19.12.03 (3of3)

Understanding the cellular processes of recovery and its utility in oil-spill restoration efforts

Project Number: ~~To be assigned~~ 03587

Restoration Category: Research, Monitoring

Proposer: EnVirtue Biotechnologies, Inc.

Lead Trustee Agency: NOAA
Cooperating Agencies: NOAA/ORR

Alaska SeaLife Center: No

Duration: 1-year project

Cost FY 01: $171,000

Geographic Area: Prince William Sound

Injured Resource/Service: Intertidal Communities; Commercial Fishing

ABSTRACT

The goal of this proposal is to elucidate the cellular and genomic mechanisms that affect the rate of recovery in bivalve species impacted by the Exxon Valdez oil-spill event. To this end, we propose to achieve the following two objectives: (1) determine the adverse affects of a long-term oil-spill exposure on specific processes of cellular physiology and genomic integrity that could potentially impede or slow the rates of recovery in populations of *Protothaca staminea*, and (2) determine the link between cellular-physiological condition with PAH-body burden in these two species of bivalves by characterizing these parameters in populations from sites that exhibit different levels of oil contamination. Completion of this work may provide a foundation to address questions critical to the issue of variable rates of recovery in both invertebrate and vertebrate species in oil-impacted areas. Understanding of the processes affected by an oil-spill exposure at all levels of the biological hierarchy may be critical for successful restoration of the impacted habitats and communities. Completion of this project will provide new and powerful tools to improve monitoring methodologies (particularly as a transitional bridge to GEM), as well as potentially providing valuable information for restoration efforts.

INTRODUCTION

Short-term effects of crude oil-spills are obvious and readily documented. Long-term effects and recovery processes of impacted species and ecosystems are much more difficult to recognize and demonstrate (3-7). One general issue concerning both short- and long-term effects of oil exposure is the recovery of a population or an ecosystem after a spill event. In this context, we define 'recovery' as a period of time when impacted populations stabilize and begin to track natural fluctuations observed at non-impacted habitats (8-11). Studies using various methodologies have grappled with the issue of physiological-, population-, community composition-, and habitat-level recovery from the *Exxon Valdez* oil-spill event (EVOS) (e.g., 5-7, 19-22). Results from these studies reflected fundamental differences in the ability of different methods to assess recovery, and more importantly, indicated that different aspects of recovery progress at different rates (5, 6, 22, 24). Such complexity in recovery processes makes assessing the long-term effects of environmental insults extremely difficult (25-31).

The difficulty in measuring the rates of recovery is exacerbated by the inability to *explain* the variable rates of recovery. Contaminant (oil) exposures or body-burdens of polynuclear aromatic hydrocarbons (PAHs) were initially considered as a potential means of linking contaminant exposure to specific biological consequences (16). That is, though several groups could readily documented the bioavailability of residual oil, they experienced much greater difficulty in interpreting biological effects of those hydrocarbons—especially direct effects as opposed to indirectly inferred impacts. Earlier attempts to link tissue burdens with biological parameters of resident organisms (histology, blood cell responses) were equivocal at best. Hence, attempts at illuminating recovery processes on the organismal level only seemed to make the processes more ambiguous.

The inability to understand the processes and mechanisms that underlie this variation of recovery can hinder efforts of restoration. "How clean is clean enough?" is a question crucial to restoration efforts and one that is dependent on organismal processes as much as it is on contaminant levels in the environment or organism. To illustrate, though PAH-body burdens may be significantly decreasing at some sites, rates of recovery have not accelerated, indicating that a stressor presence still exists. One explanation that is gaining popularity in the scientific literature is that the weathering process is altering the characteristics of the residual oil, increasing its toxicity in a means that makes it difficult to assess by standard chemical analysis. For example, adduction of benzo[a]pyrene diol epoxide (BPDE) to DNA or protein is not readily detectable by the organic fraction loaded onto a gas chromatograph or other type of organic analyzer (). Decreasing PAH-body burden content, but increasing BPDE-protein/DNA actually decreases the overall health and reproductive fitness of the organism – mechanistic effects that are perceptible on the population and community-structure level.

In 1999, a project initiated by U.S. NOAA's Hazardous Materials Response Division, in collaboration with U.S. NOAA's Marine Biotechnology Program, the College of Charleston, and EnVirtue Biotechnologies, Inc., examined cellular-level conditions in two Prince William Sound bivalve species, *Mya arenaria* and *Mytilus trossulus*, from areas within and surrounding the EVOS event. This project used a novel cellular diagnostic technology that had been laboratory and field-tested for a number of different marine and estuarine species. This technology, termed the Environmental Cellular Diagnostic System (ECDS), was developed to diagnose cellular-physiological condition, monitor stress responses, identify putative stressors, and forecast outcomes of environmental problems. The ECDS measures specific cellular and molecular parameters indicative of physiological condition. These parameters quantify specific cellular

physiological functions, including (1) whether the structural integrity of the cell is compromised, (2) the type or nature of the stress (e.g., oxidative stress, PAH stress), and (3) whether defenses have been mounted against a particular stress (i.e., pesticide, acidity, heavy metal, PAH) (**Fig.1**).

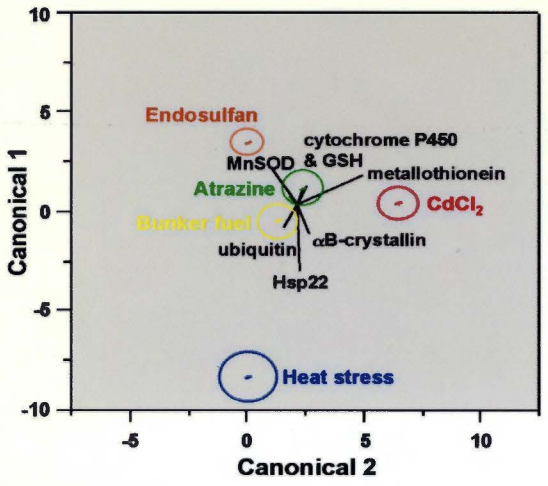

Fig. 1. Canonical centroid plot of standardized ECDS responses in estuarine snails. Original variates were biomarker levels expressed as a percentage of the control value in each experiment. Data from all experiments were combined for this figure, which is presented for heuristic purposes (hypothesis tests were performed separately for each experiment). Centroids of the distribution are marked with an x; circles around the centroids show 95% confidence intervals. Biplot rays show the directions of the original biomarker responses in this canonical space. Thus the biomarker metallothionein (which assays heavy metal stress) distinguishes cadmium chloride treatments from all others; Mn SOD differentiates endosulfan from the other treatments, etc. (Downs et al., 2001a.)

The objectives of this Prince William Sound study were to (1) determine whether bivalve populations continue to be affected by oil from the *Exxon Valdez* spill, (2) examine the effectiveness of various clean-up methods, and (3) examine the validity and utility of the ECDS as a tool for assessing recovery of communities after an oil spill. Results from this study indicated that the ECDS could be potentially used as a valid tool to assess oil-insult recovery in these species and to differentiate between sites that were remediated by different methodologies (**e.g. Table 1**). There were several caveats to this small study: it did not examine the relationship between body-burden of PAH with cellular physiological condition and (2) it did not try to link cellular-physiological level phenomena with higher-level processes, such as growth or fecundity.

TABLE 1. Summary of biomarker analyses of *Mya arenaria* from Bainbridge and Bay of Isle sites in Prince William Sound

	Non-oil-impacted area		Oil-impacted area		
	Bainbridge		Bay Isles		
Marker	Mean	SD	Mean	SD	significant difference?
BPDE	Not Detectable		35.133	17.486	yes + (p<0.0001) [W]
Cu/Zn SOD	1.379	0.388	4.957	0.822	yes + (p<0.0001)
Cyt P450	14.473	4.324	71.243	4.695	yes + (p<0.0001)
GPX	37.671	11.005	45.869	3.728	yes + (p<0.05)
GST	113.381	55.744	134.568	35.740	NS
HNE	16.028	1.466	39.660	13.065	yes + (p<0.002)
Hsp60	6.024	3.313	10.004	1.180	yes + (p<0.005)
Hsp70	36.688	30.259	318.557	73.893	yes + (p<0.0001)
Hsp90	27.587	14.788	41.127	17.351	NS
MDA	2.877	6.072	8.829	10.301	yes + (P<0.005) [W]
Mn SOD	76.218	54.893	94.503	61.074	NS
sHsp	Not detectable		43.439	18.278	yes + (p<0.0001) [W]
Ubiquitin	6.852	1.381	49.574	9.753	yes + (p<0.0001)

From Downs et al., 2002 (32);
BPDE=benze(a) pyrene diol expoxide adducted to protein, a measure of PAH contamination

In a serious effort to adapt this biotechnology to address issues crucial to oil-spill restoration, means of identifying key cellular processes that are directly affected by biologically reactive PAHs and whose activity can affect higher-order phenomena (e.g. fecundity, homeostasis) have been recently developed that were not available during the 1999 EVOS project described above. For example, we have developed new means for assaying damage to genomic integrity (DNA)-damage that can directly affect offspring viability/fitness and life span. Additionally, assays have been developed to directly measure content of BPDE-DNA and protein. Furthermore, several assays have been developed or 'improved' to assess cellular responses to xenobiotic toxicity/exposure.

NEED FOR THE PROJECT

A. Statement of Problem

The proposed work addresses two issues central to monitoring and restoration. The proposed work seeks to determine the link between PAH contaminant level of a bivalve species with cellular-physiological condition and genomic integrity. Such a foundation can be used to fully investigate the causal relationship between PAH content with the effects of chronic, sub-lethal toxicity. Secondly, the proposed work will characterize the relationship with cellular-physiological condition and genomic integrity to higher-order phenomena that is traditionally used to assess recovery, such as population density, recruitment, and community structure. By permitting us to link tissue concentrations of contaminants to biological consequences, cellular approaches like ECDS can provide a scientific basis for answering the "how clean is clean?" question that arises at all spills. The ECDS, used in conjunction with other assessment methodologies, can also potentially provide a way to isolate stresses attributable to a spill or other disturbance from those unrelated to such incidents, and thus can represent a much more meaningful baseline measurement against which future changes can be assessed.

Unlike many of the other approaches that have been used to link exposure to impact, the cellular diagnostic technique can be adapted (with the selection of appropriate assays) to provide physiological stress information across the spectrum of biota, from plants to marine mammals. Because it is clear that oil and other environmental contaminants affect different species in different ways, over time the accumulation of data in a wide range of biota will permit the identification of more sensitive or at-risk components of the ecosystem.

In addition to a pilot project in FY00 initiated under the auspices of NOAA/OR&R's long-term monitoring program, the molecular biomarker approach is also being incorporated into the Olympic Coast National Marine Sanctuary's research and monitoring program to assess current biological condition of selected organisms as well as provide a baseline against which future impacts can be quantified.

B. Rationale/Link to Restoration

As the transition is made from Restoration to GEM, the value of a biological framework within which to interpret chemistry results is only increased. The combination of chemistry and cellular diagnostic markers provides a powerful tool for evaluating exposure to contaminants and stress induced by other environmental parameters, as well as the biological significance of that

exposure. In the Restoration Program, we continue to evaluate impact from the *Exxon Valdez* spill; in Gulf Ecosystem Monitoring, we are interested in assessing present status and large-scale changes. The molecular biomarker approach provides a natural bridge between the two programs since it can be used for both purposes.

C. Location

Sample collections of *Protothaca staminea* will occur in Prince William Sound. Sample locations will be selected after consultation with field participants in the 2001 shoreline oiling assessment conducted by the NOAA/NMFS Auke Bay Laboratory. Cellular diagnostic analyses will take place at EnVirtue Biotechnologies in Walnut Creek, CA. Chemical analysis for hydrocarbons will occur at Mote Marine Laboratory (Center for Eco-toxicology) in Sarasota, Florida.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Outside of the scientist and resource managers who may have an interest in the results of this study, residents of Native communities in the spill-affected area also will be made aware of the findings. Because *P. staminea* in particular is an important subsistence resource for community members, the recovery and health status of these clam populations represents information that will be shared by the investigators through direct distribution of findings to Native corporations and communities. The results will be very relevant to restoration efforts involving attempts to establish or augment clam beds in the spill-affected area.

Initial site selection will rely substantially on input from field personnel who surveyed the shorelines of Prince William Sound in 2001; we also propose to survey residents of Tatitlek and Chenega Bay to determine areas of concern as well as relatively unimpacted areas.

PROJECT DESIGN

A. Objectives

The goal of this proposal is to elucidate the cellular and genomic mechanisms that affect the rate of recovery in bivalve species impacted by the *Exxon Valdez* oil-spill event. To this end, we propose to achieve the following two objectives:

1. Determine the adverse affects of a long-term oil-spill exposure on specific processes of cellular physiology and genomic integrity that could potentially impede or slow the rates of recovery in populations of *Protothaca staminea.*

2. Determine the link between cellular-physiological condition with PAH-body burden in these two species of bivalves by characterizing these parameters in populations from sites that exhibit different levels of oil contamination.

The project will serve to further define how to apply cellular and molecular technologies to relevant environmental assessment.

B. Methods

Field collection methods are relatively simple and straightforward, although some field processing and access to low-temperature storage will be necessary. Laboratory methods for ECDS assays, chemical analysis, and laboratory challenges are relatively complex and are summarized below.

Sampling Design and Statistical Analyses

We will use a nested (or "hierarchical") sampling design (33) that allows variation in mean clam responses to be partitioned: 1) between oiled versus unoiled locations, 2) among locations within each oil spill category, 3) among transects within locations, and 4) within transects. *Protothaca staminea* will be collected from eight locations; four extensively oiled locations, and four with minimal or no oiling. At each location, we will randomly select three sites and deploy 2 m x 10 m belt transects, which will be subdivided into five, 2 m x 2 m quadrats. Within each quadrat, we will collect 8 clams, with the goal of obtaining at least one gravid female for analysis of ECDS parameters and reproductive condition. Thus, we will sample 1 gravid female clam per quadrat; 5 per transect; 15 per location; and 120 total. Remaining clams will be reserved for analysis of hydrocarbon chemistry.

Analysis of this design is by nested analysis of variance (ANOVA), which is described in most statistical textbooks (i.e., 33). A skeleton ANOVA table is below. Based on a previous study of diagnostic markers in *Protothaca staminea*, sample sizes are sufficient to detect biologically meaningful differences, if they exist; significant F-ratios varied from 4.92-753.2 in Downs et al. (in review).

Source of variation	df	critical F-ratio	If $F_{test} > F_{crit.}$
Between oiled & unoiled locations	1	$F_{1,6} = 5.99$	(1)
Among locations within spill type	6	$F_{6,8} = 3.58$	(2)
Among transects within locations	8	$F_{8,12} = 2.85$	(3)
Among individuals within transects	12	$F_{12,92} = 1.88$	(4)
Error	92		
Total	119		

Interpretations:

(1) Mean biomarker levels differ significantly between oiled and unoiled locations.

(2) Mean biomarker levels differ significantly among sites within the oiled and unoiled categories. Thus, there is significant variation from location to location, in addition to any difference between oiled and unoiled locations.

(3) Mean biomarker levels vary significantly among transects within sites. Thus, sites are not homogeneous; there is significant variation within them, which may relate to degree of exposure, substrate composition and weathering, etc.

(4) Mean biomarker levels vary significantly among individuals sampled within transects. Thus, individuals are not homogeneous even within transects; there may be variation among them based on age, size, sex, duration or degree of exposure, and/or other factors.

Field Collections

Clams collected from each quadrat will be placed in an aluminum mesh bag, each bag individually labeled, and placed on dry ice within 10 minutes of initial handling. All samples

will be shipped on dry ice to EnVirtue Biotechnologies, Inc. upon which the samples will be transferred to a –80°C storage freezer until sample preparation.

Cellular Diagnostic Analysis

All samples will be prepared in a homogenization buffer (EnVirtue Cat# DB-102) as described in Downs et al., 2002 (32). Protein concentration for all samples will be determine as described in (32). Samples will be diluted to a concentration of 25 nanograms per 100 microliters. Samples will then be subject to ELISA using a Beckman-Coulter Biomek 2000 robotic ELISA machine with 96-well or 384-well high-binding capacity microplates. Samples will be assayed for cellular biomarker listed in Table 1, as well as assayed for an additional 15 biomarkers that describe heavy-metal responses, oil-based xenobiotic detoxification pathways as well as genomic integrity and DNA repair pathways.

A description of the cellular function for each one of these diagnostic markers can be found in Downs et al., 2000; Downs et al., 2001a, 2001 (34, 35); or requested from EnVirtue Biotechnologies, Inc as product information/MSDS literature (www.envirtue.com).

Samples are assayed in triplicate using a 96-well plate format. To ensure plate-to-plate consistency, random triplicate samples that were originally arrayed on separate plates are placed on a single plate. On each plate, columns 1, 5, and 9 are plated with the appropriate absolute standard for each of the ELISAs. Detection is via a proprietary chemiluminescence.

Quality Control Measures:

1. To validate that the above antibodies specifically cross-react with the appropriate protein/epitope and are absent of any non-specific cross-reactivity, homogenized sample of *Protothaca staminea* will be subject to SDS-PAGE/western blotting for each of the above antibodies and the secondary antibody as described in (32, 34, 35).

2. For 96-well plate ELISAs, background levels are determined *Protothaca staminea* samples, each EnVirtue concentration standard (ECS), each primary antibody, secondary antibody, blocking buffer, and wash buffer. From the information obtained from each optimization protocol, a method was synthesized for the optimal amount of *Protothaca staminea* total soluble protein, ECS standard, antibody titer, incubation period, the number of washes, and blocking solution concentration.

3. The concentration of *Protothaca staminea* total soluble protein per well is determined for the linear/curvilinear range of each antibody and ECS.

Plates are read using a multi-functional microplate reader and the data transferred to a Microsoft Excel spreadsheet. Concentrations of standards are calculated values of known concentration standards. No absolute standards are known to exist at the U.S. National Institutes of Standards and Technology. Included on each data spreadsheet are:

- Raw data generated from the microplate reader
- Designation of the mole concentration for each of the standards
- A regression plot of the absolute standard concentrations vs. detection units
- The concentration average of each sample for 25 ng total soluble protein

- The concentration average of each sample expressed as concentration per 1 ng total soluble protein

Chemistry Laboratory: Aromatic Hydrocarbons

Tissue hydrocarbon analyses will be performed at Mote Marine Laboratory. Methods are modified from the procedures described in (36, 37). Tissues from a given site will be extracted from shells and composited. The composite samples are homogenized in a blender and refrigerated in solvent-rinsed jars with Teflon®-lined caps before further sample preparation. If delay of more than two days is anticipated, the samples are frozen. For analysis, a small aliquot, 10 g, of the homogenized tissue is added to precleaned and solvent-rinsed vials. The samples are digested overnight by adding a single pellet of potassium hydroxide. To enhance the digestion, the samples are sonicated and swirled periodically. The samples are then spiked with a surrogate standard suite. The samples are dried with anhydrous sodium sulfate until the consistency of dry sand is attained and then these are extracted three times with dichloromethane. The extracts are combined into a single rotary-evaporation flask and reduced to less than 4-ml volume. At this time, the sample extract is transferred into 4-ml vials and reduced in volume further by nitrogen blow-down. The solvent is exchanged into hexane and reduced to 100 µl.

Sample fractionation, or cleanup, is required to enrich the target analytes while at the same time excluding matrix interferences. Sample fractionation is performed using silica-gel/alumina columns. The columns are calibrated to elute the desired analytes from the column in the aromatic fraction. This fraction is eluted into conical 4-ml volumetric vials and reduced to a final extract volume of 1ml before instrumental analysis. The target analytes are quantified by an internal standard method and corrected for recovery using surrogate standards.

Dry weights are determined by weighing a small amount of the homogenized tissue on a pre-conditioned, pre-numbered, and pre-weighed tin. The tin is placed into a drying oven at 90 C for 24 hours, then re-weighed.

Fecundity

Littleneck clams *Protothaca staminea* can be reproductively active from April to October when water temperatures exceed 15°C (38, 39). Clams will be harvested 2-3 weeks before spawning, and stored frozen until analysis. Clams will be processed in the laboratory, and the female gonads extracted. Excessive liquid will siphoned off using a kim wipe, and weighed. After which, the gonad tissue is incubated in a diapase proteolytic solution of a known volume/density to dissolve the extracellular matrix material. The sample is centrifuged at 1,000 g for 8 minutes to pellet out all the eggs. One hundred uL of supernatant volume is then weighed to determine the new density of the solution. The egg pellet is resuspended in a specific volume of PBS (density of PBS is known) and then weighed. After which, 50 uL of 'egg' solution is applied to a Coulter Counter cell counting device to measure the number of eggs per volume. Values obtained in this matter are then used to calculate the gonadal-tissue weight: egg weight ratio and the density of eggs per individual.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This represents a collaborative effort between industry, a non-profit research foundation, an academic institute, and NOAA/OR&R to refine, validate, and apply a new technology to real environmental problems. EnVirtue Biotechnologies, Inc. is the leader in environmental biotechnology innovation, providing novel and important tools for environmental assessment. Sound and rigorous experimental design with extensive knowledge and experience concerning the EVOS event is required for valid use of any technology or methodology. College of Charleston will construct the experimental sampling design for this project, as well as lead the statistical analysis of the data. NOAA/OR&R has extensive experience in defining critical issues in monitoring impact and recovery and will help in the determining the experimental sampling design as well as lead sampling logistical operations. The Center for Eco-toxicology at Mote Marine Laboratory has extensive experience with the technologies and methodologies in examining the chemical characterization and effects of oil and oil-dispersant toxicology. Kevin LeBlanc of the federal Canadian agency, Fisheries and Oceans Canada, is an expert on clam reproduction, monitoring, and stock assessment.

Personnel and project management

The project will be implemented by an experienced team of scientists who have been directly involved in intertidal research, monitoring studies, and cellular diagnostic biotechnology development. The work will be coordinated by EnVirtue Biotechnologies, Inc., with Craig Downs as the project leader.

Responsibilities for each of the participating offices is as follows:

EnVirtue Biotechnologies—Walnut Creek, CA (Downs)
- Overall project management
- Contracted molecular biomarker analytical support
- Assist in field sampling
- Co-author on manuscripts

NOAA/Office of Response & Restoration—Seattle, WA (Shigenaka)
- Field sampling
- Assist in data analysis
- Co-author on manuscripts

University of Charleston—Charleston, SC (Fauth)
- Subcontracted biological support
- Assist in field sampling
- Lead for statistical analysis
- Co-author on manuscripts

Mote Marine Laboratory – Sarasota, FL (Wetzel)
- Contracted chemistry support
- Hydrocarbon chemical analyses
- Data interpretation
- Assist in manuscript writing

SCHEDULE

A. Measurable Project Tasks for FY 02 (includes FY03 carryover tasks from FY02)

Field sampling will be conducted in February 2003; laboratory analysis will commence March and April 2003; data analysis will take place in August, 2003. A progress report will be prepared at the end of FY03 (September 2003), with the final report to be completed by the end of December, 2003.

B. Project Milestones and Endpoints (includes FY03 carryover tasks from FY01)

All field work will be completed by March, 2003. The final report for the work will be complete by the end of calendar 2003.

October 1, 2002:	Project initiation
October 3, 2002:	PI project planning/logistics meeting
January 2003:	Trustee workshop, Anchorage
February 28, 2003:	Field sampling in PWS and Lower Cook Inlet completed
March-April, 2003:	Begin laboratory analyses (chemistry & biomarkers)
August 1, 2003:	Laboratory analyses complete, begin statistical analysis
September 2, 2003:	PI meeting, location TBD
September 30, 2003:	Progress report/report draft
December 31, 2003:	Final project report completed

C. Completion Date

It is anticipated that the project will be completed by January 2004.

PUBLICATIONS AND REPORTS

The final report for the project will be issued as a NOAA Technical Memorandum. It is also our intent to submit the results of this experiment to a peer-reviewed journal for publication, to be determined at a later date.

PROFESSIONAL CONFERENCES

No funding is being requested for attendance at professional conferences in FY03. Funding for conferences following the completion of the project and interpretation of results may be solicited from supporting agencies in FY04.

NORMAL AGENCY MANAGEMENT

Methodological validation and mechanistic discovery will encourage incorporation of molecular biomarker approaches into impact assessment and baseline monitoring for response, NRDA, and restoration purposes – such as NOAA/OR&R's long-term monitoring program in Prince William Sound.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This is a relatively straightforward sampling and analytical program, but there is potential for collaboration with universities or other agencies that may wish to add other measures of biological effect (such as histopathology) to correlate with cellular assays. We would encourage this. Similarly, if researchers have an interest in tissue chemistry analytes beyond the targeted PAHs, aliphatics, and metals, it would be relatively easy (with modest additonal funding) to expand the suite of results. Finally, the OSRI will be invited to accompany the field team during sampling of small boat harbors so that an understanding of the project is encouraged and to facilitate outreach concerning source control in each location.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

None

PROPOSED KEY INVESTIGATORS

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BIOGRAPHICAL SKETCHES FOR PRINCIPAL INVESTIGATORS

Craig A. Downs is a principal investigator CEO of Envirtue Biotechnologies, Inc. He is a graduate of Hiram College (B.A., philosophy & biological science, 1993), Syracuse University

(M.Sc., biological science, 1997), and University of California – Berkeley (comparative biochemistry, pending). Downs, as a past researcher in U.S. NOAA's Marine Biotechnology Program, initiated projects to develop technologies based on cellular and biochemical principles and methods to address estuarine and marine ecological issues (e.g., coral bleaching, coral disease, molecular biomarkers).

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

John Fauth is a co-principal investigator for this project. Dr. Fauth received his Ph.D. from Duke University in ecology and evolution. Dr. Fauth has collaborated extensively with U.S. NOAA and Envirtue Biotechnologies to aid in the experimental design and statistical analysis of environmental assessment project using the ECDS along with other traditional methodologies of assessment.

Dana Wetzel is a co-investigator for this project. A graduate of Texas A&M University (B.S., Biochemistry, 1979) and the University of South Florida (M.S. Marine Science, 1995; Ph.D., Marine Science, 2000). She is the program manager for Aquatic Toxicology at Mote Marine Laboratory, Sarasota, Florida with extensive experience in petroleum hydrocarbon contamination and toxicology studies, environmental monitoring of contaminants in both national and international programs and is also working on developing biomarkers of contaminant stress in various marine mammals.

