1984. Chemistry 2: analytical biogeochemistry - 1983 study results. (BIOS) Baffin Island Oil Spill Working Report 83-2: 139 p. Environmental Protection Service, Environment Canada, Ottawa.

Elmgren, R., Hansson, S., Larsson, U. and Sundelin, B., 1981. The Tsesis oil spill; acute and long-term impact on the benthic ecosystem: National Oceanic and Atmospheric Administration, Boulder, Colo.

Gilfillan, E.S., and Vandermeulen, J.H., 1978. Alterations in growth and physiology of soft shelled clams Mya arenaria, chronically oiled with Bunker C from Chedabucto Bay, Nova Scotia, 1970-1976: Jour. Fish. Res. Board Can. 35:630-636.

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

Budget Category:	Authorized FY 1997	Proposed FY 1998						
Personnel		$17.8						
Travel		$5.1						
Contractual		$1.5						
Commodities		$1.3						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$25.7		Estimated FY 1999	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002	
General Administration		$2.8						
Project Total	$0.0	$28.5		$25.0	$5.0	$0.0	$0.0	
Full-time Equivalents (FTE)		1.4						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Year 01 of this project consists of conducting the clam literature review and constructing the clam habitat association model. Year 02 consists of conducting the field portion of the study , testing and refining the clam habitat association model and use of the Alaska SeaLife Center for specimen identification and preservation. All materials generated by this project will be stored at the National Park Service and UAF. Year 03 of this project consists of writing paper(s) for peer reviewed journals and completing the final report.

1998

Prepared: 6 of 13

Project Number: 98355
Project Title: Bivalve Clam Literature Review, Clam Habitat Association Model and Field Investigation
Agency: DOI/NPS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/15/97

1998 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1998
Vacant	Graduate Research Assistant	GS-6	7.0	0.5		3.5
Vacant	Graduate Research Assistant	GS-6	7.0	0.5		3.5
Vacant	Biometrician-Model Construction	GS-12	3.0	3.6		10.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		17.0	4.6	0.0	
					Personnel Total	$17.8

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1998
Seward - Fairbanks (PI meet with and train Research Assistants)	0.3	1	5	0.2	1.3
Seward - Fairbanks (PI progress consultation with Research Assistants)	0.3	2	4	0.2	1.4
Seward - Anchorage (PI meet with Biometrician/model construction)	0.1	3	6	0.2	1.5
Seward - Nanwalek (PI meet with village subsistence harvesters)	0.3	1	3	0.2	0.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$5.1

1998

Project Number:
Project Title: Bivalve Clam Literature Review, Clam Habitat Association Model and Field Investigation
Agency: DOI/NPS

FORM 3B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET
October 1, 199/ - ›eptember 30, 1998

Contractual Costs:	Proposed
Description	FY 1998
Long distance phone calls	1.0
Postage	0.2
Computer technology usage fee UAF ($5.00 per credit per semester and $0.10 per page printing fee)	0.3
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$1.5

Commodities Costs:	Proposed
Description	FY 1998
Misc. meeting supplies	0.3
Computer supplies and software for literature review	1.0
Commodities Total	$1.3

1998

Project Number:
Project Title: Bivalve Clam Literature Review, Clam Habitat Association Model and Field Investigation
Agency: DOI/NPS

FORM 3B
Contractual &
Commodities
DETAIL

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

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

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Equipment used by this project purchased with oil spill funds:		
Equipment used by this project not purchased with oil spill funds:		
Computers (2 x 486 or 586)	2	UAF
Computers (1 x 486 and 1 x 586)	2	DOI/NPS
Printers	2	UAF
Printer (HP Laserjet 5)	1	DOI/NPS

1998

Prepared: 9 of 13

Project Number:
Project Title: Bivalve Clam Literature Review, Clam Habitat Association Model and Field Investigation
Agency: DOI/NPS

FORM 3B
Equipment
DETAIL

4/15/97