LITERATURE CITED

1. Clark, R. B. *Phil. Trans. R. Soc. London B.* **1982**, 297, 433.

2. Fukuyama, A. K.; Shigenaka, G.; Hoff, R. Z.; Mar. *Poll. Bull.* **2000**, 40, 1042.

3. Mann, K. H.; Clark, R. B.; *J. Fish. Res. Board Canada* **1978**, 143, 79.

4. Teal, J. M.; Howarth, R. W.; *Environ. Manag.* **1984**, 8, 27.

5. Thomas, R. E.; Harris, P. M.; Rice, S. D.; *Comp. Biochem. Physiol. Part C.* **1999**, 122, 147.

6. Thomas, R. E.; Brodersen, C.; Carls, M. G.; Babcock, M.; Rice, S. D.; *Comp. Biochem. Physiol. Part C.* **1999**, 122, 153.

7. Monson, D. H.; Doak, D. F.; Ballachey, B. E.; Johnson, A.; Bodkin, J. L.; *Proc. Natl. Acad. Sci. USA.* **2000**, 97, 6562.

8. Skalski, J.R., Coats, D.A., Fukuyama, A.K.; *Env. Manage.* **2001**, 28, 9.

9. Holloway, M.; *Sci. Am.* **1996**, 275, 82.

10. Allen, T. F. H. *Bull. Ecol. Soc. Am.* **1984**, 65, 54.

11. Goodmman, E. *Q. Rev. Biol.* **1975**, 50, 237.

12. Odum, E. P.; Finn, J. T.; Franz, E. H.; *BioScience* **1979**, 29, 349.

13. Coats, D. A.; Imamura, E., Fukuyama, A. K; Skalski, J. R.; Kimura, S; Steinbeck, J; *NOAA Technical Memorandum. NOS OR&R.* **1999**, 1, 73.

14. Spies, R. B.; Rice, S. D.; Wolfe, D. A.; Wright, B. A.; In Proceedings of the Exxon Valdez Oil Spill Symposium. Spies, R. B., Rice, S. D., Wolfe, D. A., Wright, B. A. Eds. American Fisheries Society: Bethesda, 1996: pp1-16.

15. Houghton, J. P.; Lees, D. C.; Driskell, W. B.; Lindstrom, S. C.; *NOAA ORCA Technical Memorandum 110*, **1995**, 1.

16. Shigenaka, G.; Henry, C. B.; In Exxon Valdez Oil Spill: Fate and Effects in Alaskan Waters. Wells, P.G., Butler, J.N., Hughes, J.S. Eds. American Society for Testing and Materials. Ann Arbor, Michigan. **1996**, p. 239-260.

17. Maki, A. *Environ. Sci. Technol.* **1991**, 25, 24.

18. Wolfe, D. A.; Clark Jr., R. C.; Foster, C. A.; Hawkes, J. W.; Macleod Jr., W. D. In *Amoco Cadiz: Fates and Effects of the Oil Spill.* Proc. Intl. Symp. **1981**, pp. 599-616.

19. Boehm, P. D.; Page, D. S.; Gilfillan, E. S.; Bence, A. E.; Burns, W. A.; Mankiewicz, P. J.; *Environ. Sci. Technol.* **1998**, 32, 567.

20. Carls, M. G.; Babcock, M. M.; Harris, P. M.; Irvine, G. V.; Cusick, J. A.; Rice, S. D.; *Mar. Environ. Res.* **2001**, 51, 167-190.

21. Dean, T. A.; Stekoll, M. S.; Jewett, S. C.; Smith, R. O.; Hose, J. E.; *Mar. Poll. Bull.* **1998**, 36, 201.

22. Sol, S. Y.; Johnson, L. L.; Horness, B. H.; Collier, T. K.; *Mar. Poll. Bull.* **2000**, 40, 1139.

23. Stekoll, M. S.; Deysher, L.; *Mar. Poll. Bull.* **2000**, 40, 1028.

24. Seiser, P. E.; Duffy, L. K.; McGuire, A. D.; Roby, D. D.; Golet, G. H.; Litzow, M. A. *Mar. Poll. Bull.* **2000**, 40, 152.

25. Schaeffer, D. J.; Herricks, E. E.; Kerster, H. W.; *Environ. Manag.* **1988**, 12, 445.

26. Stomp, A. M. *Environ. Health Perspect.* **1994**, 102, 71.

27. Rapport, D. J. *J. Aquatic Ecosystem Health* **1995**, 4, 97.

28. Wrona, F. J.; Cash, K. J.; *J. Aquatic Ecosystem Health* **1996**, 5, 89.

29. Costanza, R.; Mageau, M.; *Aquatic Ecol.* **1999**, 33, 105.

30. Campbell, D. E.; *Environ. Sci. Tech.* **2001**, 35, 2867.

31. Petersen, C. H.; McDonald, L. L.; Green, R. H.; Erickson, W. P.; *Mar. Ecol. Prog. Ser.* **2001**, 210, 255.

32. Downs, C.A.; Shigenaka, G.; Fauth, J; Robinson, C; Huang, A.; *Environ. Sci. Tech.* In review. 2002.

33. Sokal, R.R.; Rohlf, F. J.; Biometry. W.H. Freeman and Company: New York, 1995.

34. Downs, C. A.; Fauth, J. E.; Woodley, C. E.; J. Exp. Mar. Biol. Ecol. 2001a, 259, 189.

35. Downs, C. A.; Fauth, J. E.; Woodley, C. E; Mar. Biotech. 2000, 3, 3.

36. Lauenstein, G.G. and A.Y. Cantillo, eds. 1993. NOAA Technical Memorandum NOS ORCA 71, Sampling and analytical methods of the National Status and Trends Program National Benthic Surveillance and Mussel Watch Projects 1984-1992, Volume III, Comprehensive descriptions of elemental analytical methods. 219 pp.

37. Wetzel, D.L., P.M. Sherblom, E.S. Van Vleet, R.H. Pierce, M.S. Henry and D. Kelley. 1997. Environmental distribution of oil-related hydrocarbons following a spill of No. 6 fuel oil in Tampa Bay. Pp. 32-54. In, Gulf of Mexico and Caribbean Oil Spills in Coastal Ecosystems: Assessing Effects, Natural Recovery and Progress in Remediation Research. Eds., E.C. Proffitt and P.F. Roscigno. U.S. Dept. Of Interior. New Orleans.

38. Giese, A. and J. Pearse. 1979. Reproduction of Marine Invertebrates: Volume V. Academic Press. New York. 352pp.

39. Hetrick, J. 1995. The hatchery production of the Alaskan littleneck clam (Protothaca staminea). J. Shellfish Res. Vol. 14 (1)

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 02	Proposed FY 03	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$18.0						
Travel		$19.0						
Contractual		$127.0						
Commodities		$1.0						
Equipment		$6.0						
Subtotal	$0.0	$171.0	Estimated FY 04					
Indirect								
Project Total	$0.0	$171.0						
Full-time Equivalents (FTE)		0.3						
			Dollar amounts are shown in thousands of dollars.					
Other Resources								

Comments:

FY03

Prepared: April 9, 2002

Project Number: 03587
Project Title: Understanding the cellular processes of recovery and its utility in oil-spill restoration efforts
Name: Craig A. Downs

FORM 4A
Non-Trustee
SUMMARY

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 03
John Fauth	Statistical analysis/sampling		2.0	6.0		12.0
Craig Downs	Project Director		1.0	6.0		6.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		3.0	12.0	0.0	
					Personnel Total	$18.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 03
John Fauth	2.0	1	8	0.1	2.8
Craig Downs	0.5	2	20	0.1	3.0
Kevin LeBlanc	2.0	1	16	0.1	3.6
Gary Shigenaka	0.5	2	16	0.1	2.6
PI planning meeting November 2003	0.5	2	2	0.1	1.2
Trustee workshop January 2003	2.0	2	6	0.1	4.6
PI meeting September 2003	0.5	2	2	0.1	1.2
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$19.0

FY03

Prepared: April 9, 2002

Project Number:
Project Title: Understanding the cellular processes of recovery and its utility in oil-spill restoration efforts
Name: Craig A. Downs

FORM 4B
Personnel
& Travel
DETAIL

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Contractual Costs:	Proposed
Description	FY 03
PAH tissue analysis, between 40-80 samples, depending on variation	45.0
ECDS analysis serivce, base price $350/sample for 10 assays + seven additional assays + genomic-based assays est. 96 samples total	65.0
Fecundity study	7.0
Float plane + 7 days	10.0
Contractual Total	$127.0

Commodities Costs:	Proposed
Description	FY 03
dry ice	0.5
liquid nitrogen	0.5
Commodities Total	$1.0

FY03

Prepared: April 9, 2002

Project Number:
Project Title: Understanding the cellular processes of recovery and its utility in oil-spill restoration efforts
Name: Craig A. Downs

FORM 4B
Contractual & Commodities
DETAIL

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 03
Description			
Liquid nitrogen dry-shipper			6.0
			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**	$6.0

Existing Equipment Usage:	Number of Units	
Description		

FY03

Project Number:
Project Title: Understanding the cellular processes of recovery and its utility in oil-spill restoration efforts
Name: Craig A. Downs

FORM 4B
Equipment
DETAIL

Prepared: April 9, 2002

Development of an Alaska Standard Species for Marine Toxicity Testing – The Alaska Green Urchin

Project Number:	03594
Restoration Category:	Research
Proposer:	Dr. Robert A. Perkins, PE, Civil & Environmental Engineering, Institute of Northern Engineering, University of Alaska Fairbanks.
Lead Trustee Agency:	
Cooperating Agencies:	
Alaska SeaLife Center:	No
Duration:	1st year, 1 year project
Cost FY 03:	$117,300
Cost FY 04:	$0
Geographic Area:	Prince William Sound collections, research at UAF
Injured Resource/Service:	Analysis of several resources

ABSTRACT

This project will develop a standard marine toxicity testing procedure using cold water and an Alaska species. None of the standard test procedures required or recommended by EPA and other environmental regulators use cold-water test animals. Use of typical warm-water species to make decisions about Alaska conditions and species is unsatisfactory from a scientific standpoint, and this practice also interferes with public acceptance of the results. Decisions requiring toxicity testing include crude oil components, and cleanup chemicals, such as dispersants and beach cleaners. We propose developing the Alaska green urchin as a test species. Tests of urchin fertilization and embryo development are sensitive indicators of toxicity.

UAF Proposal # s00003075
INE02.74

INTRODUCTION

There is currently no standard cold-water test species for marine toxicity testing. We propose to develop the Alaska Green Urchin as a standard toxicity test species and develop test procedures that emulate, except for test water temperatures, standard EPA and ASTM toxicity testing procedures. Availability of a cold-water test species and standard test protocols aid restoration by facilitating scientific comparisons of residual oil, or its components, to similar tests in warm water. Use of a cold water test species will also help in evaluating the toxicity of cleanup chemicals and dispersants that might be used in restoration projects.

Scientific investigation of links between remaining oil in Alaskan waters and its lingering effects must take into account the relationship between the effects and amount of oil. This dose-response relationship is fundamental to applied toxicology. The dose-response relationship often provides insight into the underlying toxicological mechanisms as well. Effects on large species are sometimes observable in the natural environment; however the dose to which those species were exposed is often unknown. Common laboratory toxicity testing uses the immature life stages of small animals to test the effects of varying doses. The immature life stages are usually more sensitive to toxic chemicals than mature animals. The effects of chemicals on the environment are then estimated based on this laboratory testing.

For both regulatory and scientific purposes, it is necessary to compare the toxicity of chemicals to standard toxicants or situations. For such comparisons standard toxicity testing procedures have been promulgated by the EPA, ASTM, and others [USEPA 1995; ASTM 1996; USEPA 1991]. These procedures typically use 25° C test water and warm-water test species. It is difficult to compare toxicity testing conducted with cold-water species to warm-water species. Standard tests are sometimes extrapolated to cold-water species, but this method is scientifically undesirable, because physical-chemical characteristics of many contaminants change with water temperature and cold-water species may be more resistant or susceptible to the contaminant.

The Principal Investigator for this project reviewed all the standard warm-water test procedures and compared Alaska species to determine which species were most suitable. [Perkins 2000] On this basis the Alaska green urchin, *Strongylocentrotus droebachiensis,* was selected. The gametes of the urchin are used in two standard tests, one of fertilization and one of larval development. Green urchins do well in the laboratory; they are a food species for sea otters and humans (thus a notable part of the food chain); and an analogous test with the warm-water purple urchin is commonly reported in literature.

The goals of this research are to determine if:

1. The Alaska green sea urchin, maintained in a laboratory, is a viable cold-water marine toxicity test species;
2. There are major differences in toxicity testing procedures required between the Alaska Green urchin and the EPA standard, the California purple urchin; and
3. The test results are comparable, both with reference toxicants and industrial chemicals important to Alaska, such as oil and dispersants.

NEED FOR THE PROJECT

A. Statement of the Problem.

Restoration efforts are concerned with the toxicity of chemicals in several ways. The toxicity of lingering oil, or its various constituent chemicals, often must be determined. Similarly, the toxicity of oil dispersants and other chemicals, including nutrients, used in clean-up and restoration efforts are often tested. There are many standard marine toxicity tests; for example, the federal EPA [USEPA 1995] has recommended toxicity tests for wastewater discharge permits, the Corps of Engineers has tests for dredge spoil [UAEPA 1991], and the ASTM has promulgated some general standards [ASTM 1996].

The general procedure for toxicity testing with these standard tests involves exposing appropriate test species to various concentrations of the contaminant, and observing the test animals in order to determine what concentrations harm the test species. Typically, the very young life stages are tested, because these are most susceptible to harmful contaminants. The sufficiency of these standard tests for Alaska waters, however, is questioned for several interrelated reasons:

- The standard tests are all performed in 25° C water, a temperature about 20° C (40° F) warmer than Alaskan waters;
- The standard test species are not native to Alaska, and are intolerant of cold water; and
- The chemical and physical properties of many contaminants change in cold water.

Testing with the warm-water species may yield results that lead to incorrect environmental decisions which could either damage the environment or force inefficient and unnecessary procedures on otherwise useful processes. Also, the regulatory decision-makers and the public may have little confidence in testing processes based on warm-water species. Current testing with cold-water species is not comparable to the vast body of warm-water test results because the procedures often differ significantly and these differences are not reconciled.

The major objective of this proposed project is the evaluation of the Alaska green urchin as a practical species for marine toxicity testing, and dissemination of knowledge about the test methods developed as a result of this project. An important part of that evaluation is the comparison of the Alaska green urchin to the closely related purple urchin, which is a standard EPA test species. If the results between the purple and the green species differ significantly, the agencies involved need to know that test results from the warm-water urchin species are different than the cold-water, and the knowledge disseminated so that they specify the Alaska species in future applications. If the results are substantially similar, testing with the purple might be sufficient, and future testing with the green could be limited to Alaska-specific questions.

A successful outcome of the knowledge development portion of this project would be:

- Demonstration of the laboratory viability and practicality of testing the green urchin fertilization and embryo development in cold water in a laboratory without access to fresh seawater,
- Several technical papers and reports that indicate the green urchin is a practical cold-water test species, and
- Its comparison to warm water urchins and to other cold-water test species yielding consistent results.

The successful dissemination of the knowledge would be indicated by:

- Publication of those papers, presentation at marine toxicity-related conferences, and
- By agencies such as the ADEC and the USEPA reviewing the results and agreeing to accept the Green urchin tests in the future.

The principal investigator conducted a study of the toxicity of crude oil and dispersants to marine organisms, utilizing laboratories in Fairbanks and Seward. The work was funded by the ADEC and CROSERF (Chemical Response to Oil Spills, Ecological Effects Research Forum), a group sponsored by the American Petroleum Institute and state environmental agencies. The work in Fairbanks was conducted with standard test organisms purchased from lower-48 culture facilities and air freighted to Fairbanks. The work in Seward was done with larvae of the Tanner crab. While the testing of the crab larvae was successful – useful toxicity data was obtained - the schedule for obtaining the highly seasonal larvae and logistical difficulties of maintaining the larvae at a coastal location far from UAF's main laboratories indicated a need for a more practical test animal. The tremendous difference in expense per test procedure (between the standard test organism and the crab larvae) explains the very strong bias that organizations have against testing local species. This bias is bolstered by regulatory agencies, which have little experience with Alaskan test species, and are reluctant to specify their use .

Toxicity testing is required before a permit to discharge into the marine environment can be issued. The Corps of Engineers and the EPA regulate dredge spoil, and The EPA regulates wastewater as well. Cleanup of hazardous material spills is regulated by the EPA, except oil spills on land and freshwater, which are controlled by the ADEC. The Coast Guard, with advice from EPA and ADEC, controls cleanup of spills to marine waters. Regional Citizens Advisory Councils also advise the Coast Guard. Currently all these agencies will accept applications based on toxicity testing of organisms that are not native to Alaska. During public hearings, the issues of using non-native test species frequently arise. Agencies and permit applicants usually cite the impractically or unavailability of Alaska test species. The issues of whether Alaska species react differently to the chemicals in question, or whether the chemicals have different effects in cold water, remain unanswered. If an Alaska species were developed as a test subject that was both relevant and practical in terms of cost and maintenance, public acceptance of various projects would improve.

Similar to our work with Tanner crab, the Auke Bay Laboratory [2002] of NOAA's Alaska Fisheries Science Center has conducted toxicity testing with Alaska species, using their excellent marine facilities. A review of their work indicates the lab generally investigated toxicity to Alaska species. Significantly, this work employed specialized procedures, rather than correlating with standardized EPA procedures or developing an alternative standardized procedures.

In conjunction with other research projects, the PI has laid the groundwork for this project. Urchins were procured and housed in the Alaska SeaLife Center in Seward until a suitable tank, water environmental systems, and chiller were set up at UAF. Five green urchins have been maintained in a chilled seawater tank in the UAF Water & Environmental Research Center since June 2000. Several technical problems were solved such as chilling the water, insulating the holding tanks, feeding and cleaning regimens, use of artificial sea water and water cleaning systems.

B. Rationale/Link to Restoration

Currently there are no standardized marine toxicity testing procedures suitable for Alaska, although many standardized toxicity testing procedures for warmer waters exist. When evaluating chemicals in warm waters, there is extensive data comparing toxicity between different chemicals, but such data are not available for cold-water species. Similarly, many reports of toxicity of chemicals, especially oil, to Alaska marine organisms have been published, but these tests are often not comparable with tests to warm water species.

Ecosystem recovery following a severe insult is a long-term process. Evaluating the course of recovery involves assessing the current health of species populations; usually this health is implied by population counts. The numbers of any species in an ecosystem vary with time of year, but populations also seem to follow long-term cycles, the nature of which is often poorly understood. Relating current population to past environmental insults is an important part of assessing ecosystem recovery, but this relation should be regarded in a weight of evidence analysis, rather than as sole scientific proof. Toxicity testing provides additional evidence of relationship between insult and population. Such testing is often done with immature life stages, often with physically smaller species of a lower trophic level than the charismatic species observed by public or the species commercially harvested. As a practical matter, these tests are best done with standard species. Aside from laboratory practicality, the results of any particular test are better understood when they can be compared to results from tests on other species using the standardized testing procedures, or compared to tests of the same species using different toxicants.

Laboratory toxicity testing often leads to mechanistic data. In the laboratory it is possible to test with whole effluent or water taken directly from contaminated regions. It is also possible to vary the amounts of various contaminants in the test solution, as well as test conditions such as water temperature and UV light. [Barron, et al. 2002] Varying these conditions gives insight into the mechanism of toxicity. Relating these mechanisms to concentrations of chemicals in the environment permits informed management decisions and also directs more detailed analysis of the fate and transport of the chemicals. For example, testing might indicate one component of oil is more toxic than others. If so, it the concentration of this specific chemical that should be closely monitored. It is also possible that residual oil must be cleaned with (or its natural degradation enhanced by) dispersants and other chemicals. These chemicals typically have been tested in warm water using standardized warm water toxicity tests. These should be tested in cold-water with cold-water test species.

C. Location where will project be undertaken.

Additional green urchins will be collected near Seward Alaska as necessary; the remainder of the research will take place at UAF, in the Water & Environmental Center.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

As designed this project requires no direct involvement with communities. Some native groups harvest the green urchin, (part of the reason this species was selected), but that harvest will not be affected by this project, and harvest will not affect species use in toxicity testing. UAF has a tradition of working with local groups and a strong chapter of the American Indian Science and

Engineering Society. At least one graduate student must be identified for this project, and the PI will look for opportunities to engage Alaska Native Students in this research.

PROJECT DESIGN

A. Objective

The overall goals of this research are to determine if:

1. The Alaska green sea urchin, maintained in a laboratory, is a viable cold-water marine toxicity test species;
2. There are major differences in toxicity testing procedures required between the Alaska Green sea urchin and the EPA standard, the California purple urchin; and
3. The test results are comparable, both with reference toxicants and industrial chemicals important to Alaska, such as oil and dispersants.

B. Methods.

Introduction

The overall method used will be the maintenance of green urchins in cold seawater tanks at UAF, ripening of the urchins and analysis of this procedure, using the spawn of the urchins in standardized testing procedures of fertilization efficiency and early life stage development. Parallel tests of the standard warm-water test species, the California purple urchin, will be done to permit direct comparisons with toxicants of interest to Alaska, such as oil dispersants. The results of the green urchin will also be compared to reference toxicants and those compared with results from similar warm-water results.

Marine toxicity testing is a common method of providing information about the amounts or concentrations of chemicals that may harm the environment versus the amounts of chemicals that have no apparent effect on the environment. Since there are thousands of species in any ecosystem, it is impractical to test more than a few. Selection of an appropriate test species and of the methods that will be used to test them are key issues in determining acceptable chemical levels. For example, adult fish are 10 to 100 times more resistant than the larval stage (shortly after hatching) of the same species. [Moore & Dwyer, 1974]

There are several criteria used to determine if a particular species might be acceptable as a test species. 1) Species must be readily available, either by field collection or laboratory breeding. 2) Species must remain healthy in the laboratory. 3) The relative sensitivities of the candidate species to various classes of toxicants should be known. Some species are particularly sensitive to certain chemicals. 4) Relative sensitivity of the candidate species in relation to other species in its class or phyla should be known. Is this representative particularly sensitive or resistant, compared to other species in the ecosystem? 5)In addition, the public should recognize an acceptable test species. These criteria require making a great deal of information widely available to various agencies and organizations. Therefore once a certain species becomes accepted as the standard test species, inertia against replacing it with a new species is strong.

Because all these criteria are seldom met, and because time and money are usually limited, certain species have become standard. These species and the methods used to test them are often specified in regulations or standard operating procedures of governments and industries.

Currently no standardized cold-water species exists. In a related report [Perkins, 2000], an INE researcher examined available species for testing under Alaska conditions. The Alaska species that rated most likely was the green urchin, *Strongylocentrotus droebachiensis*. The purple urchin, *Strongylocentrotus purpuratus*, is closely related to the green urchin, and it is the subject of two standard EPA marine toxicity tests. [USEPA 1995] (Many different urchin species are known by a color, and there is an East Coast purple urchin of a different species also used in toxicity testing. We will refer to *S. purpuratus* as the California purple urchin.) Besides desirability due to its use in standard toxicity testing, the California purple urchin is a common laboratory animal, easily kept for long periods in high school and college biology labs. It is an invertebrate species, and its use in testing generally is not considered an animal welfare issue.

There are two related urchin tests: the fertilization test and the embryo-larval test. The fertilization test exposes urchin sperm to a test solution for 20 minutes, after which eggs are added. After 20 more minutes the solution is fixed and examined microscopically to determine the percentage of fertilized eggs present. The embryo-larval test uses newly fertilized eggs and exposes them for 72 hours to the test solutions; during this period the un-affected will go through normal development from embryo to larval stage. The test measures the percent of embryos that develop normally versus those that develop abnormally.

The green urchin has several characteristics that might expedite its acceptability as a standard test species. The green urchin is in the same genus as the purple. The purple urchin is not native to Alaska waters, and has a low chance of survival in cold water; notably, research has shown that it requires warmer temperatures to spawn. The green is native to Alaska, easy to collect, and spawns in cold water. The phylogenetic proximity of the two species, paired with testing with reference toxicants, provides an opportunity to demonstrate if the reactions of the species are similar. Dissimilarity indicates that cold water or species adaptation to cold water might affect toxicity. Some limited toxicity testing with field-collected green urchins has been reported. [Coastal Resources Associates, 1991; Chapman, 1995]
If the procedures described above indicate the Alaska green urchin is generally comparable to the California purple urchin as a test species, the PI will design test procedures for the green urchin and present the information to those agencies and members of the public who are interested in marine toxicity.

Table 1. Outline of work tasks.

1. Set up Urchin Lab Organize INE UAF laboratory space Obtain permit and collect 20 green sea urchins Obtain and set up aquarium and salt water aquarium environmental system, test, and calibrate Monitor temperature, 4° to 6° C Transport urchins to UAF Weigh urchins, introduce to UAF aquarium, reweigh and assess health weekly
2. Establish experimental protocols Import some standard warm-water purple urchins and run standard EPA tests Establish controls values for EPA standard tests. Choose Reference toxicant Quarterly report to EVOS Trustees.
3. Emulate standard warm water toxicity tests, both embryo-larval and fertilization, with green urchin and cold water. Quarterly report to EVOS Trustees

4. Report all observed differences between the warm and cold-water tests Discuss with experts: UAF biologists, EPA experts Repeat tests several times, verifying reproducibility. Vary parameters to determine if test is sensitive to changes in: water temperature air temperature holding times human operators Quarterly report to EVOA Trustees.
5. Identify which test -- embryo-larval or fertilization -- is most practical and reproducible, or whether both may be used.
6. Compare sensitivity of Alaska green urchin in cold water to published data on sensitivity of warm-water urchins Test green urchin and compare the following parameters: reference toxicants copper chloride other reagent chemicals known environmental contaminants. Use contaminants relevant to AK, if practical Compare the chemical assays and test methods Update written test procedures
7. Compare sensitivity of Alaska green urchin with other Alaska species in order to determine if the urchin fertilization process and embryo development is sensitive or resistant compared to other tests. Assemble toxicants used in other Alaska toxicity tests Oil and dispersants UAF data from CROSERF tests, Tanner Crabs NOAA data, various species Other data sets
8. Test Alaska green urchin with several of those chemicals Test Alaska green urchin with several of those chemicals
9. Encouragement of acceptance of tests Meet with agency technical staff and commercial Alaska laboratories to answer questions and supply information to encourage acceptance of the urchin tests. IOSC, AMOP
10. Prepare Final technical report.

C. Cooperating Agencies, contracts and other agency assistance.
UAF will perform all the work described in this proposal. We will need permits from ADFG to collect and house the urchin. This is a routine permit application.

SCHEDULE

A. Measurable Project Tasks for FY 03

December 31:	Complete lab set-up and establish urchin colony at UAF.
May 31:	Complete experimental protocols.
June 30:	Complete comparisons with purple urchin
July 31:	Complete comparison with other Alaska species
August 31:	Complete write up of procedure
September 30:	Publications submitted.

B. Project Milestones and Endpoints

December 31:	Complete lab set-up and establish urchin colony at UAF.
May 31:	Complete experimental protocols.
June 30:	Complete comparisons with purple urchin
July 31:	Complete comparison with other Alaska species
August 31:	Complete write up of procedure
September 30:	Publications submitted.

C. Completion Dates.

The bulk of the work should be complete in FY03. We expect the publication process to continue into early FY04, but no additional funds should be necessary.

PUBLICATIONS AND REPORTS

We plan submitting both publications to national level journals, such as the ASCE Journal of Cold Regions Engineering, and the required reports to EVOS. If the comparison tests yield novel results, we will report to the SETAC Journal. EVOS reports will include details of the test procedure, and this document may be sent to interested agencies. In addition, the final report will be made available on the WERC website (http://www.uaf.edu/water/).

PROFESSIONAL CONFERENCES

Results of this research will be presented at Arctic and Marine Oil Spill (AMOP) and International Oil Spill Conference (IOSC). These will require a conference proceeding publication as well. Because participation in professional conferences are an important part of graduate education, funds are requested so that a graduate student involved with this project can attend the AMOP conference.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This test procedure will be a resource for researches in many areas. We expect that through announcing results to the ADEC and EPA, and publishing, this work will lead to a test of choice for making decisions about the toxicity of substances in Alaska marine waters. Wide dissemination through the avenues described above will certainly make other EVOS researchers aware of it, and the PI will be available to consult with other EVOS Trustee Council researchers.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS.

Not applicable.

PROPOSED PRINCIPAL INVESTIGATOR

Name Robert A. Perkins
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PRINCIPAL INVESTIGATOR

Robert A. Perkins, PE, has a Ph.D. in toxicology and is an associate professor in the Department of Civil and Environmental Engineering at the University of Alaska Fairbanks.. He was a principal investigator for UAF's recent work with the CROSEF group on the toxicity of dispersants, oil, and dispersed oil. He has worked with COREXIT 9500 dispersant, fresh and artificially weathered Alaska North Slope crude oil, and EPA standard Prudhoe Bay crude oil. Test species included mysid, *Mysidopsis beryllina*, larvae of the fish, *Menidia beryllina*, and the larvae of the Alaska Tanner crab, *Chionoecetes bairdi*. He was involved with toxicity testing using bacteria, *Vibrio fischeri*. He has managed hundreds of large and small engineering projects dealing with hazardous materials in Alaska.

OTHER KEY PERSONNEL

Graduate students interested in contaminant studies will do much of the day-to-day work. The urchin toxicity tests and maintenance of green urchins will not require advanced marine biology expertise; however UAF has several marine biologists who are available for consultations, if unexpected problems arise.

LITERATURE CITED

ADF&G, *Management Plan for the Harvest of Red Sea Urchins in Southeast Alaska,* Alaska Department of Fish and Game, Regional Information Report NO. 1J96-27 of 1996.

ASTM. "Standard Guide for Conducting Acute Toxicity Tests on Test Materials with Fishes, Macroinvertebrates, and Amphibians, Standard ASTM E 729-96." West Conshohocken, Pa. 1996

Auke Bay Laboratory. Exxon Valdez Oil Spill, Post Settlement (1991) Oil Publications version 1/00. http://www.afsc.noaa.gov/abl/OilSpill/bibliogr.htm. Accessed on 7 April 2002.

Barron, M.G., Carls, M.G., Short, J.W., and Rice, S. D. Photoenhanced Toxicity of Aqueous Phase and Chemically-Dispersed Weathered Alaska North Slope Crude Oil to Pacific Herring Eggs and Larvae. Report to Prince William Sound Regional Citizens' Advisory Council. February 11, 2002.

Chapman, G. A., Sea Urchin Sperm Cell Test, Chapter 6 of Fundamentals of Aquatic Toxicology, 2d Edition, Rand, G. M., ed., Taylor and Francis, Washington, D.C., 1995.

Moore, S. F., and Dwyer, R. L. 1974, Effects of oil on Marine organisms: A Critical Assessment of Published Data, Water Research, **8**, 819-827.

Perkins, R. A., Assessment of Alaskan Marine Species

for Toxicity Tests, Report to the Alaska Department of Environmental Conservation, 2000.

Rhoton, S., Acute Toxicity of the Oil Dispersant Corexit 9500, and Fresh and Weathered Alaska North Slope Crude Oil to the Alaskan Tanner Crab (*C. bairdi*), Two standard test Species, and *V. fischeri* (Microtox Assay), Masters Thesis, University of Alaska Fairbanks, December 1999.

Rand, G. M., Fundamentals of Aquatic Toxicology, Second Ed., Chapter 3, Saltwater Tests, Taylor & Francis, Washington, D.C., 1995.

Rand, G. M., Fundamentals of Aquatic Toxicology, Second Ed., Appendix A, Acute Toxicity Tests and Appendix B, Early Life Stage Toxicity Tests, Taylor & Francis, Washington, D.C., 1995.

Singer, M. , et al., Comparison of Acute Aquatic Effects of the Oil Dispersant Corexit 9500 with Those of Other Corexit Series Dispersants, Ecotoxicology and Environmental Safety, **35**, 183-189 (1996).

USEPA, Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms, (EPA/600/R-95), U.S.E.P.A., Office of Research and Development, 1995.

USEPA. Evaluation of Dredged Material Proposed for Ocean Disposal Testing Manual, Chapter 11, Table 11-1 United States Environmental Protection Agency and Department of The Army, U.S. Army Corps of Engineers, EPA publication number 503/8-91/001, February 1991

Woodby, Douglas, Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Personal communication, 1998.

APPENDIX

Discussion of Work Plan

I) Set up Urchin Lab (Two months)

A) Organize INE UAF laboratory space

B) Obtain permit and collect 20 green sea urchins

Five green urchins are currently maintained at UAF. Fifteen more need to be obtained..

C) Obtain and set up aquarium and salt water aquarium environmental system, test, calibrate.

Urchins are hardy and the purple urchin has a long history of successful laboratory culture. The purple urchin can be kept at room temperature. Typically they are kept at slightly colder than usual temperatures, then warmed in order to induce spawning. The green urchins will be kept at 6° to 8° C, the typical ambient temperature of their Alaska environment. This requires either setting up the aquarium in a cold room or use of a chiller; our decision will be based on which system supplies the most consistent temperatures. INE/WERC has a suitable cold room available. Trays with circulating cold water will be used to keep the various beakers of test solutions cold.

The aquarium requires a means of cleaning the water. This is provided by a wet-dry filter system that removes ammonia, BOD, organic contaminants, solids, and increases the dissolved oxygen. (Reefkeeper, Reefkeeper International, Denver CO) This system employes microbe colonies on various media, and these take some time to develop. The system microbes must be acclimated to the cold water. Once the system is running, the water quality needs to be checked every day. The urchin feces and other detritus will be siphoned from the bottom of the tank often. This will remove about five percent of the tank volume, which will be replaced with fresh artificial seawater. (Instant Ocean, Aquarium Systems, Mentor, OH) The initial fill of the tank will be with natural seawater from Resurrection Bay, the water in which the urchins currently are acclimated.

A standard room temperature seawater aquarium will be set up to house the purple urchins, which will be used to compare results between the warm-water and cold-water species. The overall procedures will be similar, except for the water temperatures. The purple urchins will be obtained from commercial sources in the lower 48; the appropriate ADF&G permit will be obtained.

D) Monitor temperature, 6° to 8° C.

Many marine animals are tolerant to a range of temperatures, if the temperature changes occur slowly. The chiller and pumps are mechanical equipment and subject to failure. Such a failure could change the temperature suddenly and destroy the animals, or at least delay any experiments, while the animals' health is being reassessed. Besides back-up gear, such as spare pumps and chillers, we will have temperature monitoring and recording systems. Once the equipment is set up and running, the system's ability to maintain a constant temperature range will be tested.

E) Transport urchins to UAF

The urchins and 55 gallons of seawater will be trucked from Seward to UAF. The urchins are transported dry, but must be kept at approximately the temperature they are acclimated to.

F) Weigh urchins, introduce into UAF aquarium, reweigh and assess health.
Urchin health is difficult to assess visually, unless they are very ill. Tagging or marking and weighing the urchins and monitoring for weight change is one indication of health.

Milestone I: Healthy Alaska green urchin colony at UAF INE

II) Establish experimental protocols (5 months)
A) Import some standard warm-water purple urchins and run standard EPA tests.
1) Controls
2) Reference toxicant
The purple urchin tests are "cook book" tests (i.e.; very simple to conduct), but some operator skill is required. The results are determined by microscopic examination of gametes, eggs, embryos, and larvae. These microscopic structures are the same in both the purple and green urchin, so the operator can gain skill and calibrate their interpretation of fine points on the purple urchin, for which there is ample comparative test data. The PI will train the graduate student to perform the tests and will oversee the work throughout the testing. Results from the purple urchin for the UAF lab that are similar to results from established lower 48 labs will be quality assurance.

There are two reference toxicant tests, copper salt and detergent. Both are supported by published results from a variety of laboratories and situations. Also, with the urchin tests, there are always effects seen in the controls; for example, not all the eggs fertilize and not all the fertilized eggs mature. The rate of these typical failures in the controls can also be used to gauge the sufficiency of the UAF laboratory procedures.

B) Emulate standard warm water toxicity tests, both embryo-larval and fertilization, with green urchin and cold water
1) Write up all observed differences between the warm and cold-water tests
2) Discuss with experts: UAF biologists, EPA experts

The tests with green urchins in cold water will follow the procedures established for the warm-water purple urchin, in so far as practical. Some details that must be explored are whether the water temperature needs to be raised to induce spawning, or if a change in photoperiod is needed. Urchins are synchronous spawners. Care is required to maintain them in a "static" condition, ready to spawn, but not so close that any spawn prematurely. With the warm water urchins, the danger is mostly for premature spawning. With the green urchins, spawning might not take place, unless the photoperiod or water temperature is changed. In one experimental procedure for the purple urchin, spawning is induced by chemical injection, but this does not always work, if the animals are not ripe.

There are many small technical details to be worked out, especially regarding keeping the various testing apparatus at a constant cold temperature. Certain aspects of the testing might need to be done in a cold room. Besides the obvious differences in the temperature, we expect some of these small details to be significant, and it is important that we write these details up in order to call future users attention to them.

Most of the standard EPA tests were promulgated following years of experience with those tests. For this new species, all the tests should be done in sufficient replications to indicate the stability of the testing. Modifications to the EPA standard tests required for the green urchin should be

discussed with the EPA experts who developed the purple urchin test, and UAF marine biologists, in order to determine if more tests are needed. That is, some modifications to the tests may have existed that had no effect for the reference toxicants and laboratory conditions, but might show more significant effects for a different toxicant or conditions.

3) Repeat test several times, verify reproducibility of tests
4) Vary parameters to determine if test is sensitive:
a) water temperature
b) air temperature
c) holding times
d) human operators

Although the tests will be conducted with standard operating procedures, these procedures always have tolerances. For example, the purple urchin test is performed at between 10° and 14° C, based on experience that indicated if the water was held between those limits, the test would yield consistent results. We will not be sure, if our test temperature varies between 4° and 8° C, if the animals are particularly sensitive, and one test done at 4° C might have very different results than the same test done at 8° C. These will be difficult tests with the 72-hour larval development, since laboratory control of the water temperature is typically +/- 3° C. We will need temperature recorders. Air temperature and sunlight must also be controlled.

C) Preliminary decision about which test, embryo-larval or fertilization, is most practical and reproducible.

It is generally practical to run both tests concurrently. Hence two measures of the toxicity are available. In general, the fertilization is more sensitive, especially to certain metals. The fertilization test is run over only 40 minutes, so it is rapid. Since dissolved oxygen is not important, the test does not have to be aerated, thus volatiles will not be driven off. For the larval development over 72 hours, air must be supplied to the test solutions and some volatiles can be driven off. We would expect that the colder water would inhibit volatilization somewhat. We will test reducing the airflow to the mixture and observe effects in the unexposed controls. For chemical mixtures, such as petroleum hydrocarbons, we will measure and report the concentration of volatiles at the beginning and end of the test.

Milestone II: Written test procedures for cold water species.

III) Compare sensitivity of Alaska green urchin in cold water to published data on warm-water urchins. (2 months) Run the green urchin tests with:
A) Reference toxicants
1) copper chloride
2) other reagent chemicals
B) Known environmental contaminants
1) Select several published
(a) relevant to AK, if practical
2) Chemical assays, test methods

Besides the reference chemicals, a copper salt (copper chloride) and a detergent (sodium dodecal sulfate), there have been urchin toxicity studies published for many chemicals. We will select several of these, for which data is available, and compare the result.

C) Update written test procedures

Performing these tests may result in further improvements to the procedure.

Milestone III: Publish results of comparison testing to warm water standards

IV) Compare sensitivity of Alaska urchin with other Alaska species (2 months)
- *A) Assemble toxicants used in other Alaska tests*
  - *1) Oil and dispersants*
  - *2) UAF data from CROSERF tests, Tanner Crabs*
  - *3) NOAA data, various species*
  - *4) Other data sets*

We will also test the oil dispersant, COREXIT 9500, which we used on Tanner crabs [Rhoton, 1999] and other species, and compare with the results for the green urchins. We will test the oil concentrations used in our earlier work, and also compare the work done by the Alaskan NOAA researchers [Rice, et al, 1979]. The goal of this research is to establish whether or not the green urchin, which is easily maintained in the laboratory or collected all year, is comparable with the result from previous test results in Alaska. Although variations in test regimes and different chemical composition of oils will make exact comparison impossible, there is enough data over a wide range of conditions to enable general comparisons of the two urchin methods with the earlier work.

- *B) Test Alaska green urchin with several of those chemicals*
- *C) Compare LD50 and EC50 of the urchin to those other species*

Milestone IV: Publish results of comparison testing to Alaska species previously tested.

V) Encourage acceptance of tests (1 month)
- *A) (Assuming the tests have demonstrated the Alaska green urchin is a satisfactory test species)*
- *B) Meet with agency technical staff and commercial Alaska laboratories to answer questions and supply information to encourage acceptance of the urchin tests.*

Following preparation of the research results describe above, we will make some presentations about the method to interested laboratories and the various environmental agencies in Alaska. Since the EPA already has a cookbook procedure for the warm water urchin, we need only prepare an addendum to cover the differences between warm and cold. We will prepare a slide presentation of the method and give the presentation to interested agencies and laboratories. We will also place the slide presentation on the INE web site.

- *C) Professional Conferences*
  1) Participate in Arcitc and Marine Oilspill Progarm (AMOP) and IOSC conferences present papers
  2) International Oil Spill Conference (IOSC).
- *D) Peer Reviewed Publications*
- *E) Final Report*

Milestone V: Presentation of a standard cold-water test species and comparative toxicology data to Alaska agencies and the Alaska component of federal agencies. Knowledge placed in the scientific data base.

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 02	Proposed FY 03
Personnel		$71.9
Travel		$7.0
Contractual		$9.9
Commodities		$5.3
Equipment		$0.0
Subtotal	$0.0	$94.1
Indirect		$23.5
Project Total	$0.0	$117.6
Full-time Equivalents (FTE)		1.7
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 04					
$0.0					

Dollar amounts are shown in thousands of dollars.

Comments:

F&A is 25% of Total Direct Costs

faculty benefits = 30%; GS benefits = 8.1% of summer hours only; Classified staff = 37%; APT=27%

FY03

Pre 11-Apr-02

Project Number: 03594

Project Title: Development of an Alaska Standard Species for Marine Toxicity Testing -- The Alaska Green Urchin

Name: University of Alaska Fairbanks, Institute of Northern Engineering

FORM 4A
Non-Trustee
SUMMARY

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 03
	B. Perkins	PI	4.8	9.8		47.0
	Grad Student 1	graduate student	12.0	1.6		19.2
	Grad Student 2	graduate student	2.5	1.0		2.5
	Q. Costello	lab tech	0.5	4.7		2.4
	S. Boatwright	tech editor	0.2	3.8		0.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	20.0	20.9	0.0	
					Personnel Total	$71.9

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 03
	Urchin collection (Seward) (by car)	0.2	5	3	0.2	1.6
	Urchin collection (Seward)	0.0	5	3	0.2	0.6
	AMOP Conference (2 people)	1.2	2	4	0.2	3.2
	IOSC (1 person)	0.6	1	5	0.2	1.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$7.0

FY03

Pre 11-Apr-02

Project Number:
Project Title: Development of an Alaska Standard Species for Marine Toxicity Testing -- The Alaska Green Urchin
Name: University of Alaska Fairbanks, Institute of Northern Engineering

FORM 4B
Personnel
& Travel
DETAIL

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Contractual Costs:	Proposed
Description	FY 03
Hazmat Disposal	0.5
Graduate Student 1 tuition (2 semesters)	6.2
Graduate Student 2 tuition (1 semester)	3.2
Contractual Total	$9.9

Commodities Costs:	Proposed
Description	FY 03
Reefkeep setups (3)	0.8
Chiller (reconditioned)	0.5
Microscope (reconditioned)	0.5
glassware, tubing	2.0
chemicals	0.5
purple urchins	1.0
Commodities Total	$5.3

FY03

Pre 11-Apr-02

Project Number:
Project Title: Development of an Alaska Standard Species for Marine Toxicity Testing -- The Alaska Green Urchin
Name: University of Alaska Fairbanks, Institute of Northern Engineering

FORM 4B
Contractual & Commodities DETAIL

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 03
Description			
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number of Units	
Description		

FY03

Pre 11-Apr-02

Project Number:
Project Title: Development of an Alaska Standard Species for Marine Toxicity Testing -- The Alaska Green Urchin
Name: University of Alaska Fairbanks, Institute of Northern Engineering

FORM 4B
Equipment
DETAIL

Project Title: Securing Flow Data for a Lower Kenai Peninsula Salmon Stream

Project Number:	03596
Restoration Category:	Monitoring
Proposer:	Cook Inlet Keeper
Lead Trustee Agency:	ADFG
Cooperating Agencies:	DOI-USGS, ADEC
Alaska SeaLife Center:	No
Duration:	1-year request for funding
Cost FY 02:	$14,500
Geographic Area:	Cook Inlet basin
Injured Resources/Service:	This project will result in direct and indirect benefits to all injured resources and lost or reduced services located in the Cook Inlet basin.

ABSTRACT

Since August 1998, Cook Inlet Keeper and the Homer Soil and Water Conservation District have been collecting discharge and water quality data from four important salmon streams on the lower Kenai Peninsula in Southcentral Alaska: Ninilchik River, Anchor River, Deep Creek, and Stariski Creek. With the loss of funding, USGS no longer can maintain the Ninilchik River gauge. Keeper, HSWCD, Ninilchik Traditional Council and others depend on this gauge for the flow data needed to achieve a complete picture of water quality in these watersheds. Keeper requests funds from the *Exxon Valdez* Oil Spill Trustee Council to contract with USGS to maintain the gauge for one year, during which time long-term funding will be secured.

INTRODUCTION

In response to population growth and rapidly changing land use on the Kenai Peninsula, Cook Inlet Keeper and the Homer Soil and Water Conservation District (HSWCD) initiated a water quality monitoring program on four salmon-bearing streams on the lower Kenai Peninsula. Through this program, Keeper's Stream Ecologist collects baseline water quality and flow data from the Ninilchik River, Deep Creek, Stariski Creek, and Anchor River. HSWCD conducts a coordinated education and information project that involves local communities in the monitoring and protection of these watersheds.

To conduct this comprehensive monitoring program and understand water quality patterns, Keeper and HSWCD rely on a gauge station on the Ninilchik River maintained by USGS. With the loss of funding for the National Water-Quality Assessment Program, USGS can no longer maintain the Ninilchik River gauge. Recognizing the importance of Keeper and HSWCD's monitoring program and the three and a half years of data collected from these streams, USGS has been working with Keeper to help ensure that flow data can continue to be collected. If Keeper and its partners can secure funding by May 2002, USGS will not remove the Ninilchik River gauge this spring. A grant has been secured to partially fund maintenance of the gauge during spring and summer 2002. Keeper has been working with ADEC and U.S. EPA to secure the rest of the funding needed to maintain the gauge during this period. A grant from the *Exxon Valdez* Oil Spill Trustee Council will maintain the gauge from October 2002 through September 2003 and provide time for long-term funding to be secured. The Ninilchik Tribal Council plans to secure long-term funding for the gauge by the time the FY 2003 Trustee Council grant period concludes. (Please see enclosed letter of support.)

Three years of continuous discharge data have already been collected on the Ninilchik River and it is important that Keeper and HSWCD continue this dataset. With the USGS gauge data and Keeper's in-stream discharge data, Keeper and HSWCD are beginning to understand how the hydrographs of the Anchor River, Deep Creek, and Stariski Creek differ from the Ninilchik River hydrograph. Through this comparison, Keeper and HSWCD are able to estimate the magnitude of the peak flow of these other salmon streams, based on data from the Ninilchik River. With this knowledge, Keeper's Stream Ecologist can target high flow events on each of the four streams and capture water quality samples at times of greatest concern.

Keeper and HSWCD's program is playing an important role in protecting these watersheds from degradation. Keeper and HSWCD have been working closely with Alaska Department of Environmental Conservation, Alaska Department of Fish and Game, U.S. Geologic Survey, and University of Alaska Anchorage Environment and Natural Resources Institute (ENRI), Anchor River Community Rivers Planning Coalition (CRPC), and local communities to protect these salmon streams from nonpoint source pollution. This study has already revealed that for the Ninilchik River watershed, as well as other watersheds on the lower Kenai Peninsula, water quality issues related to temperature and sediment and of particular concern. Fifty-eight percent of water temperatures collected in July (1999 – 2001) exceeded Alaska's standards in the lower reaches of these salmon streams. Throughout the past four years of this salmon stream monitoring project, 32% of the total phosphorus measurements exceeded EPA standards. In January 2002, ADEC, ADFG, USGS, and ENRI met with Keeper and the HSWCD to discuss

these findings. At the meeting it was determined that the frequency and duration of elevated water temperatures needs further investigation and that high phosphorus levels may be the result of geologic characteristics of the lower Kenai Peninsula. More information is needed to determine whether the observed phosphorus levels are naturally occurring and whether increased sedimentation is exacerbating the problem and threatening to degrade the water quality in these watersheds. Keeper and HSWCD rely on the Ninilchik gauge to assess baseline conditions of these salmon streams, increase understanding of the water quality issues Keeper and HSWCD have observed, and track changes in these watersheds.

NEED FOR THE PROJECT

A. Statement of Problem

The Cook Inlet watershed was hit hard by the *Exxon Valdez* oil spill. The currents in the Gulf of Alaska caused oil to move up into Cook Inlet, along the Kenai Peninsula and back down the Alaska Peninsula, soaking much of the shoreline and ocean floor with crude oil. As a result, many of Cook Inlet's coastal resources, and the services which they support, were impacted.

Although some recovery has occurred, Cook Inlet's sensitive resources face additional threats from ongoing, unsustainable activities including rapid filling of wetlands, additional oil spills from an aging oil and gas infrastructure, discharge of pollutants from industrial activities, and increased nonpoint source runoff from population growth and sprawl. Approximately 400,000 people, nearly 2/3 of Alaska's population, live in the Cook Inlet watershed, and a population increase of 600% over the past thirty years has substantially magnified pressures on Cook Inlet's sensitive resources. Water quality in Cook Inlet's coastal watersheds is extremely important because these watersheds support diverse wildlife and fish populations including all five species of Pacific salmon, steelhead trout and Dolly Varden. These resources support recreational uses including sportfishing and hunting, that are vital to the economic and social wellbeing of Southcentral Alaska's coastal communities.

Because of the rapid changes taking place in Southcentral Alaska, it is essential that we invest in long-term monitoring now before further impacts have occurred. Baseline information collected from monitoring provides a benchmark for measuring future changes in habitat and water quality, and establishes a basis for developing and implementing best management practices and pollution prevention techniques.

As state and federal budgets for monitoring continue to decline, agencies rely heavily on other sources of monitoring information. In recent years, communities and organizations have stepped in to fill this important role to gauge the health of our viable yet stressed public resources. Since 1998, Cook Inlet Keeper has been working with the Homer Soil and Water Conservation District to collect discharge and water quality information from coastal watersheds of four important salmon streams on the lower Kenai Peninsula: Ninilchik River, Anchor River, Deep Creek, and Stariski Creek. The Alaska Department of Environmental Conservation rated the Ninilchik River at "high risk" from nonpoint source pollution and as "high need" for data collection.

Collecting discharge data from stream gauges in conjunction with other water quality parameters is essential for having a complete picture of water quality conditions. Discharge is an important stream variable because of its impact on water quality and on the living organisms and habitats in the stream. Discharge, or stream flow, is a function of water volume and velocity. Water volume is affected by weather, snow melt, evapotranspiration, topography, geology, and human withdrawals. Stream velocity changes with channel width and depth and can affect the organisms living in the water, the rate of sediment delivery, and dissolved oxygen concentrations. Changes in climate, impervious surfaces, vegetation composition, and abundance can alter discharge patterns in a watershed. In addition to providing important information about water quality and quantity, discharge data provides a continuous hydrograph allowing Keeper to relate other water quality parameters to stream discharge in order to understand how and why water quality parameters change throughout the year and between years.

Kenai Peninsula's coastal watersheds are under new development pressures with increased road building, logging, and gravel mining. These activities may affect stream water quality by changing the natural hydrograph of these systems as well as introducing sediments to the stream channel. In order to know if real changes are occurring in these watersheds because of land-use activity, Keeper and HSWCD must understand how water quality parameters change naturally with discharge. With this information, Keeper and HSWCD can begin to assess how activities in these watersheds might be changing the quality and quantity of water in the lower Kenai Peninsula's salmon streams.

Since 1998, Keeper and HSWCD have relied on a stream gauge on the Ninilchik River established by USGS to understand water quality patterns. With the loss of funding for the National Water Quality-Assessment Program, USGS no longer can maintain the Ninilchik River gauge. The importance of having long-term continuous discharge data can not be overstated for these valuable salmon streams of the lower Kenai Peninsula. Having water quality and discharge data collected concurrently makes these two types of data much more valuable than if they are collected separately. Understanding the relationship between discharge and water quality will allow us to quantify natural variability and detect how our activities in the watershed might be changing the quality and quantity of water in our salmon-bearing streams.

B. Rationale/Link to Restoration

Healthy coastal resources are critical to the economic and social wellbeing of Cook Inlet communities. One of the challenges in the efforts to restore the environment following the *Exxon Valdez* oil spill has been the lack of adequate data describing conditions prior to the spill. It is essential that monitoring takes place in Cook Inlet now, before more impacts are realized, so that reference conditions can be established from which to detect changes. Yet, state and federal agencies responsible for water quality monitoring are strapped by budget cuts, and unable to collect the water quality information needed to ensure compliance with state and federal water quality standards.

Keeper and HSWCD's salmon stream monitoring project has already contributed significantly to the restoration and monitoring of Alaska's public resources. Through three years of data collection and analysis, Keeper and HSWCD were able to identify water quality issues of particular concern in these watersheds (e.g. high summer temperatures and elevated phosphorus levels). By working closely with other organizations and agencies, Keeper and HSWCD have responded to these issues by implementing new monitoring protocols and will continue to work to protect these important watersheds.

Funding from the Trustee Council will provide Keeper, HSWCD, and the Ninilchik Traditional Council with an opportunity to continue collecting important baseline data and to work collaboratively with other agencies and organizations and agencies to secure long-term funding for the Ninilchik River gauge.

C. Location

Cook Inlet Keeper and Homer Soil and Water Conservation District's salmon stream monitoring project monitors water and habitat quality of four watersheds on the lower Kenai Peninsula: Ninilchik River, Anchor River, Deep Creek, and Stariski Creek.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

This project will further community involvement by providing a critical data source to the Ninilchik Traditional Council (NTC). The Tribe is in the ongoing process of developing community water and wastewater profile programs and water quality monitoring programs for the community of Ninilchik and neighboring communities encompassed within its Tribal Boundaries. NTC relies on the reliable flow data available from the Ninilchik River gauge for the success and future development of these programs. These programs are of great importance to NTC's Tribal Members because they promote environmental and human health.

Other audiences which may find particular use for monitoring data include community planners, local and Tribal governments, commercial and sport fishermen, university personnel and students, environmental consultants, decision makers, and resource agencies such as Alaska Department of Fish and Game, the U.S. Fish and Wildlife Service, and others.

In addition, this project will further community involvement by providing Keeper and HSWCD with an opportunity to continue involving local communities in the collection of important flow data from coastal watersheds. In addition, this flow data will provide important information about the health of watersheds that Keeper and HSWCD will relay to communities.

PROJECT DESIGN

A. Objectives

The goal of this project is to maintain the Ninilchik River gauge so that discharge data are available to Keeper, HSWCD as well as citizens of the Ninilchik River watershed and other users of its resources.

B. Methods

Cook Inlet Keeper will contract with USGS to maintain the Ninilchik River gauge. Keeper's Stream Ecologist will continue to collect in-stream discharge data as well as water quality data. These data will be correlated in Keeper's annual report on the lower Kenai Peninsula salmon stream monitoring project. The USGS discharge data will also be provided online by USGS.

C. Cooperating Agencies, Contracts and Other Agency Assistance

U.S. Geological Survey: The U.S. Geological Survey's (USGS) Cooperative Water Program will provide a 50% match for maintenance of the gauge from October 2002 through September 2003. USGS will operate and maintain the gauge. They will use consistent techniques of data collection and archiving, with the information stored in a common data base readily available to all.

Alaska Department of Environmental Conservation: ADEC is the primary funder of Keeper and HSWCD's lower Kenai Peninsula salmon stream monitoring project and is collaborating closely with monitoring groups to make their data more useful to agencies and more accessible to the public. Keeper is working with ADEC to secure the remaining $8,500 needed to maintain the gauge during spring and summer 2002.

U.S. Environmental Protection Agency: EPA will provide $1,000 through a Regional Geographic Initiative Grant to maintain the gauge during spring and summer 2002.

Community Rivers Planning Coalition: The Community Rivers Planning Coalition is the grant administrator of the EPA Regional Geographic Initiative Grant.

Ninilchik Traditional Council: The Ninilchik Traditional Council (NTC) is the Tribal governing body for the federally recognized Ninilchik Tribe. Ninilchik is located on the Kenai Peninsula between Kenai and Homer, Alaska on the east coast of Cook Inlet. The Ninilchik Traditional Council plans to secure long-term funding to service and maintain the gauge through BIA funding or other sources. Please see attached letter of support.

Homer Soil and Water Conservation District and Cook Inlet Keeper: The Homer Soil and Water Conservation District and Cook Inlet Keeper are playing a central role in watershed protection and community-based water quality monitoring in Southcentral Alaska. Since 1998, HSWCD and Keeper have been working together through the Cook Inlet Watershed Health Monitoring project to establish Alaska's first successful community-based effort to gather baseline water quality data and track water quality trends related to current and potential land use and management within the Cook Inlet basin. They continue to partner to collect valuable data on the Lower Peninsula Salmon Streams.

SCHEDULE

A. Measurable Project Tasks for FY 03 (October 1, 2002 – September 30, 2003)

October 1	Keeper will initiate contract with USGS to maintain gauge
October 1 – September 30	USGS will maintain gauge Keeper will collect discharge data
January 2003	Keeper will attend EVOS Annual Workshop
September 2003	Keeper and HSWCD will publish annual report for lower Kenai Peninsula salmon stream monitoring project
April 2004	Keeper will provide final report to Trustee Council

B. Project Milestones and Endpoints

Fulfillment of project objectives will be measured by the following milestones:

1. Contract initiated with USGS to maintain Ninilchik River gauge (October 2002)
2. Continuous discharge data available to Keeper (October 2002 – September 2003)
3. Data published in annual report (September 2003)

C. Completion Date

This project will be completed by September 30, 2003

PUBLICATIONS AND REPORTS

September 2001, Keeper and HSWCD published the third annual report, "A Preliminary Water Quality Assessment of Lower Kenai Peninsula Salmon-bearing Stream," which Keeper made available to policy-makers, scientists, and the general public and posted them on the Internet as a link from Keeper's website. The fourth annual report from this project will be released by September 2002 and another edition of the report will be released during the FY 2003 grant period.

Keeper and HSWCD's salmon stream monitoring project has received considerable media attention recently. This month, Alaska Public Radio Network aired a story which featured Keeper's Stream Ecologist conducting stream monitoring in the field. Stories like these bring information about habitat and water quality monitoring to diverse individuals and communities. Keeper will continue to expand media coverage of its water quality monitoring work in order to reach and engage diverse audiences. Keeper also highlights its monitoring programs in its quarterly newsletters, which are sent to more than 500 individuals, organizations, and agencies and are linked to Keeper's website.

Keeper is currently researching the opportunities for other publications, but is unaware at this point, which publications it will pursue during FY 03.

PROFESSIONAL CONFERENCES

Several professional organizations hold conferences relevant to water quality monitoring. Keeper attends conferences where it may make the best use of its particular experience and expertise, and where Keeper can best benefit from the networking and exchange of information. Through conference participation, Keeper's monitoring work is strengthened and better able to stay current in the field.

In January 2002, Keeper attended the *Exxon Valdez* Oil Spill Trustee Council 2002 Annual Workshop. Keeper will attend the 2003 workshop and may present on the water quality database (project 02668) and the Effectiveness of the Citizens' Environmental Monitoring Program (project 02667).

In March 2002, Keeper attended the Technology Networking Conference sponsored by the Alaska Department of Transportation and Public Facilities. This was an information sharing conference focusing on the data gathering capabilities of existing and proposed meteorological, natural resource, maritime, and transportation remote sensing sites. Keeper presented information about its monitoring programs and networking capacity at the conference. Keeper plans to attend the conference again next year.

Cook Inlet Keeper plans to attend the 20th Annual Native American Fish and Wildlife Society National Conference April 29 - May 2, 2002 in Anchorage, Alaska. Attending this conference will continue to build relationships with the Native Alaskan community. The conference covers topics such as watershed and fisheries issues, Indigenous research, Tribes and Environmental groups, and more.

Cook Inlet Keeper plans to attend Alaska's Oceans and Watersheds: Sustainability in the Context of Change, on June 18-19, 2002 in Anchorage, AK. The two-day symposium is sponsored by: State of Alaska, University of Alaska, *Exxon Valdez* Oil Spill Trustee Council, North Pacific Research Board, North Pacific Fisheries Management Council, Alaska Board of Fisheries, Alaska Coastal Policy Council, NOAA, DOI: USGS/USFWS, EPA

NORMAL AGENCY MANAGEMENT

Not applicable.

COORDINATION AND INTEGRATION OF RESTORATION EFFORTS

Keeper works closely with agencies involved in habitat and water quality monitoring in the Cook Inlet basin. These agencies include: U.S. Geological Survey, Alaska Department of

Environmental Conservation, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, Alaska Department of Fish and Game, Alaska Department of Natural Resources, and the Cook Inlet Regional Citizens Advisory Council. Representatives from each of these agencies participate as members of Keeper's TAC.

Keeper is currently conducting three restoration projects supported by the Trustee Council. In a project that is enhancing the capacity of water quality monitoring in the Cook Inlet watershed, Keeper is working with Kachemak Bay National Estuarine Research Reserve to bring together citizen volunteer monitors and professional researchers to collect water quality data. Keeper and the NERR will work with Vessels of Opportunity to deploy a systematic array of electronic sensors along the south and north sides of Kachemak Bay, which will coincide with volunteer water quality monitoring sites, to assess water circulation patterns throughout the Bay.

In addition, the *Exxon Valdez* Oil Spill Trustee Council has provided Keeper with a grant to analyze the effectiveness of the Citizens' Environmental Monitoring Program to determine if sampling frequency, methods, parameters, and site selection are effective at meeting the monitoring objectives of detecting significant changes in water quality over time. Keeper will share this information to its partner monitoring groups at the conclusion of the project.

A third grant from the Trustee Council is helping Keeper work with ADEC and a database committee to develop a unified database for the reporting and management of data collected by citizen-based water quality monitoring programs. This database, which will make important water quality information easily accessible by policy-makers, scientists, and the general public, will be integrated with CIIMMS.

Cook Inlet Keeper has a close relationship with many other restoration efforts that have been funded by the Trustee Council. Most notably, Keeper shared its *Cook Inlet GIS Atlas* on CD ROM and Annotated Bibliography to assist the Kachemak Bay National Estuarine Research Reserve's Ecological Characterization Project, and CIIMMS. Keeper is linked to the CIIMMS web page, and will link its water quality database and the comprehensive GIS map of monitoring program in the Gulf of Alaska to CIIMMS. The information Keeper shares with CIIMMS contributes greatly to a more holistic understanding of Cook Inlet's natural resources.

Keeper collaborates with numerous other local and national groups and agencies. Keeper collaborates with UAA's Kachemak Bay Campus which makes an in-kind contribution of lab space for water quality analysis. Keeper is a partner in the Pratt Museum's Kachemak Bay Discovery Project, a member of the River Network and a member of the National Water Keeper Alliance.

Cook Inlet Keeper's water quality monitoring has been funded through ADEC by EPA 319 Nonpoint Source Pollution Program funds over the last three years, along with other sources to meet EPA's required 40% non-federal match. Keeper's other monitoring support has included grants from the Skaggs Foundation ($8,000 in 1999 and $10,000 in 2001), EPA Wetlands Development Program ($8,824 from a collaborative grant with the Homer Soil and Water Conservation District and Community Rivers Planning Coalition in 2002), Norcross Wildlife Foundation ($10,000 in 1999 and $13,000 in 2001), River Network Watershed Assistance Grant

($20,000 in 1999), Bullitt Foundation ($10,000 in 2001), individuals and businesses (~$10,000/yr.) fees for GIS services (~$5,000/yr.), and in-kind contributions of time and services (~$25,000/yr.).

Keeper's monitoring budget for FY 03 is $205,634. Keeper anticipates a few more years of funding from ADEC, including $105,000 in FY 03. In addition, other pending and possible grants include: $18,000 from the Norcross Wildlife Foundation, $10,000 from the Ben and Jerry's Foundation, $15,000 from the U.S. Fish and Wildlife Service Coastal Program, and $5,000 from the FishAmerica Foundaiton. Keeper will raise additional funding from other grants, individuals, businesses and fees for services.

Funding from the *Exxon Valdez* Trustee Council will provide Keeper with an opportunity to continue collecting important flow data from lower Kenai Peninsula salmon streams. This data will provide important information to enhance the understanding, monitoring, and protection of these watersheds.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Not applicable.

PROPOSED PRINCIPAL INVESTIGATOR IF KNOWN

Name:	Joel Cooper, Research Coordinator
Affiliation:	Cook Inlet Keeper
Mailing Address:	PO Box 3269, Homer, Alaska 99603
Phone number:	(907) 235-4068
Fax number:	(907) 235-4069
E-mail Address:	joel@inletkeeper.org

PRINCIPAL INVESTIGATOR

Joel joined Keeper's staff in 1998. Joel coordinates and oversees citizen water quality monitoring in Kachemak Bay. Prior to joining Keeper, Joel's work experience includes conducting stream surveys for the U.S. Forest Service, serving as an Organic Chemist for the Rocky Mountain Analytical Laboratory, and working as Environmental Scientist for the Southern Illinois University Department of Pollution Control. Joel has a B.S. in Environmental Studies focusing on forestry, plant and soil sciences from Southern Illinois University.

OTHER KEY PERSONNEL

Sue Mauger, Keeper's Stream Ecologist, will compile flow data from USGS and correlate these data with Keeper's water quality information in the annual report for the salmon stream monitoring project.

Miranda Weiss, Keeper's Development Director, will conduct grant administration and reporting.

Kathy Peel, Keeper's Office Manager, will be responsible for financial administration of this grant.

Ninilchik Traditional Council
Environmental Programs Office
P.O. Box 39070
Ninilchik, Alaska 99639
Ph: 907 567-4394 / Fx: 907 567-4395
E-mail: boepg@ptialaska.net

April 11, 2002

Joel Cooper, Research Coordinator
Cook Inlet Keeper
P.O. Box 3269
Homer, AK 99603

Dear Joel:

As you know, the Ninilchik Traditional Council is in the ongoing process of developing community water and wastewater programs for the community of Ninilchik and neighboring communities encompassed within our Tribal Boundaries. In addition, we have current grant funding to develop a comprehensive set of Tribal Environmental Policies, Enacting Ordinances and Enforcement Policies. To meet the objectives and goals of these programs, accurate and consistent water quality and quantity data must be available. The Ninilchik Traditional Council relies on gauging stations, including the Ninilchik River gauge, for this important information.

The success and future development and implementation of the Tribe's Environmental and Water Resource Programs depend on access to the data available from the Ninilchik River gauge. Impacts from unprecedented development along our local rivers and streams will certainly result in catastrophic degradation to the quality of these waters if we do not make every possible effort at this time to preserve all of the data and science that we currently have at our disposal and incorporate this data in useful ways into our monitoring and protection efforts. Losing the consistent scientific data currently obtained from the USGS Ninilchik River gauge will perpetuate profound negative impacts to all future attempts to protect these important waters, and will simultaneously scuttle the water programs which our Tribe and others have worked so diligently to devise in an effort to promote understanding and protection of the waters on which we so greatly depend.

The Ninilchik Traditional Council will make all efforts to pursue whatever level of positive contribution it can make to assist in the long-term maintenance of the Ninilchik River gauge. Because the Tribe is eligible to receive 50% matching funds from USGS, I will contact USGS and EPA and others to see what financial and political resources we can secure to address this important issue. We do not want to see all of our past efforts diminished as a result of the Ninilchik River gage being removed at such an important time.

Sincerely,

Bruce Oskolkoff
President
Ninilchik Traditional Council

Budget Category:	Authorized FY 02	Proposed FY 03	
Personnel		$1.6	
Travel		$0.5	
Contractual		$10.5	
Commodities		$0.0	
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS
Subtotal	$0.0	$12.6	Estimated FY 04
Indirect		$1.9	
Project Total	$0.0	$14.5	None
Full-time Equivalents (FTE)		0.0	
			Dollar amounts are shown in thousands of dollars.
Other Resources			

Comments: Matching funds for Cook Inlet Keeper's Lower Kenai Peninsula Salmon Stream Monitoring project are provided primarily through ADEC's Nonpoint Source Pollution program ($45,000 in FY 2002 and an anticipated $45,000 in FY 2003). The FY 2003 budget for this project is $67,770. Keeper secures additional funds for this project through grants from private foundations ($10,000 from Bullitt Foundation in 2001 and $6,000 pending from the Norcross Wildlife Foundation), other state and federal grants, membership and business contributions, and fees for services. Cook Inlet Keeper uses an indirect cost rate of 15% to account for grant administration and reporting, financial reporting, and other indirect costs (portion of rent, utilities, etc.) related to this project. Expenses related to participation at the EVOS workshop represent $900 (personnel, travel, and accomodations for Stream Ecologist) of the budget. Expenses related to report writing represent $300 of this budget.

FY03

Prepared: 4/12/02

Project Number: 03596
Project Title: Securing Flow Data for a Lower Kenai Peninsula Salmon Stream
Name: Cook Inlet Keeper

FORM 4A
Non-Trustee
SUMMARY

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 03
J. Cooper	Research Coordinator		0.2	2.9		0.4
S. Mauger	Stream Ecologist		0.4	2.9		1.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.6	5.8	0.0	
					Personnel Total	$1.6

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 03
1 RT Homer to Anchorage - EVOS Workshop		0.2	1	2	0.1	0.3
1 Rental Car - 2 days for EVOS Workshop ($50/day)						0.1
Accomodation 2 nights - EVOS Workshop ($50/day)						0.1
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$0.5

FY03

Prepared: 4/12/02

Project Number:
Project Title: Securing Flow Data for a Lower Kenai Peninsula Salmon Stream
Name: Cook Inlet Keeper

FORM 4B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FY 03
Contract with USGS to maintain Ninilchik River gauge for one year (minus 50% match from USGS)	10.5
Contractual Total	$10.5

Commodities Costs:	Proposed
Description	FY 03
None	
Commodities Total	$0.0

FY03

Prepared: 4/12/02

Project Number:
Project Title: Securing Flow Data for a Lower Kenai Peninsula Salmon Stream
Name: Cook Inlet Keeper

FORM 4B
Contractual & Commodities DETAIL

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 03
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.	**New Equipment Total**		$0.0

Existing Equipment Usage:	Number	
Description	of Units	
None		

FY03

Project Number:
Project Title: Securing Flow Data for a Lower Kenai Peninsula Salmon Stream
Name: Cook Inlet Keeper

FORM 4B
Equipment
DETAIL

Prepared: 4/12/02

4/15

A synthesis of the ecological findings from the EVOS Damage Assessment and Restoration Programs, 1989-2001

Project Number:	03600
Restoration Category:	Monitoring, Research
Proposer:	Robert B. Spies, EVOS Chief Scientist, Applied Marine Sciences, and collaborators
Lead Trustee Agency:	Alaska Department of Natural Resources
Cooperating agencies:	None
Alaska SeaLife Center:	No
Duration:	2nd year, 3 year project
Cost FY 03:	$212.0K
Cost FY 04:	$184.8K
Geographic Area:	No field work

Injured Resource/Service: All resources

ABSTRACT

This project is synthesizing the results from 12 years of post-spill study in the EVOS damage assessment and restoration programs in the context of anthropogenic and natural factors causing change in the northern Gulf of Alaska ecosystem. The results of the work will be an integrated synthesis book. The book will consist of three major sections: 1. The basic structure and function of the ecosystem, 2. How does it change over time and in respond to disturbances? and, 3. The effect of the spill: how our understanding of the ecosystem has matured and what future path will help us better understand this valuable marine ecosystem? The book will be a major product of the EVOS restoration program and help set the foundation for the Gulf Ecosystem Monitoring Program.

INTRODUCTION

The effort being proposed is a synthesis of the main scientific findings from the EVOS Restoration Program, with an emphasis on what new has been learned about the affected ecosystem, particularly the variability in this ecosystem in response to the spill and to natural factors. It will be based mainly on the products of the scientific studies following the spill and will cover the period of 1989 to 2001, with reference of course to literature covering earlier ecosystem responses and significant findings from non-EVOSTC studies. Publications, final reports and data will be evaluated to determine what can learned about human and natural forcing factors in the spill area ecosystem.

The following is a brief summary of FY 2002 activities to date (4/15/02). The final consideration of this project for funding was deferred from the August 2001 meeting of the Trustee Council to the December 2001 meeting. The project was approved at the later meeting. The contract between ADNR and Applied Martine Sciences for this project was signed in February 2002. A meeting was held of all the major collaborators in Anchorage late in February 2002. At the meeting the structure, approach and general flow of topics in outline of the book was agreed to by the participants. Particular emphasis was given to integration of the subject matter and collaboration of contributors within the major sections or chapters of the book. Also, all agreed that the book should be written in a manner that would appeal to and be understood by the educated non-scientist. Among other implications this placed a greater emphasis on imaginative graphics and straight forward presentation of concepts, keeping scholarly elaboration and qualification to a minimum. The other major objectives for FY 2002 are also being addressed. The relevent publications are being gathered and inventoried. In addition, an approach is being formualted for a proposal to potential publishers for the book.

NEED FOR THE PROJECT

A. Statement of the problem

The proposed long-term monitoring and research program for the northern Gulf of Alaska (GEM) is best put in place on a solid foundation from previous intensive work in the ecosystem affected by *the Exxon Valdez* Oil Spill. With over 300 separate research projects addressing all major ecosystem components for 12 years, and many simultaneous studies that potentially captured large-scale variability in various ways, and with major ecosystem studies now completed, but with minimal interaction between them, the foundation has been laid in the damage assessment and restoration programs for a comprehensive synthesis. And, with at least some GEM activities due to start in FY 2003 and to expand

slowly over the first 5 years of the program, the time for a synthesis is in FY 2002-2004.

One of the primary needs for this synthesis includes an update of the current conceptual model of ecosystem forcing that is contained in the Gulf Ecosystem Monitoring Program Plan; GEM 2001 (www.oilspill.state.ak.us).

Since the occurrence of the spill much has been learned about long-term ecological change in the north Pacific, both due to human activities and due to climate variability. The efforts to ascribe ecological change to particular causes over the last 12 years have been focused on various aspects of the ecosystem and have produced over 300 publications by Trustee Council scientists and an almost equal number form Exxon-sponsored studies. Recent analyses of multiple biological and physical data sets indicate that large-scale climate-induced shifts occurred in the North Pacific in 1977 and 1989 (Hare and Mantua, 2000). Another change may be underway starting in 1999 or 2000. These changes, particularly the change in mid-1970s corresponded with profound changes in the production of some fish stocks (Francis et al., 1998). Both of these shifts likely had consequences that interacted in unique ways with the massive damage from the *Exxon Valdez* oil spill and the subsequent recovery of the ecosystem.

B. Rationale/link to Restoration

Beginning in 2003 a new phase of the restoration process will start, long-term monitoring supported by the Restoration Reserve. This effort, the Gulf Ecosystem Monitoring Program (GEM) has as one of its main goals detection of natural and anthropogenic change in the ecosystem. The program will be based on a conceptual model that describes how the ecosystem works and how it varies with external forcing factors, both natural and human. The program is being designed so that this model will change as our knowledge of the Gulf of Alaska matures and deepens. Ecological insight that can inform this conceptual model will be especially useful in the next several years. The National Research Council (NRC) is conducting a review of the proposed program and plan. One of their main recommendations is to build GEM on a good understanding of what has been learned from the last 12 years. In order to do this, the NRC and many scientists familiar with the Restoration Program have suggested that a comprehensive scientific synthesis be performed, with special emphasis on what has been learned from EVOSTC research.

C. Location

There is no field work being proposed for this project. The outcome of this study should contribute substantially to GEM and eventually to a better understanding

of the ecosystem on which the coastal communities of the northern Gulf of Alaska depend.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

We will interact with regional communities and subsistence users principally in two ways. First, In the first year of the project all of the community facilitators, and the Chugach Regional Resource Commission will be contacted during the information gathering phase of the project. They will be invited to contribute to the synthesis. Secondly, during the completion of the work a multimedia display will be developed to explain the findings of the study in understandable terms and presentations made at those communities that wish to participate.

PROJECT DESIGN

A. Objectives

The project has the following objectives for FY 2002:

The objectives for FY 2003 are to:

A, Do the bulk of the writing of the synthesis.

B. Formulate and begin to execute a plan for graphics based on the outline, text and consultation with the chapter contributors.

C. Hold a meeting mid-year of the P.I.s to discuss progress on component chapters and to integrate approaches and effort the book.

D. Complete rough drafts of the component chapters of the integrated synthesis.

The Objectives for FY 2004 include:

1. Exchange drafts for internal review by synthesis team, make recommendations for change and revise chapters.

2. Make a multimedia presentation for the public.

4. Obtain outside peer review of revised rough draft.

5. Submit synthesis to the publisher.

B. Methods

The methods for conducting this synthesis are those employed in a large scholarly undertaking. They can conveniently be broken down into the following steps:

1. *Gathering the relevant information.* All of the EVOS final reports are in the office of Bob Spies, who will serve as Principal Investigator and editor. These reports are also available as PDF reports online at www.dtlcrepository.downlegal.com/ARLIS-/PDF. Many of the publications from the scientific literature are also available in Spies's office, at ARLIS, or at the EVOS Restoration Office in Anchorage. Bibliographies of Trustee- and Exxon-sponsored studies is kept by the EVOS Restoration Office. Publications will be gathered and distributed by administrative staff at Applied Marine Sciences (AMS). ARLIS, the natural resources library in Anchorage, is available to support this phase of the project. AMS also subscribes to Cambridge Scientific Abstracts, an online service that provides literature searches returning full references for publications and their abstracts. Each of the contributing authors will be asked to keep a reference list using Endnote or another mutually agreed upon software package. These lists will be exchanged between authors and the editor to identify additional literature.

2. *Evaluation.* Each of the contributing authors will read the appropriate reports and publications, examine the relevant data sets, and then evaluate them with regard to anthropogenic and natural forces in ecosystem change. Contributing authors will be asked to take notes on phenomena reported by the authors of the primary literature that may be the results of system forcing.

3. *Initial synthesis meeting*: Early in the project, in the spring of 2002 and before the initial evaluation of the literature takes place, all of the contributing authors will meet and discuss innovative ways to approach the synthesis. It is likely that some approach based strongly on ecosystem processes will emerge given the backgrounds and initial discussions among the team. Writing assignments will be made during this meeting. It is envisioned that each chapter in the synthesis will have a lead author and others that contribute in order to have the maximum degree of sythesis.

4. *Chapter outlines.* Following the meeting, an outline of each of the chapters will be produced and a reference list will be circulated among the entire synthesis team. These lists will be reviewed and revised in light of any comments provided. The outline for the integrated synthesis will then be finalized.

5. *Obtaining a publisher.* The leading potential book publishers will be contacted to determine their interest in the synthesis based on the outline. A publisher will be chosen and negotiations for publications will be undertaken.

6. *Manuscript preparation.* The individual authors will write their chapters based on the outline. The editor will hold periodic conference calls and at least one face-to-face meeting per year will be held.

7. *Initial review.* Draft manuscripts will be exchanged among authors and with the editor during the first part of FY2003 for review.

8. *First revisions.* Review comments from authors and the editor will provide a basis for the first revision. The editor will monitor progress and encourage completion as the deadline for revisions of the drafts approaches. At this stage we will contract with an independent science writer to suggest changes to make the book more accessible and engaging for the non-scientist.

9. *Independent review.* Outside reviewers will be enrolled to review the revised manuscripts and provide written comments.

10. *Final revision.* The final revisions will be incorporated and the manuscripts submitted for publication.

C. Organization

The following is the revised general outline for the book. :

1. Introduction
2. Ecosystem structure and function.
    - physical processes and forcing, currents and tides, eddies and fronts
    - nutrient cycling and transport
    - biological processes and productivity

3. Ecosystem change
    - description of long-term changes in the ecosystem
        - pre-spill
        - post-spill
    - correlative associations
    - mechanisms

4. Summary of synthesis, including a revised conceptual model for GEM

D. Cooperating agencies, contracts, and other agency assistance.

The Principal Investigator is an employee of AMS, which is proposed as the prime contractor for production of this synthesis. All of the other author contributions will be written on fixed price contracts with the authors contracted as consultants to AMS.

SCHEDULE

A. Measurable project tasks for remainder of FY2002 (informational) and FY2003 (proposed)

July 2002	Preliminary chapter outlines completed and list of references assembled
August 2002	Book outline finalized
September 2002	First drafts of chapters initiated
November 2002	Negotiations with a publisher completed
February 2003	Second meeting of synthesis team for integration
June 2003	Rough drafts of all chapters due
August 2003	Completion of internal reviews of chapter rough drafts
September 2003	Chapter reviews redistributed to authors with recommendations for revision
December 2004	Multimedia presentation completed
March 2004	Revised chapters due from authors
April 2004	Start of external review of chapters
June 2004	External chapter reviews due, distribute to authors
August 2004	Final revised chapters due
September 2004	Send entire manuscript to publisher

B. Project milestones (see schedule above)

C. Completion date

The project will be completed in September 2003.

PUBLICATION AND REPORTS

The manuscript for book will be produced at the end of the three-year period. The title will be decided at a later date.

PROFESSIONAL CONFERENCES

The P.I. requests travel to one professional conference in 2003 to present the results of the synthesis effort and travel expenses to one annual EVOS meeting for each of the authors.

NORMAL AGENCY MANAGEMENT

Not applicable, as none of the authors is from an agency.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Coordination will be through the Office of the Chief Scientist working with the staff of the Restoration Office and ARLIS to obtain the materials necessary to complete the proposed work.

EXPLANATION OF CHANGES

The following changes have been made in the proposal approved by the Trustee Council in December 2001:

1. The outlline has been changed as a result of the first meeting of the collaborators. It is now organized into the introduction three major chapters dealing with ecosystem structure and change and a revision of the GEM conceptual model.

2. It has been decide to write the book in such a way as to make it very interesting and readable for an educated non-scientitst. This will involve making the presentation of the material concise with abundant support by imaginative graphics.

3. In order to keep the cost of publishing the book and its price reasonable, we will have to have a copy-ready manuscript available to the publisher rather than just a standard manuscript text. This will require that more of the internal funds be available for document preparation and text-graphics integration. This was consensus opinion at the first meeting of the writing team.
4. We have invited Dr. Gordon Kruse of the University of Alaska to join the team to add expertise in fisheries, crustaceans and fisheries management. This was also a consensus opinion at the first meeting of the writing team.

PROPOSED PRINCIPAL INVESTIGATOR

Robert B. Spies, Ph.D.
EVOS Chief Scientist
Applied Marine Sciences
4749 Bennett Dr., Suite L
Livermore, CA 94550
Phone (925) 373-7142
Fax (925) 373-7834
e-mail address: spies@amarine.com

Principal Investigator

Dr. Robert B. Spies has a Ph.D. from the University of Southern California (1971). He has over 30 years of expereince in marine science. He has been Chief Scientist to the EVOS Trustee Council since 1990. In that role he has reviewed all of the reports for the many scientific projects conducted following EVOS, conducted numerous workshops to identify gaps in studies of natural resources impacted by the spill, and has reported to the Executive Director and the Trustee Council on the status of the impacted ecosystem on a regular basis. Dr. Spies is also past editor of *Marine Environmental Research* and serves on its Editorial Board. He also serves on the Editorial Board of *Aquatic Toxicology*. He has over 40 publications on marine ecology and ecotoxicology.

Other key personnel

Dr. Thomas Weingartner. Dr. Thomas Weingartner is an observational physical oceanographer on the faculty of the University of Alaska's Institute of Marine Science. For the past twelve years he has conducted research in the seas and oceans surrounding Alaska, including the Gulf of Alaska, Prince William Sound, and the Bering, Chukchi, and Beaufort seas. He is currently a Principal Investigator in the Gulf of Alaska GLOBEC program. His research interests include the effects of physical environmental variability on marine ecosystems.

Robert T. Cooney received his doctoral degree in Biological Oceanography from the University of Washington, Seattle (1971). He joined the faculty of the University Alaska Fairbanks and studied the plankton communities of Alaska waters for 30 years. His specialties include zooplankton assemblages found in coastal, shelf and oceanic waters of the northern Gulf of Alaska and Bering Sea. Dr. Cooney has had extensive experience with food-webs supporting juvenile pink salmon in Prince William Sound dating back to 1976. Collaborative investigations with the Prince William Sound Aquaculture Corporation and Alaska Department of Fish and Game were responsible for acquiring and using a real-time oceanographic buoy system in the Sound to log seasonal and annual changes in surface ocean climate and plankton. Most recently Dr. Cooney was the Lead Scientist for the EVOS-sponsored Sound Ecosystem Assessment (SEA) study of the post-spill recovery of pink salmon and herring. He is presently helping to revise the Gulf Ecosystem Monitoring program and implimentation studies.

Dr. Stan Rice-Stanley D. Rice has a Ph. D. in comparative physiology from Kent State University (1971). He has 30 years of experience in oil pollution work in Alaska; 15 years of program manager experience at the Auke Bay Lab; 12 years of experience on the *Exxon Valdez* spill. Short and long-term damages, and oil persistence are his primary research areas. Dr. Rice has over 100 peer-reviewed publications on oil effects. These publications include reviews and synthesis articles, covering effects of oil on fish, and specifically effects of oil on pink salmon. He has also contributed to the National Academy of Science reviews of oil inputs and effects. Dr. Rice has 25 papers on other contaminant issues as well.

Dr. Alan Springer has been involved in marine bird and mammal research in the N. Pacific for 25 years. In that time He has conducted studies at numerous breeding sites and at sea from southeastern Alaska to the Arctic Ocean, thereby gaining first hand knowledge of the haunts and habits of seabirds and marine mammals and an appreciation of the needs for and limitations of information on them. He also has broad experience in oceanographic studies and in research with lower trophic levels. As a peer reviewer during development of the APEX study, and as a core reviewer now, he is familiar with studies that have been supported by EVOSTC, as well as by others that are relevant to the goals of this synthyesis. Throughout his career, he has attempted to understand birds, mammals, fish, and plankton in the context of marine food webs and the physical environment. Dr. Springer has published several papers that synthesize large amounts on information on various aspects of the marine ecology of the N. Pacific

Dr. Jennifer Nielsen-- Dr. Nielsen has a Ph.D. from the University of XXX (19XX). Dr. Nielsen has XX years of experience as a geneticist and XXXX. Her work included xxxxxxxxxxxxxxxxxxxxxxx. Dr. Nielsen currently is the xxxxxxxxxxxx, Anchorage, AK.

Dr. Gordon Kruse---

Personnel time allocation

The involvement of the Chief Scientist, Dr. Spies, in the Restoration Program, is declining, particularly with regard to holding reviews and workshops. It is also anticipated that more of the administrative functions for the science program will reside in the EVOS office in FY2002-FY2003 than had previously been the case. Consequently, Dr. Spies will have the time to act as the Principal Investigator for this effort. Dr. Spies will be a very active editor and bring his extensive knowledge of the program to bear. He will be engaging the authors on a variety of issues and suggesting cross-cutting themes in the synthesis.

Literature Cited

Francis, R.C., S.R. Hare, A.B. Hallowed and W.S. Wooster. 1998. Effects of interdecadalk climate variability on the oceanic ecosystems of the NE Pacific. Fisheries and Oceanography7, 1-21.

Hare, S.R. and N.J. Mantua. 2000. Empirical evidence for North Pacific regime shifts in 1997 and 1989. Prog. Oceanogr. 47, 103-145.

Peterson, C. 2001. The *Exxon Valdez* oil spill in Alaska: Acute, indirect and chronic effects on the ecosystem. Advances in Mar. Biol. 39, 1-103.

03600

Scientific Support Services-Planning for EVOS Synthesis
Year 2, Cost Summary
Prepared by
Applied Marine Sciences, Inc.

Task & Personnel	Total Hours	Rate	Cost	Total
SYNTHESIS				
Robert Spies	734	$122.89	$90,200.75	
Diane Stafford	51	$30.67	$1,564.34	
Sue Chase	88	$57.40	$5,051.37	
Deborah Florer	76	$43.68	$3,319.85	
Nearshore Biologist	50	$100.00	$5,000.00	
Contract Writers	440	$100.00	$44,000.00	
Reviewers	25	$100.00	$2,500.00	
Subtotal			$151,636.31	$151,636
Other Direct Costs				
Travel			15,852.00	
Shipping/Communications			1,023.00	
Graphic Presentations			8,000.00	
Miscellaneous			800.00	
Total Direct Costs				**$25,675**
Total Labor and Direct				$177,311
Gen. and Admin. Overhead	6.40%		$11,347.92	
Fee (5%)			$9,432.96	
TOTAL COST				**$198,093**

+ GA 13.9

$212.0

03600
backup

Scientific Support Services - Planning for EVOS Synthesis
Labor Hours, Year 2
Prepared by
Applied Marine Sciences, Inc.

TASK	AMS Labor Hours						Contract Writers / Reviewers	
	Spies	Stafford	Chase	Florez	Gunther	Bell	No.	total hours
EVOS Synthesis								
Plan	44	15		6				
Coordinate	50	12	12	12				
Review	300	18		16				
Meetings	40		32	36				
Writing	300	6		6				
Contract Writers / Reviewers								
First Draft			44				4	200
Final Report							4	240
Nearshore Biologist							1	50
Reviews							5	25
subtotal	734	51	88	76			14	515
Total Labor Hours	734	51	88	76			14	515

Scientific Support Services - Planning for EVOS Synthesis
Year 2, Travel Costs
Prepared by
Applied Marine Sciences, Inc

03600
backup

TASK	number	days @ $42	nights@ $115	airfare	Cost
Systhesis Meetings	12	36	36	$10,200.	$15,852.
(2 mtg for RBS + 5 writers)				$0.	$0.
Total	12	$1,512.	$4,140.	$10,200.	$15,852.

Project Title: Submitted Under the BAA - Creating a Comprehensive Geographic Information Systems (GIS) Map of Water Quality Monitoring Sites Across the Gulf of Alaska

Project Number:	03607-BAA
Restoration Category:	
Proposer:	Cook Inlet Keeper
Lead Trustee Agency:	NOAA
Cooperating Agencies:	ADEC
Alaska SeaLife Center:	No
Duration:	1-year request for funding
Cost FY 03:	$12,000
Geographic Area:	State of Alaska
Injured Resources/Service:	This project will result in direct and indirect benefits to all injured resources and lost or reduced services located in the Cook Inlet basin.

ABSTRACT

Cook Inlet Keeper will synthesize existing data to create a comprehensive Geographic Information Systems (GIS) map and database of monitoring sites across the Gulf of Alaska. This map will be published in hardcopy and will be linked to CIIMMS and STORET, through which the map and data can be easily updated and made available to monitoring entities as well as policy-makers, scientists, and the general public. This map and the accompanying data will serve as a lasting tool for the restoration and protection of the Gulf of Alaska's resources by coordinating diverse monitoring efforts and establishing a framework into which information about current and future monitoring programs can be entered.

INTRODUCTION

Cook Inlet Keeper requests $12,000 in one year of funding from the Exxon Valdez Oil Spill Trustee Council through the GEM Transition: Synthesis and Retrospective Analysis Program to create a comprehensive Geographic Information Systems (GIS) map of all water quality monitoring sites in the Gulf of Alaska's offshore, Alaska Coastal Current, nearshore, and watershed habitats.

Cook Inlet Keeper was the first community-based group in Alaska to implement a credible Citizens' Environmental Monitoring Program founded on U.S. Environmental Protection Agency- and Alaska Department of Environmental Conservation-approved methods. In 1996, Keeper convened a Technical Advisory Committee comprised of water quality professionals, and began to train volunteers to monitor water quality and habitat in and around Kachemak Bay. As part of its monitoring work, Keeper created Alaska's first EPA- and ADEC-approved Quality Assurance Project Plans and Volunteer Manual which assure scientific credibility of citizen-collected data.

As a result of its successes, Keeper has moved into a Quality Assurance Agent role to guide and support other Cook Inlet communities in their efforts to establish similar monitoring programs. Keeper works with the Kenai Watershed Forum to support citizen-based monitoring of the Kenai River, and with University of Alaska Anchorage's Environment and Natural Resources Institute, Anchorage Waterways Council, and Wasilla Soil and Water Conservation District through formal Memoranda of Understanding to facilitate volunteer monitoring in the Anchorage Bowl and the Mat-Su Valley. These groups make up CEMP, the Citizens' Environmental Monitoring Program, which uses Keeper's EPA- and ADEC-approved protocols to train volunteers to collect water and habitat quality data throughout the Cook Inlet watershed. Keeper also networks with Anchor Point's Community Rivers Planning Coalition, Seldovia Oil Spill Response Team, Ninilchik Traditional Council, and Port Graham/Nanwalek Watershed Council on monitoring projects in Kachemak Bay and on lower Kenai Peninsula salmon streams.

In December 2000, Keeper organized the first annual full-day meeting of partner organizations monitoring water and habitat quality in the Cook Inlet watershed. This meeting was well attended by over 26 professionals representing 14 different organizations and agencies. At the meeting, monitoring groups expressed the need for consistent management and representation of water quality data, and easy access by the public to this important information. Keeper took the lead in convening a Database Committee of representatives from the partner monitoring groups and in raising funds to support the project. Currently, grants from the *Exxon Valdez* Oil Spill Trustee Council and the U.S. Fish and Wildlife Service Coastal Program are providing Keeper with an opportunity to work with its CEMP partners and ADEC to establish a unified water quality and habitat database and make it accessible on the Internet.

In February 2002, Keeper held the Second Annual Conference of water quality monitoring partner organizations and agencies at the Alaska Forum on the Environment in Anchorage. The groups represented included: Cook Inlet Keeper; Alaska Boreal Forest Council; Alaska Department of Environmental Conservation; Alaska Department of Fish and Game; Alaska Department of Natural Resources; Anchorage Waterways Council; Association of Village Council Presidents; Cooperatively Implemented Information Management System (CIIMMS); Chikaloon Village; Division of Governmental Coordination; *Exxon Valdez* Oil Spill Trustee Council; Homer, Upper Susitna and Wasilla Soil and Water Conservation Districts; Kenai

Watershed Forum; Native American Fish and Wildlife Society; Native Village of Eklutna; Native Village of Elim; Port Graham/Nanwalek Watershed Council; Port Graham Village Council; Seldovia Village Tribe; Stebbins Community Association; University of Alaska Anchorage's Environment and Natural Resources Institute; U.S. Environmental Protection Agency; U.S. Fish and Wildlife Service; and U.S. Geological Survey.

Keeper facilitated a roundtable discussion during which participants expressed a need for a map showing all water quality monitoring sites across the Gulf of Alaska. All organizations and agencies present felt this map would be an important tool for the coordination of monitoring efforts and the protection of water quality.

In 1997, Cook Inlet Keeper created the first *Cook Inlet GIS Atlas* on CD ROM. The Atlas contains a wealth of information on the region including marine mammal habitat, salmon streams, transportation routes, and property boundaries. Keeper conducted educational workshops with the Atlas in Native Villages around Cook Inlet, and made the CD ROM available to schools, agencies, and organizations. Keeper's GIS Atlas has been widely used by schools, the Kenai Peninsula Borough, and other entities. Since the publication of the Atlas, Keeper has been successfully incorporating GIS into all of its programs. Keeper uses GIS maps to relay important watershed issues in engaging ways to the public, to help prioritize habitat in need of protection, and to aid in designing water quality monitoring programs.

With ongoing success at using GIS to protect the Cook Inlet watershed, Keeper is well-prepared to synthesize information available from agencies and organizations to create a comprehensive GIS map showing water quality monitoring sites across the Gulf of Alaska. This map, which could easily be expanded to include state-wide efforts, will provide a framework for consistent representation of Gulf of Alaska monitoring programs and help organizations and agencies understand their role in the monitoring of Alaska's public resources. In addition, the map will help organizations and agencies design their monitoring efforts so that they are as effective and efficient as possible and it will provide an opportunity to assess where water quality monitoring is needed.

This map and its data must be easily updated in order for this project to serve as a lasting tool for the restoration and protection of the Gulf of Alaska's resources. To fulfill this need, Cook Inlet Keeper will coordinate with the Alaska Department of Environmental Conservation to incorporate this GIS map and its data into the Cook Inlet Information Management and Monitoring (CIIMMS) web site and ADEC's development of an interface with the STORET database. Through CIIMMS, ADEC will establish an easy mechanism for organizations and agencies to update their data according to the framework and format Keeper has created. This will provide an opportunity for the GIS data and map to show current and accurate information about water quality monitoring across the Gulf of Alaska.

With consistent, credible, and comprehensive monitoring across the Gulf of Alaska and beyond, organizations and agencies can work together to assess the state of water quality and ensure that public resources, such as sport and commercial fisheries and wildlife habitat, are protected now and into the future.

NEED FOR THE PROJECT

A. Statement of Problem

The *Exxon Valdez* oil spill impacted the rich biological and economic resources of the Gulf of Alaska. The spill traveled nearly 500 miles from Prince William Sound to the Alaska Peninsula, soaking over a thousand miles of coastline and the ocean floor with crude oil. As a result, this region's water resources, and the services which they support, were seriously impacted. Some species of water fowl and marine mammals show little or no signs of recovery and the Gulf's important fisheries still show signs of impact.

Some recovery has occurred, but the Gulf of Alaska's sensitive resources face additional threats from a host of ongoing, unsustainable activities, including additional oil spills from an aging oil and gas infrastructure and changes in land use. Organizations such as Cook Inlet Keeper and agencies such as ADEC and NOAA have recognized the need for long-term water quality monitoring to establish a benchmark for measuring future changes and to ensure that public resources such as fisheries and wildlife are protected now and into the future.

Because of the need for water quality data and the high level of interest and involvement of diverse organizations and agencies in monitoring, we must invest in tools that help unify these efforts. A comprehensive map of water quality monitoring sites across the Gulf of Alaska will help make water quality monitoring efforts efficient and effective, and provide an opportunity to assess where more monitoring is needed.

B. Rationale/Link to Restoration

The economic and social wellbeing of the Gulf of Alaska's coastal communities depends on healthy resources such as fisheries and wildlife habitat. One of the challenges in the efforts to restore the environment following the *Exxon Valdez* oil spill has been the lack of adequate data describing conditions prior to the spill. Many diverse organizations and agencies, as well as citizens from diverse communities, are stepping in to collect important water and habitat quality data that provide information on baseline conditions and be used to track environmental changes.

It is essential that these monitoring efforts are credible and consistent, and that monitoring funds and efforts are used as effectively and efficiently as possible. To date, no map exists that pulls together all of the existing offshore, Alaska Coastal Current, nearshore and watershed water quality monitoring sites across the Gulf of Alaska. This map will be an important tool to make monitoring as efficient and effective as possible and ensure that monitoring is initiated or continued where it is needed most. By aiding region-wide monitoring efforts, this map will help all organizations and agencies working to restore the Gulf of Alaska's important resources.

C. Location

Cook Inlet Keeper, located in Homer, will create a GIS map that includes all water quality monitoring sites in offshore, Alaska Coastal Current, nearshore, and watershed habitats of the Gulf of Alaska.

COMMUNITY INVOLVEMENT AND TRADTIONAL KNOWLEDGE

Cook Inlet Keeper and its CEMP partners have shown that successful habitat and water quality monitoring can be a community-owned and community-driven effort. Citizen-based monitoring is a highly effective way to bridge the gap between citizens and natural resource agencies. Citizens are directly involved in collecting and tracking water quality information, and have a greater sense of ownership of the monitoring findings.

This project will further community involvement in the restoration and protection of Gulf of Alaska resources by providing communities with a greater understanding of where water quality monitoring is occurring, improving access to monitoring results and translating this information in visual ways which are educational and meaningful. GIS maps are particularly effective tools for engaging communities because they are eye-catching, informative, and easily understood. Audiences which may find particular use for a comprehensive water quality monitoring map include community planners, local and Tribal governments, commercial and sport fishermen, university personnel and students, environmental consultants, decision makers, and resource agencies such as Alaska Department of Fish and Game, U.S. Fish and Wildlife Service, U.S. Geological Service, and others.

PROJECT DESIGN

Objectives

1. Create a GIS map that illustrates all water quality monitoring sites in offshore, nearshore, Alaska Coastal Current, and watershed habitats of the Gulf of Alaska.

2. Make this map available citizens, organizations, and agencies as a link from CIIMMS and STORET.

A. Methods

This synthesis project will involve the collection of existing data only. The data will be synthesized, then presented on paper and digital maps using Geographic Information Systems software (Environment and Natural Resource Institute's ArcView 3.2a, and ArcExplorer).

Keeper's GIS Specialist will identify agencies and groups with pertinent environmental monitoring data. He will then gather the following data about each monitoring program: location (latitude and longitude); entity conducting monitoring; type of data collected (physical, chemical, & biological); type of site (offshore, nearshore, stream, etc.); and status of monitoring (active or inactive). He will then process data using ArcView 3.2a. Processing involves re-projecting all data into the same coordinate system, and creating a simple database (associated with the digital product) to record data source, type, dates, as well as other information about monitoring program. Once data are processed, ArcView 3.2a together with additional data (such as shoreline, lake or stream locations) will be used to create attractive, legible, 24" x 34" paper maps. ArcExplorer will be used to assemble the data into a simple project that can be read by anyone with a modern PC. (ArcExplorer is available as a free download from www.esri.com). In

addition, Keeper will create a prototype CD with the GIS map and data to supply to the *Exxon Valdez* Oil Spill Trustee Council at the conclusion of the project.

B. Cooperating Agencies, Contracts and Other Agency Assistance

Diverse agencies and organizations are involved in water quality monitoring in Southcentral Alaska. These include:

Cook Inlet Keeper; Alaska Boreal Forest Council; Alaska Department of Environmental Conservation; Alaska Department of Fish and Game; Alaska Department of Natural Resources; Anchorage Waterways Council; Association of Village Council Presidents; CIIMMS; Chikaloon Village; Division of Governmental Coordination; *Exxon Valdez* Oil Spill Trustee Council; Homer, Upper Susitna and Wasilla Soil and Water Conservation Districts; Kenai Watershed Forum; Native American Fish and Wildlife Society; Native Village of Eklutna; Native Village of Elim; Port Graham/Nanwalek Watershed Council; Port Graham Village Council; Seldovia Village Tribe; Stebbins Community Association; University of Alaska Anchorage's Environment and Natural Resources Institute; U.S. Environmental Protection Agency; U.S. Fish and Wildlife Service; and U.S. Geological Survey.

Cook Inlet Keeper will solicit data from the above entities to complete the GIS map and database. ADEC will also play an important role in this project. ADEC is the primary funder of citizen-based monitoring programs in Alaska and is collaborating closely with monitoring groups to make their data more useful to agencies and more accessible to the public. ADEC is working to link citizen-collected data to EPA's STORET. In addition, ADEC and ADNR manage CIIMMS. Cook Inlet Keeper will work closely with ADEC to establish an easy mechanism for organizations and agencies to update data about their own monitoring programs through an Internet link to the GIS map and data.

SCHEDULE

A. Measurable Project Tasks for FY 02 (October 1, 2002 – September 30, 2003)

October 1- December 1	Identify data sources and collect information
December 1 – February 1	Synthesize data
January	Attend Annual EVOS Workshop
February 1 – April 1	Create Arc Explore project on CD ROM
April 1 – May 1	Publish map and create prototype CD
May 1 – September 30	Make map available as link to CIIMMS and STORET
April 2004	Submit final report to EVOS

B. Project Milestones and Endpoints

Fulfillment of project objectives will be measured by the following milestones:

1. Map created showing all monitoring of offshore, Alaska Coastal Current, nearshore, and watershed sites of the Gulf of Alaska (May 2003)
2. Map available on the internet (September 2003)

C. Completion Date

Cook Inlet Keeper will create a comprehensive GIS map of water quality monitoring sites across the Gulf of Alaska by May 2003, and will submit a final report to EVOS by April 2004.

PUBLICATIONS AND REPORTS

By May 2003, Cook Inlet Keeper will publish GIS maps showing all water quality monitoring sites across the Gulf of Alaska. In addition to the publication of paper maps, Keeper will work with ADEC to make this map and its data available on the Internet as a link from CIIMMS and STORET. Keeper will also create a prototype CD with the GIS data and map.

PROFESSIONAL CONFERENCES

Several professional organizations hold conferences relevant to water quality monitoring. Keeper attends conferences where it may make the best use of its particular experience and expertise, and where Keeper can best benefit from the networking and exchange of information. Through conference participation, Keeper's monitoring work is strengthened and better able to stay current in the field.

In January 2002 Keeper attended the *Exxon Valdez* Oil Spill Trustee Council 2002 Annual Workshop. Keeper will attend the 2003 workshop and may present on the water quality database (project 02668) and the Effectiveness of the Citizens Environmental Monitoring Program (project 02667)

In March 2002 Keeper attended the Technology Networking Conference sponsored by the Alaska Department of Transportation and Public Facilities. This was an information sharing conference looking at the data gathering capabilities of existing and proposed meteorological, natural resource, maritime, and transportation remote sensing sites. Keeper presented information about its monitoring programs and networking capacity at the conference. Keeper plans to attend the conference again next year.

Cook Inlet Keeper plans to attend the 20th Annual Native American Fish and Wildlife Society National Conference, April 29 - May 2, 2002 in Anchorage, Alaska. Attending this conference will continue to build relationships with Native Alaskan communities. The conference covers topics such as watershed and fisheries issues, Indigenous research, Tribes and Environmental groups, and more.

Cook Inlet Keeper plans to attend the Alaska's Oceans and Watersheds: Sustainability in the context of change on June 18-19, 2002 in Anchorage, AK. The two-day symposium is sponsored by: State of Alaska, University of Alaska, *Exxon Valdez* Oil Spill Trustee Council, North Pacific Research Board, North Pacific Fisheries Management Council, Alaska Board of Fisheries, Alaska Coastal Policy Council, NOAA, DOI-USGS/USFWS, and EPA

NORMAL AGENCY MANAGEMENT

Not applicable.

COORDINATION AND INTEGRATION OF RESTORATION EFFORTS

Keeper works closely with agencies involved in habitat and water quality monitoring in the Cook Inlet basin. These agencies include: U.S. Geological Survey, Alaska Department of Environmental Conservation, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, Alaska Department of Fish and Game, Alaska Department of Natural Resources, and the Cook Inlet Regional Citizens Advisory Council. Representatives from each of these agencies participate as members of Keeper's TAC.

In addition, Keeper cooperates with the following organizations and agencies, and provides technical support and quality assurance oversight for water quality monitoring efforts: Alaska Boreal Forest Council; Anchorage Waterways Council; Association of Village Council Presidents; CIIMMS; Chikaloon Village; Division of Governmental Coordination; *Exxon Valdez* Oil Spill Trustee Council; Homer, Upper Susitna and Wasilla Soil and Water Conservation Districts; Kenai Watershed Forum; Native American Fish and Wildlife Society; Native Village of Eklutna; Native Village of Elim; Port Graham/Nanwalek Watershed Council; Port Graham Village Council; Seldovia Village Tribe; Stebbins Community Association; University of Alaska Anchorage's Environment and Natural Resources Institute; and U.S. Fish and Wildlife Service.

Keeper is currently conducting three restoration projects supported by the Trustee Council. In a project that is enhancing the capacity of water quality monitoring in the Cook Inlet watershed, Keeper is working with Kachemak Bay National Estuarine Research Reserve to bring together citizen volunteer monitors and professional researchers to collect water quality data. Keeper and the NERR will work with Vessels of Opportunity to deploy a systematic array of electronic sensors along the south and north sides of Kachemak Bay, which will coincide with volunteer water quality monitoring sites, to assess water circulation patterns throughout the Bay.

In addition, the *Exxon Valdez* Oil Spill Trustee Council has provided Keeper with a grant to analyze the effectiveness of the Citizens' Environmental Monitoring Program to determine if sampling frequency, methods, parameters, and site selection are effective at meeting the monitoring objectives of detecting significant changes in water quality over time. Keeper will share this information with its partner monitoring groups at the conclusion of the project.

A third grant from the Trustee Council is helping Keeper work with ADEC and a database committee to develop a unified database for the reporting and management of data collected by citizen-based water quality monitoring programs. This database, which will make important water quality information easily accessible by policy-makers, scientists, and the general public, will be integrated with CIIMMS.

Cook Inlet Keeper has a close relationship with many other restoration efforts that have been funded by the Trustee Council. Most notably, Keeper shared its *Cook Inlet GIS Atlas* on CD ROM and Annotated Bibliography to assist the Kachemak Bay National Estuarine Research Reserve's Ecological Characterization Project, and CIIMMS. Keeper is linked to the CIIMMS web page, and will link its water quality database and the comprehensive GIS map of monitoring sites in the Gulf of Alaska to CIIMMS. The information Keeper shares with CIIMMS contributes greatly to a more holistic understanding of Cook Inlet's natural resources.

Keeper collaborates with numerous other local and national groups and agencies. Keeper collaborates with UAA's Kachemak Bay Campus which makes an in-kind contribution of lab space for water quality laboratory analysis. Keeper is a partner in the Pratt Museum's Kachemak Bay Discovery Project, a member of the River Network and a member of the National Water Keeper Alliance.

Cook Inlet Keeper's water quality monitoring has been funded through ADEC by EPA 319 Nonpoint Source Pollution Program funds over the last three years, along with other sources to meet EPA's required 40% non-federal match. Keeper's other monitoring support has included grants from the Skaggs Foundation ($8,000 in 1999 and $10,000 in 2001), EPA Wetlands Development Program ($8,824 from a collaborative grant with the Homer Soil and Water Conservation District and Community Rivers Planning Coalition in 2002), Norcross Wildlife Foundation ($10,000 in 1999 and $13,000 in 2001), River Network Watershed Assistance Grant ($20,000 in 1999), Bullitt Foundation ($10,000 in 2001), individuals and businesses (~$10,000/yr.) fees for GIS services (~$5,000/yr.), and in-kind contributions of time and services (~$25,000/yr.).

Keeper's monitoring budget for FY 03 is $205,634. Keeper anticipates a few more years of funding from ADEC, including $105,000 in FY 03. In addition, other pending and possible grants include: $18,000 from the Norcross Wildlife Foundation, $10,000 from the Ben and Jerry's Foundation, $15,000 from the U.S. Fish and Wildlife Service Coastal Program, and $5,000 from the FishAmerica Foundaiton. Keeper will raise additional funding from other grants, individuals, businesses and fees for services.

Funding from EVOS will provide Keeper with an opportunity to synthesize data from diverse agencies and organizations involved in water quality monitoring of offshore, Alaska Coastal Current, nearshore, and watershed habitats. This map will serve as a lasting, easily updated tool for organizations,agencies, citizens and communities involved in restoration and protection of the Gulf of Alaska's important natural resources. In addition, policy-makers, scientists, and the general public will be able to easily access this map and data from the Internet.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Not applicable.

PROPOSED PRINCIPAL INVESTIGATOR IF KNOWN

Name: Mike Gracz, GIS Specialist

Affiliation:	Cook Inlet Keeper
Mailing Address:	PO Box 3269, Homer, Alaska 99603
Phone number:	(907) 235-4068
Fax number:	(907) 235-4069
E-mail Address:	mike@inletkeeper.org

PRINCIPAL INVESTIGATOR

Mike Gracz, Geographic Information Systems (GIS) Specialist
Mike is a forest ecologist with degrees from State University of New York-Syracuse College of Environmental Science and Forestry (B.S.) and the University of Washington (M.S.). He has backgrounds in computer mapping, forest disturbance ecology, and botany. Prior to joining Keeper in 1997, Mike worked for the Kenai National Wildlife Refuge, Alaska Maritime National Wildlife, and Olympic National Park.

OTHER KEY PERSONNEL

Joel Cooper is Cook Inlet Keeper's Research Coordinator. Joel will be responsible for providing support and guidance as needed to GIS Specialist, attending EVOS workshop, and working with ADEC to make map available through CIIMMS and STORET.

Miranda Weiss is Cook Inlet Keeper's Development Director. Miranda will be responsible for grant administration and reporting as needed.

Kathy Peel is Cook Inlet Keeper's Office Manager. Kathy will be responsible for financial management of this project.

Budget Category:	Authorized FY 02	Proposed FY 03
Personnel		$9.3
Travel		$0.5
Contractual		$0.3
Commodities		$0.3
Equipment		$0.0
Subtotal	$0.0	$10.4
Indirect		$1.6
Project Total	$0.0	$12.0
Full-time Equivalents (FTE)		0.2
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 04
None

Dollar amounts are shown in thousands of dollars.

Comments: Creating a comprehensive GIS map of water quality monitoring sites in offshore, Alaska Coastal Current, nearshore and watershed locations of the Gulf of Alaska will be part of Cook Inlet Keeper's Cook Inlet Citizens' Environmental Monitoring project. The FY 2003 budget for this project is $137,863. This project is largerly funded by ADEC's Nonpoint Source Pollution Program ($60,000 in FY 2002, and an anticipated $60,000 in FY 2003). Other funding comes from other state and federal grants, private foundations, membership contributions and fees for services. Cook Inlet Keeper uses an indirect rate calculation of 15% to include: portion of rent and utilities utilized by this project, grant administration, financial administration, and other indirect expenses for this project. Expenses associated with participation at the EVOS Workshop represent $1,300 (personnel, travel and accomodations for GIS Specialist and Research Coordinator) of the budget. Expenses for report writing represent $300 of this budget.

FY03

Prepared: 4/10/02

Project Number: 03607-BAA
Project Title: Creating a Comprehensive Map of Water Quality Monitoring Sites Across the Gulf of Alaska
Name: Cook Inlet Keeper

FORM 4A
Non-Trustee
SUMMARY

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 03
M. Gracz	GIS Specialist		2.5	3.4	0.0	8.5
J. Cooper	Research Coordinator		0.3	2.8	0.0	0.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.8	6.2	0.0	
					Personnel Total	$9.3

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 03
2 RT Homer to Anchorage - EVOS Workshop		0.2	2	2	0.1	0.4
1 Rental Car - 2 days for EVOS Workshop ($50/day)						0.1
Accomodation 2 nights - EVOS Workshop ($50/day)						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$0.5

FY03

Project Number:
Project Title: Creating a Comprehensive Map of Water Quality Monitoring Sites Across the Gulf of Alaska
Name: Cook Inlet Keeper

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/10/02

Contractual Costs:	Proposed
Description	FY 03
Communications (phone, fax, email, postage)	0.3
Contractual Total	$0.3

Commodities Costs:	Proposed
Description	FY 03
Grant will cover supplies including paper, in-house printing supplies, CD ROMs, etc.	0.3
Commodities Total	$0.3

FY03

Project Number:
Project Title: Creating a Comprehensive Map of Water Quality Monitoring Sites Across the Gulf of Alaska
Name: Cook Inlet Keeper

FORM 4B
Contractual & Commodities
DETAIL

Prepared: 4/10/02

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 03
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.	**New Equipment Total**		$0.0

Existing Equipment Usage:	Number	2
Description	of Units	
GIS map plotter: Hewlett Packard Design Jet 450c	1	
Computer: Super Software computer, 512 MB memory	1	

Kodiak Archipelago Youth Area Watch

Project Number:	03610
Restoration Category:	General Restoration
Proposer:	Kodiak Island Borough School District
Lead Trustee Agency:	ADFG
Cooperating Agency:	Kodiak Island Borough School District
Alaska SeaLife Center:	Yes
Duration:	1st year, 3-year project
Cost FY 03:	$57.8 (project cost) + $4 (ADF&G GA) = $61.8 (total)
Cost FY 04:	$61.8
Geographic Area:	Kodiak Archipelago
Injured Resources/Services:	Harbor seals, sub-tidal and inter-tidal communities, subsistence, archaeological resources, near shore seasonal surveys, and commercial fisheries

ABSTRACT

The Kodiak Archipelago Youth Area Watch is an ongoing project designed to engage students in projects with goals aligned with the general restoration efforts of the Trustee Council. Students and site coordinators will conduct interviews with local experts and document TEK, publishing it in a District oral history magazine. Participation of KAYAW adults and students in the annual Academy of Elders/Science Camp will be strongly recommended. Such participation will serve as another avenue for more tribal members to learn about restoration efforts, scientific monitoring techniques, and occupations related to such work. The value and implications of TEK will be strongly emphasized throughout the implementation of the KAYAW project.

INTRODUCTION

In FY 99, Chugach Regional Resources Commission collaborated with the Kodiak Island Borough School District to institute an internship program within the Community Involvement Project. This internship program chose one student in the communities of Akhiok, Larsen Bay, Old Harbor, Kodiak and Ouzinkie. In FY 00 this project was expanded to develop the Kodiak Archipelago Youth Area Watch Program. The program collaborated with four research projects in FY 00, including EVOS-sponsored 00482, PSP Field Testing Kit; EVOS-sponsored 00245, Harbor Seal Bio-Sampling; intensive monitoring with the Fisheries Industrial Technology Center and National Oceanic and Atmospheric Administration; and an algae testing project with Dr. Gerry Plumley.

Increased involvement by students, teachers and community members was realized during the 1999-2000 school year to include: four students from Ouzinkie, one teacher and one community member; two students from Old Harbor, one teacher, and several community members; two students from Larsen Bay, one teacher, and one community member; two students from Kodiak, and one teacher; and two community members from Akhiok. Total involvement for 1999-2000 school year included ten students, four teachers, and over five community members.

During the 1999-2000 school year many KAYAW project activities took place. In the fall of 1999 a KAYAW orientation meeting took place in Kodiak to connect the District teachers with the scientists and their projects. During the Kodiak Island Borough School District Rural School's Science Fair the community members from Akhiok performed seal bio sampling with seals that had been harvested for a community dinner. A number of students from throughout the region, as well as their teachers, were exposed to the data collection and purpose of this project. Orders were taken to purchase equipment for the students to use. This was done through the recommendations given by the scientists, and coordinated by Brian Himelbloom and Bob Pfutzenreuter of University of Alaska-Fairbanks and the Fisheries Industrial Technology Center located in Kodiak. In December another meeting was held to further the development and organization of the KAYAW.

In 2000 a student/teacher orientation meeting took place to train participations in the use of the equipment and process data collection and reporting. Old Harbor School began to redesign their High School Science studies in order to integrate the KAYAW into their general requirements. During the 2000-01 school year the teachers focused more of their curriculum on marine studies, school-wide, K-12. Students began to collect data pertaining to ocean water temperature, presence of algae, general weather conditions, marine mammal sightings, and seal bio sampling. Students also began research regarding PSP and its presence in the Kodiak waters. In June of 2000 another training session took place that introduced participants to the collection of samples and use of the PSP testing kit created by Jellet Biotek.

During FY 01 the project included the expansion into two additional communities, Chiniak and Port Lions; site teacher training in collaboration with the Kodiak College; the construction of a web site for students, teachers, administrators, and project scientists to collaborate, share, and coordinate projects, as well as post data; additional equipment for monitoring activities; and, participation by students, teachers and scientists in the annual Science Camp held at Afognak. All these steps continued the project in the direction of student oceanographic monitoring in collaboration with the Fisheries Industrial Technology Center, continued beach monitoring for

PSP and algal blooms, harbor seal bio-sampling, and hands-on training for a select number of students within the Kodiak Island Borough School District with western scientific knowledge and traditional ecological ways of knowing. A project with the National Marine Fisheries Service to investigate the presence of sandlance and capelin has been integrated as well. The Youth Area Watch program instituted in the Prince William Sound and lower Cook Inlet has been one of the most popular and supported projects that the Trustee Council has implemented. The spill area does not strictly include only those areas; it also encompasses the Kodiak Archipelago and the Alaska Peninsula.

During FY 01 we continued the efforts of the previous years of this program. The Alaska Native Harbor Seal Commission, through 01245, Harbor Seal Bio-sampling continued to support the program through bio-sample training in Old Harbor and Kodiak and included students and hunters from throughout the region. The Fisheries Industrial Technology Center and National Oceanic and Atmospheric Administration, and the National Marine Fisheries Service continue to collaborate with the project and students to collect oceanographic monitoring data. This information will be used to assist the Trustee Council with the Gulf Ecosystem Monitoring Plan. Data collected through this program will fill a hole of oceanographic information that will be necessary for the formation of a 100-year data set. Continued work with 01482, Field-Testing of PSP Test Kits for Subsistence Use was achieved in FY01 regarding beach monitoring and chronic PSP site identification. Students have begun to work on mapping traditional use areas, which include Sugtestun terminology. The Chiniak site is working to determine the presence and abundance of sandlance and capelin along some Chiniak Bay beaches, as well.

In addition, students and site coordinators selected local projects to conduct and expand. Connections to traditional knowledge with integration of TEK data were made to enhance project reports and individual projects. Individual projects were developed and many were entered into the Kodiak Regional Rural Science Fair that is coordinated with the Alaska Rural Systemic Initiative with support from the Alaska Federation of Natives. Teri Schneider, Alutiiq Studies Coordinator for KIBSD and Aleut Regional Coordinator for AKRSI is very interested in pursuing this continued integration. It has proven to be a factor to motivate students to pursue individual or small group investigations that make sense to where and how they live. Student projects were expected to be presented at the March 2001 TEK Conference and CRRC Annual Gathering, but because of a conflict with scheduling, KAYAW students were unable to attend. Students will report their projects directly to the tribal council in their community. An intense "Immersion Institute" took place in April for all Kodiak's rural high school student. With help from Henry Huntington, all of our students were training in the documentation, integration and use of TEK, and learned interview techniques. Each student was given the opportunity to interview community members and Elders, which led to the first re-publication of the oral history magazine, *Illuani*. A number of KAYAW students, also, presented their projects to local and regional Elders and western science judges during the Kodiak Regional Science Fair. Five of our students, including three who were working with the PSP testing, won honors to present their projects at the Alaska Native Science and Engineering Society's Statewide Science Fair and the Alaska Science and Engineering Science Fair.

KAYAW in FY'02 integrated the Alutiiq Museum and Archaeological Repository into its program. The Museum provides technical assistance in the gathering and publishing of traditional ecological knowledge, provides opportunities for archaeological site surveys near the outlying villages, as well as hosting three high school student interns in their *Community*

Archaeology project that will take place during the 2002 summer season. Museum staff tour students throughout their facility while students explore the rich natural resources that the museum was built to protect and house. Personnel from the museum will also take part in the science camp activities, providing all camp participants the opportunity to explore archaeological resources as they are found in the field, while teaching the process of recovery, cleaning, documentation and preservation.

NEED FOR PROJECT

A. Statement of Problem

Kodiak Archipelago Youth Area Watch shares much of the same values and objectives as the original Youth Area Watch in the Chugach region. The KAYAW participants are committed to assisting in the restoration of the spill area through the collection and requisite samples and data for principal investigators of research projects. Research dollars are often scarce – the assistance of labor through this project to the four core projects is an invaluable asset to the overall restoration effort.

The public aspect of this is also invaluable to the Trustee Council. Youth involved in science, especially Alaska Natives, has been difficult to achieve in many cases. This project gives students hands-on experience and an avenue to achieve goals that may have once seemed impossible. The Youth Area Watch projects have received tremendous support throughout the spill area and beyond and the benefits of this project are felt in many different arenas. The Trustee Council would be supporting a win-win situation by funding this project again.

It is not sufficient for our KAYAW to wait for interested scientists to ask for help from the students, as has happened to some extent in Prince William Sound. Instead, the KAYAW will continue to create some of its own activities, building upon the special projects that some sites have already begun in previous years. Because they can't guarantee if or when outside scientists might become interested in the product of their efforts, students and site coordinators will begin to focus on addressing local interests and concerns. This will also help to build local support and give the students a sense of contributing to something substantive immediately, rather than just completing homework assignments and filing monitoring information for possible future use.

Given the need to have the tribes involved in GEM and in work related to documenting, learning and applying traditional knowledge, the KAYAW coordinator, site coordinators and student participants will organize a joint workshop with the tribes and the school district to outline a long term KAYAW program that draws upon traditional knowledge to develop a local environmental assessment and monitoring program. There are great resources among the students, the teachers, school district staff, and the Elders. Bringing them together on a collaborative project that focuses on the ecology, natural history and cultural perspectives of each could accomplish great things.

This work will begin with a traditional and scientific inventory of the local ecosystems around each community. The students will interview Elders, read scientific publications, and describe what exists in their area. The description will include species, how they interact, how they are affected by the physical environment, how humans have and could use them, what impacts those

uses would have, and where and when the species is particularly sensitive. Habitat mapping will include kelp bed studies, watershed mapping, and beach mapping to include drift studies. A thorough inventory will take the form of a series of reports on various species or areas, and together the series would make a natural history encyclopedia of the region. These reports can be integrated into the student-developed website that each community has already established. Additional communication will be enhanced through a monthly KAYAW newsletter that will be disseminated throughout the region. By understanding how the local system works from the local perspective, the community will then be able to design a monitoring program that looks at parameters they find relevant to their interests and observations.

Global Learning and Observations to Benefit the Environment (GLOBE) will be implemented at each site to provide a structure with defined protocols for monitoring while providing an effective avenue for publishing student work (www.globe.gov).

Such a program will take some time to set up and get going, but will be well worth the effort, capitalizing on the opportunity that exists in Kodiak by giving some structure to the enthusiasm that persists for KAYAW.

B. Rationale/Link to Restoration

The Kodiak Archipelago Youth Area Watch will work in primarily three areas. First, harbor seals disastrously affected by the oil spill were being studied under 02245. KAYAW participants will continue to assist in this recovery effort of the Alaska Native Harbor Seal Commission and Trustee Council. Secondly, the focus on the archaeological resources will continue to be a focus, capitalizing on the expertise of the Native owned and operated "Alutiiq Museum and Archaeological Repository." Our own Dr. Sven Haakanson, Jr. is now the director of that facility and is excited about the opportunity to work directly with the KAYAW project. Finally, the Fisheries Industrial Technology Center has ongoing oceanographic monitoring that is being done with KAYAW students. This includes ongoing near shore monitoring projects being conducted by Dr. Robert Foy. The eagerness of this organization and its staff from the University of Alaska Fairbanks has been confirmed through their commitment in the development of the current monitoring data into a long-term KAYAW project.

The public/youth involvement through this project in the restoration process will assist the Trustee Council in their mission to inform and involve the public regarding the restoration program. A more direct line of communication between the Trustee Council and the Kodiak Archipelago communities will be established through the gatherings and trainings, the newsletter and the website.

C. Location

Kodiak Archipelago Youth Area Watch will take place in the Kodiak Island communities of Akhiok, Old Harbor, Port Lions, Ouzinkie, Chiniak, and Kodiak (Larsen Bay and/or Karluk may participate depending upon fluctuating student enrollment.) Site coordinators and students will be continually trained through the school district, Kodiak College, the Fisheries Industrial Technology Center, the Alaska Native Harbor Seal Commission, the Alutiiq Museum and Archaeological Repository, and as other opportunities present themselves with visits to our island communities from the many scientists that travel there. Teri Schneider will serve as the

coordinator and principal investigator for the program for the school district, with outreach to tribal councils through the Kodiak Archipelago. Additionally, traditional ecological knowledge will be integrated into the program with the assistance of TEK Specialist, Dr. Henry Huntington. Guest scientists will be invited to take part in gatherings and conduct site visits to the participating villages in order to share their work and provide feedback to our students and their work.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

In addition to assisting in research, community involvement and the utilization of traditional ecological knowledge are at the heart of this program. Tribal councils, schools, communities, regional organizations, and researchers will all be collaborating to ensure that this project is a success. KIBSD will work closely to ensure that each of the tribal councils where there are KAYAW participants will have a voice in the research and curriculum of the program. Cooperation and communication will be enhanced between the Principal Investigator and Kodiak area community facilitator, Paul Panamarioff. Traditional ecological knowledge will be integrated into the projects that students and communities design and collaborating researchers will be encouraged to utilize TEK on their particular projects. As KIBSD resurrects the oral history magazine, *Illuani*, it will become an additional avenue to communicate the importance and application of local knowledge with regards to the environment and natural resources. Highlights from Elder interviews will also be featured in the monthly KAYAW newsletter and the museum's newsletter.

PROJECT DESIGN

A. Objectives

Selected students in the identified communities will participate in the project to accomplish the following objectives:

1. Communicate KAYAW activities to each site, local agencies, and tribal councils.

2. Identify all research and data collection activities.

3. Orient researchers on working with students.

4. Conduct research with the cooperating scientists.

5. Purchase consumable monitoring supplies for maintenance of area-wide monitoring, as needed.

6. Complete site teacher training in cooperation with the Kodiak College, the Fisheries Industrial Technology Center, the Alutiiq Museum and Archaeological Repository, and the Alaska Native Harbor Seal Commission regarding science monitoring, research, and traditional ecological knowledge.

7. Conduct school orientations for KAYAW students.

8. Maintain the Kodiak Archipelago Youth Area Watch web site to store data, provide information regarding all activities, and coordinate efforts of staff, students, researchers, and community members.

9. Involve KAYAW students, scientists and Elders in the annual Science Camp to be held in July and August of 2003.

10. Complete student project training with tribal council and site teacher.

11. Facilitate project follow-up training with site teachers.

12. Organize and host an annual workshop with the tribes and the school district to outline a long term KAYAW program that draws upon traditional knowledge to develop a local environmental assessment and monitoring program.

13. Conduct interviews with Elders and community members with regards to developing a traditional and scientific inventory of the local ecosystems around each community.

14. Host scientific researchers to present findings, research, and their understandings of the Kodiak Archipelago to school and tribal communities.

15. Continue KAYAW efforts throughout the summer months when school is not in session.

16. Identify and develop individual and small group student research projects that are relevant to their community.

B. Methods

The Kodiak Island Borough School District's Alutiiq Studies Coordinator will communicate directly with tribal councils throughout the island to ensure their meaningful involvement in the project. Researchers involved will sign agreements to ensure their follow-through to involve the youth in their projects.

Teri Schneider, Alutiiq Studies Coordinator and support staff of the Kodiak Island Borough School District will work cooperatively to plan the involvement and logistics of youth, tribal councils and researchers fieldwork. Additionally, training will take place with all involved parties to ensure that this project will work for everyone.

Selection of students is site based and flexible based upon the methods developed by site coordinators to choose students. Some are selected on their academic standing, personal interest, and potential for improvement, while other students are involved as a part of their regular curricular activities. Approximately 48 students will participate. While distribution varies according to interest and ability of students that apply, it is expected that the distribution will be as follows: 14 from Old Harbor, 14 from Ouzinkie, 12 from Port Lions, 2 from Chiniak, 2 from Akhiok, and 4 from Kodiak. Twelve of these students will be designated as interns. These students will be the primary ones to travel to special events and will be the 'leaders' of the

projects. The rest of the students will participate to a lesser degree but will be actively involved in the local implementation of the projects. The communities with a large number of students participating have chosen in the past to integrate the KAYAW project into their science curriculum, allowing all high school and/or middle school students to participate in either all, or part of the projects.

Early in the school year, participating KAYAW teachers will congregate to conduct a two-day training to become familiar with what the program will encompass. We will ask that researchers attend as well. Protocols from principal investigators and program details will be discussed. In addition to the site teachers, we will invite tribal council representatives.

All of the coordinating projects, archaeological site surveys, preservation and maintenance, algae testing, bio-sampling, near-shore monitoring, and oceanographic monitoring will take place geographically close to the participant's communities. It will be the responsibility of the site teacher and participants to determine field schedules. Harbor seal bio-sampling will require two training sessions and coordination with local seal harvesters. The oceanographic monitoring project will require coordinated efforts on contracted vessels and such. This will be negotiated between the individual licensed boat operators and KIBSD. Schedules will be determined when appropriate. Quarterly, students and support staff will congregate via audio-conference or in person in a chosen community to discuss progress, brainstorm ideas, and evaluate the program. Written reports describing the students' activities and the progress of the program will be submitted to EVOS quarterly. Training will be ongoing and project objectives will be met.

Ongoing projects will include:

1. Archaeological site surveys, preservation and maintenance – Alutiiq Museum and Archaeological Repository – Dr. Sven Haakanson, Jr. and the staff of the museum will work directly with students, both in the lab of the museum and on site in the villages, to identify archaeological sites while teaching proper preservation and maintenance of the identified sites. Students will learn about erosion (natural and human-caused), care of found archaeological materials, while discouraging "pot hunting." Students will engage in discovering the scientific and cultural relevancy of found objects through their interaction with Elders and scientists, while engaging in the local harvest of wild resources.

2. Harbor Seal Bio-sampling – Alaska Native Harbor Seal Commission – KAYAW will work with local harvesters involved in the program to bio-sample harbor seals caught for subsistence purposes. Mitch Simeonoff, Akhiok, and Vickie Vanek from ADF&G will work with the school district to train and involve students.

3. Fisheries Industrial Technical Center - This will involve utilizing the monitoring kits we have acquired in establishing and continuing a long-term oceanographic and near-shore monitoring program. Indicators to be monitored will include ocean temperature, salinity, alkalinity, tides, as well as the presence of predator/prey, seabirds, and habitat, and other information as it pertains to the projects. Dr. Robert Foy and other staff members of the Fisheries Industrial Technology Center will involve students in conducting parts of surveys and will visit sites to share his findings while providing feedback to students regarding their findings.

4. GLOBE – The district will provide on going support to site coordinators to ensure the use and implementation of defined protocols is continued and enhanced.

In addition to these four core projects, students will work with their tribal council or local site teacher to identify a local research project to implement that is achievable. We will encourage the tribal councils to identify an area of TEK that may be of interest and integrate that with western science methods. TEK Specialist Henry Huntington will be called upon to assist in this effort.

The participation of the students in the annual Science Camp will be a continued component of this year's program. The annual Science Camp is an opportunity for students, teachers and community members from across the islands to learn from Elders and other culture bearers how traditional ways of knowing can be incorporated into western science. This camp will allow students to present their work to the other camp participants, educating and enlarging the support and momentum of the project. The Science Camp will be an opportunity for youth to recap the activities of the year and plan for the coming year. The KAYAW student participants will have the opportunity to provide some introductory training while showcasing their skills in water monitoring, seal bio-sampling and traditional observational skills to younger students and interested community members.

The development of a web site that will be integrated into the Kodiak Island Borough School District will be maintained, as well. The Kodiak School District's Technology staff will work with project staff to continue construction and maintenance of the site. The formation of this web site is seen as a necessary step to bring the program to a new level of communication, coordination, and information transfer. There will be links created between this site and each of the community's websites. The KAYAW website will continue to be a place to post oceanographic data, algae data and results, predator/prey presence, and harbor seal bio-sample information, as well as appropriate TEK. There will also be linkages to the GLOBE and Alutiiq Museum site.

School credit for the youth involvement in this project is strongly encouraged. High school juniors and seniors are strongly encouraged to integrate a KAYAW project into their junior or senior project. Other school credit may be earned in integrated math, science, technology, Alutiiq studies, social studies, or language arts. This will encourage even more participation and give credibility to the project among site teachers and students who are thinking about applying to the project. Students and site coordinators will be contracted to continue their work when school is not in session to guarantee the continuity of their monitoring and documenting efforts.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The Kodiak Island Borough School District will serve as the administering agency for this project. KIBSD will work hard to coordinate and collaborate with tribal councils, site coordinators, researchers, and students on the successful implementation of the project.

Partnerships with the Fisheries Industrial Technology Center, National Marine Fisheries, and the Alaska Department of Fish and Game will continue to perpetuate the marine mammal monitoring, near-shore monitoring, and ocean-monitoring components of the project. Staff from each of these organizations has already integrated our KAYAW students into their research and

outreach component of their programs by providing shadowing opportunities and exchanging research with students.

The Alutiiq Museum will provide technical assistance in conducting site surveys and will host student interns during their Community Archaeology summertime project. Staff will provide support to students and site coordinators in their efforts to conduct Elder interviews, as well as support for individual and small group research projects.

The Native Village of Afognak Tribal Council provides the facilities and additional funding needed to conduct the Academy of Elders/ Science Camp.

Henry Huntington will be contracted to consult with the KAYAW coordinator and provide training to KAYAW students and tribal councils in the skills needed to conduct TEK investigations.

Individuals with 6-pack licenses may be contracted to provide transportation to remote sites in the monitoring and documentation processes.

SCHEDULE

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

October 15:	Confirm research and data collection activities
October 31:	Site teacher, tribal, and researcher orientation
October 31:	Monthly newsletter is developed and distributed
November 15:	Students selected and preliminary site research plan is developed
December 15:	School site orientations
December 15:	Student orientation and training
January 31:	Individual or small group projects submitted to regional science fair
May 15:	Regional workshop is conducted
May 15:	Summer plans for continued work by students and site coordinators are submitted to Principal Investigator
May 25:	Students and site coordinators for summer work to be completed sign Contracts
July 15 - August 15:	Students, site coordinators and researchers participate in Science Camp

On-going activities will include:

October 1 - September 30:	Students conduct archaeological site surveys, preservation and maintenance
October 1 - September 30:	Students analyze found archaeological objects
October 1 - September 30:	Students conduct harbor seal bio-samples
October 1 – September 30:	Students shadow cooperating scientists
October 1 – September 30:	Researchers visit sites to exchange research with students

October 1 - September 30: Students conduct their local research project

B. Project Milestones and Endpoints

Ongoing:	Communicate KAYAW activities to each site, local participating agencies, and tribal councils.
October 1:	Identify all research and data collection activities.
Annually and as needed:	Orient researchers on working with students.
Ongoing:	Conduct research with the three projects.
Annually:	Purchase additional monitoring and research equipment for expansion of area-wide monitoring, as well as replacing consumable materials, such as test strips.
Biannually:	Complete site teacher training in cooperation with the Kodiak College, the Fisheries Industrial Technology Center, the Alutiiq Museum and Archaeological Repository, and the Alaska Native Harbor Seal Commission regarding science monitoring, research, and traditional ecological knowledge.
Annually:	Conduct school orientations for KAYAW students.
Ongoing:	Maintain the Kodiak Archipelago Youth Area Watch web site to store data, provide information regarding all activities, and coordinate efforts of staff, students, researchers, and community members.
Annually:	Involve KAYAW students, local scientists and knowledgeable Elders in the annual Academy of Elders/Science Camp to be held annually in July and August.
Annually:	Conduct student project trainings with tribal council and site teacher.
Annually:	Facilitate project follow-up training with site teachers.
Annually:	Organize and host a joint workshop with the tribes and the school district to outline a long term KAYAW program that draws upon traditional knowledge to develop a local environmental assessment and monitoring program.
Biannually:	Conduct interviews with Elders and community members with regards to developing a traditional and scientific inventory of the local ecosystems around each community.
Ongoing:	Host scientific researchers to present findings, research, and their understandings of the Kodiak Archipelago to school and tribal communities.

C. Completion Date

Objectives identified in the project design will serve as guidelines for community involvement within the civil settlement throughout the life of the restoration effort. It is expected that the KAYAW will be completed upon termination of the restoration and monitoring effort.

PUBLICATIONS AND REPORTS

Project reports that will include a description of student activities and the progress of the program will be submitted to EVOS quarterly.

PROFESSIONAL CONFERENCES

Concentration of presenting project progress and results will be done locally in conjunction with gatherings pertaining to training opportunities and during the annual workshop in Kodiak.

NORMAL AGENCY MANAGEMENT

Not applicable.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will work closely with the Community Involvement and GEM Planning Project (03052).

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Many changes have been made in this DPD as compared to the previously funded DPD primarily in response to peer reviewer comments and lead agency suggestions. Reorganization of the KAYAW has been suggested to make it more efficient and effective. One full-time certified teacher would have one third of her duties specifically dedicated to the coordination and implementation of the project. The other half of this staff person's duties correlates well with the overall objectives and goals of KAYAW. The need for better island-wide communication will be met with a monthly newsletter that will be distributed through the region. Site coordinators and student participants will be contracted for their continued services through the summer months when school is not in session so that continuity of monitoring and communication will not be broken. The KAYAW students and adult participants will host an annual gathering focusing on TEK documentation and ecological assessments of each community of the Kodiak Archipelago. Publication and distribution of TEK documentation will be integrated into the KIBSD oral history magazine that is bi-annually distributed. Henry Huntington will continue his involvement as a TEK consultant, providing training for students and KAYAW tribes. Because a number of the original projects KAYAW worked with have no longer been funded by their sources, and because there is an on-going need to protect archaeological sites and objects around the archipelago, the additional project with the Alutiiq Museum has been organized.

PROPOSED PRINCIPAL INVESTIGATOR

Teresa L. Schneider
Kodiak Island Borough School District
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Kodiak, Alaska 99615
(907) 486-9276
Fax: 486-9152
tschneider@kodiak.k12.ak.us

PRINCIPAL INVESTIGATOR

Teri Schneider is the Alutiiq Studies Coordinator for the Kodiak Island Borough School District and the Aleut Regional Coordinator for the Alaska Rural Systemic Initiative. Teri has been in this position since 1997. She works closely with all KIBSD Native and rural educational programs and projects and many AKRSI statewide and regional educational projects with goals to integrate Native Ways of Knowing into the public school system. Teri, an Alaskan Certificated Educator, is a member and the advisor/coordinator of the Native Educators of the Alutiiq Region, a professional organization that works closely with the Alutiiq Elders Council to implement Native educational initiatives. She has experience in project development and administration, tribal relations, and managing budgets. Ms. Schneider will be responsible for all expenditures, contracts, and project management duties that are approved by KIBSD administrative staff.

OTHER KEY PERSONNEL

1. Janet Long, Administrative Assistant for KIBSD, will assist with logistical arrangements and communications.
2. Ray Maltos, Regional Village Principal, will provide administrative oversight and guidance. He has extensive experience in developing and managing budgets and well as implementing educationally sound programs.
3. Sally Wilker, KIBSD Itinerant Curriculum Specialist, will assist the Principal Investigator and site coordinators with student research and project design. Ms. Wilker will also work to integrate aspects of the KAYAW research and procedures into the existing KIBSD science curriculum, which will eventually help to define how we "do" science education in our district.
4. Eric Waltenbaugh, KIBSD Itinerant Curriculum Specialist, will assist the Principal Investigator and site coordinators in the gathering reporting of TEK through his continued development of the oral history magazine, *Illuani*.
5. Teachers from each of the KAYAW sites will fill the role as site coordinators. They are actively involved in building KAYAW into the school's curriculum while providing organization and communication for such activities in each of their communities.
6. Dr. Brian Himelbloom, Dr. Susan Payne, Vicki Vanek, Dr. Sven Haakanson, Jr., Dr. Kate Wynn, and Dr. Robert Foy are all scientists who have dedicated numerous hours of their time for the benefit of our KAYAW students will continue to work closely with the KIBSD coordinator, site coordinators, and students.
7. Carla Lam, Craig Baker and Larry LeDoux are district GLOBE trainers and will provide professional development opportunities for our site coordinators.

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 02	Proposed FY 03
Personnel	$17.6	$18.0
Travel	$21.2	$21.2
Contractual	$16.2	$18.1
Commodities	$0.5	$0.5
Equipment	$2.3	$0.0
Subtotal	$57.8	$57.8
General Administration	$4.0	$4.0
Project Total	$61.8	$61.8
Full-time Equivalents (FTE)	0.3	0.3
Other Resources	$141.0	$141.0

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 04					
$61.8					

Dollar amounts are shown in thousands of dollars.

Comments:

FY03

Prepared:04-11-02

Project Number: 03610
Project Title: Kodiak Archipelago's Youth Area Watch
Agency: Kodiak Island Borough School District

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 02	Proposed FY 03
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Commodities	$0.5	$0.5
Equipment	$2.3	$0.0
Subtotal	$57.8	$57.8
Indirect	$4.0	$4.0
Project Total	$61.8	$61.8
Full-time Equivalents (FTE)	0.3	0.3
Other Resources	$141.0	$141.0

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 04					
$61.8					

Dollar amounts are shown in thousands of dollars.

Comments:
*No indirect costs will be taken by the Kodiak Island Borough School District. Administrative oversight, secretarial support and general grants management will be absorbed as cost sharing contributions to this project. Total cost sharing contributions from KIBSD include 0.7 certified staff, facilities and utilities, miscellaneous commodities, site coordinator costs, additional costs for the coordinators of the Science Camp, and expertise from the Native Educators organization and the Academy of Elders.
*Costs for the Principal Investigator to attend the annual restoration workshop is estimated at $500.00.

FY03

Prepared:04/12/02

Project Number: 03610
Project Title: Kodiak Archipelago's Youth Area Watch
Name: Kodiak Island Borough School District

FORM 4A
Non-Trustee
SUMMARY

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 03
T. Schneider	KAYAW Coordinator (0.3)		12.0	1.5		18.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		12.0	1.5	0.0	
					Personnel Total	$18.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 03
KAYAW coordinator, up to two roundtrips to each rural KAYAW site	0.2	8	8	0.1	2.4
Researchers, site coordinators and student travel for trainings, etc.	0.2	22	42	0.1	8.6
Student, site coordinator, researcher, and Elder travel to science camp and science fair	0.2	12	4	0.1	0.0 2.8
Student, site coordinator, researcher, and Elder travel to regional workshop	0.2	17	35	0.1	6.9 0.0
KAYAW coordinator, one roundtrip to the Trustee Council's Annual Restoration Workshop	0.3	1	2	0.1	0.0 0.5
					0.0
					0.0
					0.0
					0.0
				Travel Total	$21.2

FY03

Prepared: 04/12/02

Project Number: 03610
Project Title: Kodiak Archipelago's Youth Area Watch
Name: Kodiak Island Borough School District

FORM 4B
Personnel
& Travel
DETAIL

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Contractual Costs:	Proposed
Description	FY 03
Professional technical services from Huntington Consulting and Alutiiq Museum	4.0
Vessel Charters	1.5
Printing newsletter, reports and other communications	1.0
Professional technical services for website development and maintenance	1.0
Summer site coordinators	3.0
Summer student participants	3.6
Elder honorariums	4.0
Contractual Total	$18.1

Commodities Costs:	Proposed
Description	FY 03
Replacement of consumable water monitoring materials	0.3
Consumable audio/visual supplies	0.2
Commodities Total	$0.5

FY03

Prepared:04/12/02

Project Number: 03610
Project Title: Kodiak Archipelago's Youth Area Watch
Name: Kodiak Island Borough School District

FORM 4B
Contractual & Commodities DETAIL

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 03
Description			
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number of Units
Description	
Portable computer	1
Seal bio-sampling kits	7
Marine station monitoring kits	5
Tape recorders	4
Digital camera	1

FY03

Project Number: 03610
Project Title: Kodiak Archipelago's Youth Area Watch
Name: Kodiak Island Borough School District

FORM 4B
Equipment
DETAIL

Prepared:04/12/02

A monitoring program for near-surface temperature, salinity, and fluorescence fields in the Northeast Pacific Ocean

(Collaborating institutions: Institute of Marine Science, University of Alaska Fairbanks (lead institution) and Center for Coastal Physical Oceanography, Old Dominion University)

Project Number:	03614
Restoration Category:	Ecosystem Synthesis/GEM Transition/New Projects/ Innovative Tools and Strategies to Improve Monitoring
Proposer:	Stephen R. Okkonen Institute of Marine Science University of Alaska Fairbanks Fairbanks, Alaska 99775
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	None
Alaska Sea Life Center:	No
Duration:	2nd year, 2-year project
Cost FY 03:	$20,900
Cost FY 04:	$0
Geographic Area:	Northeast Pacific Ocean
Injured Resource/Service:	

ABSTRACT

The objective for this proposed research is to a use a thermosalinograph and fluorometer, to be installed on a crude oil tanker, to acquire continuous, long-term measurements of the near-surface temperature, salinity, and fluorescence fields along the tanker route between Valdez, Alaska and Long Beach, California.

INTRODUCTION

The research proposed herein describes a two-year, proof-of-concept project to demonstrate the use of a crude oil tanker as platform from which to acquire measurements of oceanographic field variables (near-surface temperature, salinity, and fluorescence) in the Northeast Pacific Ocean. The results from this project will be used as a basis to pursue GEM funding for long-term monitoring of oceanographic field variables from crude oil tankers.

NEED FOR THE PROJECT

A. Statement of Problem

In order to assess the long-term recovery of marine resources impacted by the Exxon Valdez Oil Spill against the background of climate-driven variability of those resources, long-term measurements of oceanographic conditions are required. Additionally, while the most significant spill-related impacts upon the marine environment occurred in coastal and near-shore domains, the long-term health of those marine ecosystems depends, in part, upon biophysical linkages to the shelf, slope, and open-ocean domains. Consequently, multi-decadal records of oceanic conditions within each of these domains is necessary to develop an understanding of natural and anthropogenic variability in the marine environment of the northern Gulf of Alaska.

B. Rationale

In recent years there has been increasing awareness of large-scale, multi-decadal changes in the climate of the world ocean. However, translating awareness of long-term climate variability into understanding the regional and local physical and biological consequences of a changing environment has been hampered by the dearth of long-term oceanographic measurements in the Northeast Pacific. Presently, the only multi-decadal time series of oceanographic conditions (temperature and salinity) in the region are for Ocean Station P/Line P and station GAK-1 near Seward, Alaska (Figure 1).

Commercial cargo vessels operating within established shipping corridors in the Northeast Pacific are potential ships-of-opportunity from which high-resolution measurements of oceanographic conditions could be acquired at regular intervals. Crude oil tankers, travelling between Valdez, Alaska and Long Beach, California are particularly well suited for this purpose as individual tankers cross shelf, slope, and open ocean regimes every 10 to 14 days and will continue to do so for many years to come.

To demonstrate the suitability of tankers as a travelling platform, we propose to install a thermosalinograph (TSG) and fluorometer on a tanker to acquire high-resolution

measurements of near-surface temperature, salinity, and fluorescence (a proxy for phytoplankton biomass).

Some might argue that satellites are better platforms from which to acquire these measurements of ocean surface conditions. However, ocean color and sea surface temperature sensors detect wavelengths in the visible and infrared portion of the electromagnetic spectrum and are therefore unable to detect sea surface features through the clouds which cover much of the Gulf of Alaska for much of the year. With respect to remote sensing of sea surface salinity, there are no satellite-borne salinity sensors at this time.

C. Location

Measurements of temperature, salinity, and fluorescence will be acquired along the tanker corridor between Valdez, Alaska and Long Beach, California (Figure 1).

PROJECT DESIGN

A. Objectives

The objectives for this project are to:

1. Establish a working relationship with the crude oil tanker fleet to use individual tankers as platforms from which to acquire continuous, long-term measurements of oceanographic field variables (e.g. temperature, salinity, fluorescence) along the shipping corridor between Valdez, Alaska and Long Beach, California. Install a thermosalinograph and fluorometer on a tanker to acquire these measurements.

2. Identify the seasonal migration and evolution of frontal features associated with the Alaska Coastal Current (ACC), shelf break, and mesoscale eddies.

3. Identify the dominant length scales of variability (and seasonal modulation of those length scales) characterizing the near-surface temperature, salinity, and fluorescence fields along the shipping corridor. These scales of variability will likely differ between shelf and the open ocean.

4. Compare TSG/fluorometer measurements with TOPEX altimeter observations of the Gulf of Alaska eddy field.

5. Compare TSG/fluorometer data with contemporaneous NEP GLOBEC field data.

6. Provide temperature, salinity, and fluorescence field data to David Welch (Pacific Biological Station, Nanaimo, British Columbia) for comparison with coincident continuous plankton recorder (CPR) observations.

A. Methods

The TSG and fluorometer will be installed in the sea chest of a tanker. The sea chest draws seawater through an intake located a few meters below the sea surface. The exact depth of the intake water will depend on the particular vessel design and the amount of cargo and/or ballast carried. With approval of the ship's chief engineer, a remote temperature sensor will be installed as close to the intake as is practical to mitigate the biasing of the temperature measurements due to the ship's thermal inertia.

TSG and fluorometer measurements will be acquired once per five seconds (nominal). For a tanker travelling at 20 knots this translates to a sample spacing of ~50 m. This data stream will be merged will concurrent GPS navigation data and stored on the hard drive of a dedicated PC. Repeat measurements along the shipping corridor will allow time-space matrices of temperature, salinity, and fluorescence to be constructed. After a yearlong record of measurements is acquired, characteristic spatial scales of variability and their seasonal modulation will be determined from spectral and geometric analyses of the data matrices.

The seasonal evolution of frontal features associated with the ACC, the shelf break, and mesoscale eddies will also be monitored. Because of secondary circulation associated with frontal features, they tend also to be zones in which there are population aggregations across many trophic levels.

SCHEDULE

A. Measurable Project Tasks for FY 02 (1 October 2001 – 30 September 2002)

15 October 01:	Order instrumentation and ancillary hardware
15 Feb 02:	TSG arrived in San Diego
April 02:	Dave Cutchin visits Polar Alaska to meet with captain and chief engineer and look over engine room plumbing
May 02:	Install TSG
May 02 - 30 September 02:	Data acquisition

B. Project Milestones and Endpoints

Oct 2001 - ongoing	Project Design Objective 1
May 2002 - ongoing	Project Design Objectives 2, 4, 5, 6
1 Jan 2003 - 1 Mar 2003	Project Design Objective 3 (use first year of data)
1 Mar 2003 - 30 Apr 2003	Prepare manuscript(s), see Publications and Reports section below

15 Apr 2003 Submit annual report

C. Completion Date

30 September 2003 Completion of final report

PUBLICATIONS AND REPORTS

Potential FY 03 publications: Seasonal evolution of frontal features in northern Gulf of Alaska; Comparison of TSG, fluorescence, and TOPEX altimeter observations of Gulf of Alaska eddies; Comparison of TSG, fluorescence and continuous plankton recorder observations in the Northeast Pacific Ocean (with David Welch, Pacific Biological Station, Nanaimo, British Columbia).

PROFESSIONAL CONFERENCES

Attend Trustee Council's annual workshop in Anchorage January 2002, 2003.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Data acquired for this project will be posted on the UAF/Institute of Marine Science web page.

Okkonen has an ongoing NASA-funded project to use the TOPEX altimeter to observe the mesoscale eddy field in the Gulf of Alaska and to share that data with collaborating NEP GLOBEC researchers (Tom Weingartner, UAF; Tom Royer, ODU)

Royer is a funded researcher with the NEP GLOBEC project for the next four years.

Existing collaborative relationships with NEP GLOBEC researchers will be exploited to (1) compare TSG surface field observations (this proposed research) with contemporaneous subsurface temperature and salinity measurements from within Prince William Sound and from the nearby shelf and (2) use retrospective studies of historical VOS (XBT and XCTD) and GAK1 data to provide a historical context for consideration of the TSG data.

The opportunity also exists to make similar comparisons of the TSG data with historical and contemporaneous Ocean Station P/Line P data.

We also plan to share our data with David Welch, Pacific Biological Station, Nanaimo, British Columbia. He has a current project in which he has a continuous plankton recorder (CPR) deployed 5x/year on a tanker travelling between Valdez and Long Beach.

The TSG/fluorometer/CPR data sets would be highly complementary in that temperature, salinity, and fluorescence gradients could be directly compared with plankton distributions along the tanker route.

PROPOSED PRINCIPAL INVESTIGATOR

Stephen R. Okkonen
Institute of Marine Science
University of Alaska Fairbanks
Fairbanks, Alaska 99775
(907) 283-3234
okkonen@alaska.net

Okkonen will have primary responsibility for initial data processing, length scale analyses, frontal feature analyses, and comparison with TOPEX data.

CO-PRINCIPAL INVESTIGATOR

Thomas C. Royer
Center for Coastal Physical Oceanography
Department of Ocean, Earth and Atmospheric Sciences
Old Dominion University
768 W. 52nd St.
Norfolk, VA 23529
(757) 683-5547
(757) 683-5550 (FAX)
royer@ccpo.odu.edu

Royer will have primary responsibility for comparison of TSG data with GLOBEC data and with historical data.

OTHER KEY PERSONNEL

Dave Cutchin
San Diego, California

Dave Cuthcin will be issued a sub-contract to install the thermosalinograph, fluorometer, and ancillary hardware on the tanker and to provide annual maintenance of the instruments. He was responsible for TSG installations on other VOS platforms both prior to and during WOCE.

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 02	Proposed FY 03	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$8.9						
Travel		$0.7						
Contractual		$4.3						
Commodities		$0.7						
Equipment		$0.0						
Subtotal	$0.0	$14.6	Estimated FY 04					
Indirect		$3.7						
Project Total	$0.0	$18.3						
Full-time Equivalents (FTE)		0.2						
			Dollar amounts are shown in thousands of dollars.					
Other Resources								

Comments:

NOTE: ADF&G GA of $2.6 needs to be added to this project, for a total of $20.9.

FY03

Prepared:

Project Number: 03614
Project Title: Collaborative Proposal: A monitoring program for near-surface temperature, salinity, and fluorescence fields in the Northeast Pacific Ocean
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 03
	Okkonen, S.	PI, Research Asst. Professor	1.5	4.9		7.4
	Partee, D.	Web Page Developer	0.3	5.0		1.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	1.8	9.9	0.0	
					Personnel Total	$8.9

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 03
	Kenai - Anchorage (Trustee Council workshop)	0.2	1	2	0.2	0.6
	Taxi	0.1	1			0.1
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$0.7

FY03

Prepared:

Project Number: 03614
Project Title: Collaborative Proposal: A monitoring program for near-surface temperature, salinity, and fluorescence fields in the Northeast Pacific Ocean
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Contractual Costs:	Proposed
Description	FY 03
Dave Cutchins (subcontract for annual instrument maint.)	1.0
TSG calibration	0.3
Kill cell	0.1
Annual fluorometer characterization	0.3
RT shipping	0.4
Publications	2.0
Software maintenance	0.2
Contractual Total	$4.3

Commodities Costs:	Proposed
Description	FY 03
Project supplies/postage	0.4
Phone, fax, internet	0.3
Commodities Total	$0.7

FY03

Prepared:

Project Number: 03614
Project Title: Collaborative Proposal: A monitoring program for near-surface temperature, salinity, and fluorescence fields in the Northeast Pacific Ocean
Name: University of Alaska Fairbanks

FORM 4B
Contractual & Commodities DETAIL

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 03
			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	

FY03

Project Number: 03614
Project Title: Collaborative Proposal: A monitoring program for near-surface temperature, salinity, and fluorescence fields in the Northeast Pacific Ocean
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared:

Lingering Oil and Predators: Pathways of Exposure and Population Status

Project Number:	03 620
Restoration Category:	Research and Monitoring
Proposers:	
Part I: NOAA- ABL	Stanley Rice, Jeff W. Short, Mandy Lindeberg; NMFS, Auke Bay Laboratory; ABL Program Manager: Dr. Stan Rice NOAA Trustee Liason: Pete Hagen
Part II: DOI-USGS:	James L. Bodkin and Brenda E. Ballachey DOI Program Manager: Dede Bohn
Lead Trustee Agency:	NOAA
Cooperating Agencies:	DOI-USGS
Alaska Sea Life Center:	No
Duration:	1st year of a 1 year project
FY03	340K Part I (NOAA): 149.3 K Part II (USGS): 190.7 K
FY04	30K (Estimated: closeout)
Geographic Area:	Prince William Sound, Gulf of Alaska
Injured Resource/Service:	Intertidal, Sediments, Sea Otters, Harlequin Ducks

ABSTRACT

Lingering oil and continued effects to sea otters and sea ducks are the most surprising and best documented long term impacts of the *Exxon Valdez* oil spill. Strong evidence is accumulating which implicates lingering oil as a factor constraining recovery of the nearshore ecosystem in western Prince William Sound (PWS). Acute and chronic contamination of sediments and prey species were well documented during the years following the spill. Twelve years later, elevated biomarker levels in sea otters and sea ducks (top-level predators) have indicated continued exposures to hydrocarbons (USGS). Evidence implicating a route of exposure to date has been largely circumstantial. However, in 2001 and 2002, extensive sampling was undertaken by NOAA (ABL) to document the distribution, abundance, and bioavailability of lingering oil along those shorelines most heavily impacted by the 1989 *Exxon Valdez* spill. This has paved the way for identifying specific areas where sea otters and sea ducks could be currently foraging and exposed to lingering oil. The following proposal is an outgrowth of the ABL and USGS studies and will focus on the direct pathways of lingering oil to sea otter and sea duck populations in two western PWS heavily impacted bays. There are two parts to the proposal, both are targeted at linkage between oil and effects to the predators.

GENERAL INTRODUCTION

From the late 1990's to present, the finding of oil persistence and evidence of continued exposure and impacts to sea otters and sea ducks are the most surprising and best documented of the long term impacts of the *Exxon Valdez* oil spill. The results were unanticipated, and have sparked some levels of controversy. Acute toxicity was expected in the early days of the spill, but the lingering oil and effects 12 years after the spill were never anticipated. Oil persistence is required for new effects to continue, requiring special exposure pathways and biology. In 2001, rigorous field surveys documented the extent and intensity of the lingering oil throughout the western part of Prince William Sound, thus giving strong support to the growing evidence of continued exposure to sea otters and sea ducks, and providing a chemical basis for the positive biomarker findings. These results suggest that the poor recovery of the top level predators in some areas of the sound is constrained by the continued oil exposure. In particular, some of the heaviest oiled areas in 1989 continue to have a significant incidence of oil, including subsurface oil that is relative low in the intertidal zone and in the biological productive zone. The species continuing to show impacts share one thing in common; they live, forage, or spawn in the intertidal zone, where stranded oil continues to have some persistence. Hence there is a match between oil persistence and a "special biology".

In 2002, the focus of a joint study by USGS and ABL, was the study of 5 sites with an emphasis on bioavailabiltiy of oil and linkage to continued effects. The 5 sites ranged from no oil to sites where oil was present to the "worst case" sites. The potential for oil bioavailability was the focus of the chemistry studies by ABL, while USGS continued the study of biomarkers and impacts to sea otters and sea ducks. This was the first year of the joint study, and was targeted at the same sites, to give a better integration of the two research themes. These studies are in progress, but field results to date continue to demonstrate the probability of a linkage between oiled sites, oiled prey, and exposure/poor recovery of these species. For example, clams were sampled in March 2002 that were determined visually to be in oiled sediments at the zero tide level in Herring bay, and the shells were stained with oil (chemical analyses has not been completed, but is expected to confirm high PAH contamination).

In 2003, further linkage studies are proposed, and are an outgrowth of the current studies. Bioavailability is a measure of exposure potential, but is not a true measure of significance. In 2003, we intend to measure the contamination in the foraging habitat, including prey, and determine the extent of the contamination on a percentage basis. This will attempt to put into perspective the bioavailability measurements with foraging habitat. This can not be done practically for a large region; therefore we will focus on two bays. Herring bay, arguably the worst contaminated site, still does not have otters residing and utilizing the forage, although it supported about 35-40 otters in 1989 prior to the spill. Bay of Isles has some localized high contamination areas, but for the most part, is probably much less oiled, and has partial utilization by resident sea otters. These bays will act as "canaries" for the northern Knight Island area--- when the

bioavailability of oil at these sites is negligible, and otters have re-established, then the spill can probably be declared as over. The linkage theme will be further evaluated by USGS, through continued biomarker research and population monitoring, along with assessments relative to the extensive 2001 field survey for oil. Linkage is the focus for both parts of the study, and is expected to be a one year study, followed by closeout.

Overall Objectives:

Mini-workshop: in early December 2002 to review progress of ABL and USGS studies in 2001/2002, review sampling designs for use in 2003.

Part I (NOAA-ABL): Pathways of exposure and significance

1.Determine the total foraging base habitat in two oil impacted bays where otters/sea ducks forage, by generating habitat maps based on biology rather than geomorphology. (Herring Bay; Bay of Isles)

2.Determine the percentage of foraging habitat and prey that continues to be oil contaminated. in two bays.

3. Estimate the significance of the habitat and prey contamination levels relative to the bay, and to the region (close-out synthesis).

Part II (USGS-DOI): Population Status

1. Obtain current estimate of the WPWS sea otter population size.

2. Obtain current estimate of the northern Knight Island sea otter population size.

3. Identify locations of sea otters/sea ducks relative to known locations of lingering oil.

4. Identify those locations where sea otters and harlequin ducks with known blood and liver P450 values are residing and foraging relative to known locations of lingering oil.

5. Monitor survival of marked sea otters at Knight Island and relate survival outcome to CYP1A levels and liver alterations.

PART I: Lingering Oil and Predators: Pathways of Exposure (NOAA-ABL)

ABSTRACT

Lingering oil from the *Exxon Valdez* oil spill remains throughout Western Prince William Sound and appears to have chronic effects on sea otter and sea duck populations in these areas. Studies conducted in 2001 have documented the extent of oiling throughout the sound, and studies in progress in 2002 will attempt to document the bioavailability of the oil to prey and oil sampling devices (5 sites; within and near known oil patches). In 2003, Part I of this project would attempt to measure the significance of oiled forage habitat and prey on a limited scale, by intensely measuring forage habitat base and oil in two bays; Bay of Isles and Herring Bay. In 2003, stratified random assessment techniques used in 2001 would be applied to the two bays, except that the population of beach sites sampled for oil presence and prey contamination would be based on forage base rather than oiling history for the specific site. Part II will attempt to measure habitat utilization as well as continued monitoring of oil effects in sea otters and harlequin sea ducks, who forage in the lower intertidal where oil is still present in some contaminated areas. The coordination initiated in 2002 will continue.

INTRODUCTION

For the past several years a series of projects conducted by the Auke Bay Laboratory (ABL) have been evaluating lingering oil from the *Exxon Valdez* oil spill and its continued impacts. These studies were prompted by the lack of recovery by sea otters and sea ducks 12 years after the oil spill. Herring Bay, for example, supported about 35-40 otters in 1989 (that was the number of dead carcases found in Herring Bay), yet in 2002, no otters have been documented to have re-established within Herring Bay.

The 2001 shoreline survey (project #02543) documented the remaining oil in Prince William Sound (PWS). At least 28 acres of shoreline was estimated to remain contaminated with oil. The quantity of oil remaining was surprising, as well as the vertical distribution on a beach. Most of the oil remaining was found subsurface, usually 5-15 cm deep, was often found in a liquid form, showing little weathering compared to surface oil samples. The worst case pits were found most frequently at three major sheltered rocky bays that were hard hit in 1989: Herring Bay, Northwest Bay, and Bay of Isles. Most of the oil in these bays was a liquid, subsurface oil in the biologically productive lower intertidal. These are also areas where sea otter and harlequin duck populations have failed to fully recover (Bodkin et al., 2002, Esler et al., 2000a,b, Irons et al., 2000, Lance et al., 2001, and Trust et al., 2000). Biomarker evidence indicates continued contaminant exposure for both Sea Otters and Harlequin Sea ducks, presumably to the oil found in the lower intertidal zone. Both species forage in the lower intertidal zone, where contact to oil directly or indirectly through contaminated prey is possible for these contaminated sites.

In 2002, ABL is currently assessing the potential bioavailability of lingering oil (project #02585) at five sites, by measuring chemical uptake into passive samplers that are placed in, above, and near known oil patches (discovered and mapped during the 2001 survey). In addition, a limited number of prey items will be sampled to determine their contamination levels. The winter cruise has been completed at this time (February deployment), but chemical results are not available yet. But, based on observations of finding clams living in obviously oiled sediments (and shells stained with oil), we certainly expect to see that contaminated prey are potentially available to predators. We expect that the survey in progress will confirm a range of contamination potentially available to predators from the 5 sties being studied.

What we will not know after 2002 is- what is the percentage of oil habitat and forage within these worst case bays that are probably responsible for the chronic oiling problems still being found in Otters and sea ducks. Is it the mussels or the clams? Is it 1% or 10% or 30% of the primary forage habitat within these bays? The study in 2003 proposes to intensely study two "worst case" bays to quantify the total forage habitat available, and determine what percentage of that habitat is still contaminated with oil. Herring bay will be studied as the "worst case" (significant oiling; no otter recovery) and Bay of Isles will be also be studied (marginal oiling except for one small site known; partial recovery of otters).

NEED FOR THE PROJECT

A. Statement of Problem

The 2001 shoreline survey revealed that a significant amount of oil still remains on beaches in Prince William Sound and certain bays have persistent patches of oil. In 2002, the bioavailability of the oil is under study at 5 specific sites, with coordinated studies by USGS on otters / sea ducks and on the persistence of oil by ABL. However, the significance of oil remaining to foraging habitat and prey is unknown, and this study will focus on the possible linkage of the remaining oil with foraging habitat and contaminated prey. Significance of the remaining oil is dependent on two criteria; bioavailability at each site, and the significance of the remaining oil as a percentage of the foraging habitat. For example, if 2% of the habitat is oiled in a bay like Herring bay, this is very significant if that small amount of total area contains a high percentage of the forage like clams. Clams are not evenly distributed throughout a bay like mussels, but are usually constrained within a limited habitat. The task in 2003 will be to merge oiling levels with forage habitat and prey. The scale of all contaminated areas is too large for detailed studies, but an intense look at oil persistence, as a percent of the foraging base can be assessed in detail at two bays, and coordinated with USGS on the species studies. This study will determine the amount of oil remaining within two bays, what percent of the foraging habitat that is, and Part II will continue followup studies on the utilization of those habitats by otters and sea ducks, as well as impacts. This coordinated work

will assess the oiled areas as a source of chronic oil exposure, and the significance of that contamination to the limiting recovery of those species.

B. Rationale/ Link to Restoration

Part I of this proposal will provide a means to relate primary foraging habitat and contamination data with known oiled shorelines in two bays where sea otters and sea ducks have not recovered from the *Exxon Valdez* oil spill. Once contaminated prey and habitats have been identified within these bays, individuals observed foraging or captured in these areas can be linked to chronic exposure data (Part II). Recovery from the spill will have occurred when contaminated foraging habitat and chronic exposure to top level predators has fallen below detection levels at these "worst case bays".

C. Location

All surveying and sampling will be conducted within Herring Bay and Bay of Isles located on Knight Island in Prince William Sound.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Charters to support the research will be solicited from the spill impacted area. Further, some labor support for some of the field operations may be solicited from the Native villages.

PROJECT DESIGN

D. Objectives

1. Determine the total foraging base habitat in two oil impacted bays where otters/sea ducks forage, by generating habitat maps based on biology rather than geomorphology. (Herring Bay; Bay of Isles)

    Task: Generate habitat maps delineating shoreline types and primary foraging habitats for sea otters and sea ducks within two bays, based on observations at the zero tide level.

2. Determine the percentage of foraging habitat and prey that continues to be oil contaminated. in two bays.

    Task: Estimate the amount of shoreline (length and area) by assessing oil contamination at 20% of the habitat types, down to the zero tide level.
    Task: Determine prey contamination levels at multiple sites with each bay.

3. Estimate the significance of the habitat and prey contamination levels relative to the bay, and to the region (close-out synthesis).

B. Methods

Habitat Assessment

Foraging habitat will be assessed at zero tide stage by ground truthing surveys throughout both bays. Basically, algal cover and clam/mussels habitat will be determined for the entire shoreline of each bay. Habitat data from the EVOS GIS database (ADNR 1992) and the 2001 survey estimated oiled shoreline for Herring Bay and Bay of Isles are summarized in (Table 1). The EVOS GIS maps show the habitat types, generated by 1992, and were based on geomorphology types, and were constructed for purposes other than estimating foraging habitat, but are the base from which we will expand. Summaries of our current knowledge of the habitats and oiling history within these bays are presented in Figs. 1 and 2. This information will be fine tuned by a ground-truthing at low tide in the spring of 2003, and should be completed within one tide series. During ground-truthing, habitat information will be recorded at several different levels. Shoreline types will be verified and added to based on the Environmental Sensitivity Index (ESI) which classifies shoreline locations according to geomorphology and exposure (Halls et al. 2000). Shoreline types will be refined even more to include across shore components (changes in tidal zone substrate types) and biological zones (algal cover, mussel beds, clam beds, eelgrass beds, and kelp beds). This will provide the appropriate baseline information for defining primary foraging habitats for sea otters and sea ducks within each bay. Current and/or future monitoring data of sea otters and sea ducks can also be added to the updated GIS database.

Oiled Shoreline Survey

The quantity of oiled habitat in each bay will be assessed using similar stratified random sampling concept, as was done in 2001, but will be optimized for the two bays, based on a power analysis from the scat I survey completed in 2001. The number of pits and size of the collumns will likely be modified. Most importantly, the selection of sites will be based on habitat types, rather than oiling history, so that there is direct cross over with the data for both foraging habitat and oil contamination. Using SCAT I data does predict oil probabilities for Herring bay, but it is not of fine enough scale to use to predict how that relates to foraging habitat. After the habitat mapping has been completed, 20% of the primary foraging habitats within each bay will be randomly targeted for an oiled shoreline survey. The specifics of the design will evolve during the winter, and should be reviewed in the winter prior to implementation in the spring. Oil patches discovered during the summer survey will also be integrated into the GIS database. The oiled shoreline survey will use the same stratified random sampling (SRS) design implemented during the 2001 shoreline survey, except the lower zone will be extended down to the zero tide level.

This will allow for detection of oil well into the biological zone and foraging habitat. The beach segments will be partitioned into rectangular blocks by a number of equal-width alongshore columns and 0.5 m tidal elevation intervals. The maximum beach segment length, 100 m, will be divided into eight columns, each 12.5 m wide, resulting in 48 blocks. Shorter beach segments will be divided into fewer columns and blocks. Two 0.25 m^2 quadrats will then be randomly placed within each block and a test pit excavated within each to a depth of 0.5 m or until boulders or bedrock are encountered. Oiled surface and subsurface area and its variance for any sampled segment will be estimated from these random quadrats, using standard SRS formulas.

Oil contamination
Visibly oiled mussels, clams, and gunnels (10 of each in both bays = 60 samples) will be collected for GCMS analysis from multiple sites within a bay. Chemical analyses from project #02585 will be reviewed to prioritize analyses of samples acquired during the summer of FY03.

To determine the source and weathering condition of remaining oil, 10 sediment samples from pits with visible subsurface oil will be collected within each bay. All samples will be analyzed by GC-MS (summarized in Short et al. 1996) to determine whether PAH composition matches weathered *Exxon Valdez* oil. A weathering index (Short and Heintz 1997) will be determined for each sample.

Sampling Locations:

1. Bay of Isles: impacted bay; marginal numbers of recovering otters and sea ducks; chronic exposures.

2. Herring Bay: impacted bay; "worst case" site for recovering otters and sea ducks; acute exposures.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The overall project is a joint effort with NOAA-ABL and USGS-BRD based on their expertise and Trustee funded research in the past. ABL personnel will conduct studies on habitat assessment and the oiled shoreline survey as described in Part I of this DPD. USGS-BRD personnel will be responsible for directing and conducting sea otter and sea duck studies as described in Part II of this DPD.

SCHEDULE

A. Measurable Project Tasks for FY03 (October 1, 2002 – September 30, 2003)

December 2002	Mini-workshop; review progress to date; review field sampling designs
April 2003:	Complete research on habitat information and GIS database preparation.
May 2003:	Complete habitat ground truthing and mapping in bays. 1 tide series
June 2003:	Complete oiled shoreline survey in bays. 1 or 2 tide series.
December 2003:	Complete oiled shoreline estimates and chemical analyses.
January 2004:	Attend Annual Workshop.
April 2004:	Complete Final Report.

B. Project Milestones and Endpoints

FY03: A spring (May 2003) mapping cruise would be followed a month later (June) for implementation of the oiled shoreline survey. This would utilize the large spring tides for sampling in the biological zone. All chemical analyses will be initiated in FY03.

FY04: Close out of the project is anticipated for both agencies in FY03. Further work would be dependent on results, and would be applied for as an independent proposal. Some chemical analyses will spill into FY04, but all data analyses will be completed by Jan 2004. Final report, with a synthesis would be due June 1, 2004.

C. Completion Dates

This is a one year field project, followed by a closeout year. All field collections and analyses will be completed in the FY03 funding cycle. Chemical analyses will be completed by December 2003 and a final report by June 1, 2004.

PUBLICATIONS AND REPORTS

We will provide a final report to the Trustees office by April 15, 2004.
Expected publication titles:

1. Contamination of mussels and clams near oil patches from two bays in Prince William Sound.
2. Percent of oil contamination of the forage habitat from bays in Prince William Sound, 13 years after the Exxon Valdez oil spill.
3. Significance of oiled habitat and prey as a probable cause of chronic impacts to sea otters and harlequin ducks.

PROFESSIONAL CONFERENCES

The EVOS Trustee meetings will be attended by the principal investigators. One additional scientific meeting will be attended by one of the principal investigators (AMOP or SETAC).

NORMAL AGENCY MANAGEMENT

None of these projects are part of normal agency management activities.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is related to the Shoreline assessment and Lingering Oil and Bioavailability of Lingering Oil projects and will use information generated from these studies. Likewise, the sea otter and harlequin duck work is an outgrowth of projects funded in FY 01and 02, and will utilize information from those projects. Further, there has been coordination between the two agency component parts in development of the proposal, to ensure geographical overlap and relationship.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

N/A

PROPOSED PRINCIPAL INVESTIGATORS

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PRINCIPAL INVESTIGATORS

Stanley D. Rice
GM-14 Physiologist

Received BA (1966) and MA (1968) in Biology from Chico State University, and PhD (1971) in Comparative Physiology from Kent State University. Employed at Auke Bay Fisheries Laboratory since 1971 as a research physiologist, task leader and Habitat Program Manager since 1986. Rice has researched oil effects problems since 1971, and has published over 115 papers, including over 75 on oil effects. Studies have ranged from field to lab tests, behavioral to physiological to biochemical studies, from salmonids to invertebrates to larvae to meiofauna. Rice has conducted and managed soft funded projects since 1974, including the Auke Bay Laboratory *Exxon Valdez* damage assessment studies since 1989. Activities since the oil spill have included leadership and management of up to 10 damage assessment projects, field work in PWS, direct research effort in some studies. Quality assurance of all studies, particularly the biological impacts research has been the continuing focus through the restoration years. Principal investigator in subtidal sediment studies, pink salmon effects studies, and in the SCAT surveys of 2001. In addition, Rice has lead the effort on use of LDPE research by the Auke Bay Lab.

Jeffrey W. Short
Research Chemist

Education: M.S. (Physical Chemistry). 1989- Present: Established and managed the hydrocarbon analysis facility at ABL to analyze hydrocarbon samples generated by the *Exxon Valdez* NRDA effort. Responsible for quality control and data interpretation of all data hydrocarbon data produced by ABL labs. Principle investigator of several EVOS projects through the damage assessment and restoration years, paarticularly those studies involved in tracking oil (subtidal sediments), tracking the Hydrocarbon Data Base, several specific projects (Pristane; Coal as a background source), and most importanly, principal investigator of the large shoreline assessment project (SCAT) in FY 2001. Many publications.

Mandy R. Lindeberg
Fisheries Research Biologist

B.S. Marine Biology. 1990- present: Mandy has been involved in *Exxon Valdez* oil spill research for the last 11 years. Her research includes studies on intertidal invertebrates and seaweeds, mussel populations, and a co-principal investigator of spot shrimp populations in Prince William Sound. She was the field chief of the intensive PWS oiled shoreline survey during 2001 and lingering oil bioavailability in 2002. Her responsibilities include quality control of field and laboratory sample processing, data analysis, graphics, and proposal/report preparation.

OTHER KEY PERSONNEL

Chemists Marie Larsen, Larry Holland, Josefina Lunasin will participate in the chemical analyses of the samples.

LITERATURE CITED

See combined "Literature Cited" section for Parts I & II.

Table 1. Current estimates (meters or kilometers) of habitat shore types for Bay of Isles and Herring Bay, Prince William Sound based on the EVOS GIS database. Estimates from the 2001 shoreline survey of total contaminated shoreline are listed at the bottom of each table for the two bays.

	Shore	Bay Length		Percent
Bay of Isles	**Type**	**(meters)**	**(km)**	**Oil**
Exposed rocky shore	1	1,046.41	1.05	?
Exposed wavecut platforms	2	486.22	0.49	?
Fine-grained sand	3	0.00	0.00	?
Coarse grained sand	4	0.00	0.00	?
Mixed sand and gravel	5	12,779.77	12.78	?
Gravel, cobble, and boulder	6	327.82	0.33	?
Exposed tidal flats	7	0.00	0.00	?
Sheltered rocky	8	16,008.14	16.01	?
Sheltered tidal flats	9	0.00	0.00	?
Marshes	10	2,095.97	2.10	?
		32,744.33	**32.74**	
Estimated oiled shoreline 2003				?

	Shore	Bay Length		Percent
Herring Bay	**Type**	**(meters)**	**(km)**	**Oil**
Exposed rocky shore	1	4,710.27	4.71	?
Exposed wavecut platforms	2	955.54	0.96	?
Fine-grained sand	3	0.00	0.00	?
Coarse grained sand	4	0.00	0.00	?
Mixed sand and gravel	5	13,261.52	13.26	?
Gravel, cobble, and boulder	6	0.00	0.00	?
Exposed tidal flats	7	0.00	0.00	?
Sheltered rocky	8	31,088.00	31.09	?
Sheltered tidal flats	9	0.00	0.00	?
Marshes	10	0.00	0.00	?
		50,015.33	**50.02**	
Estimated oiled shoreline 2003				?

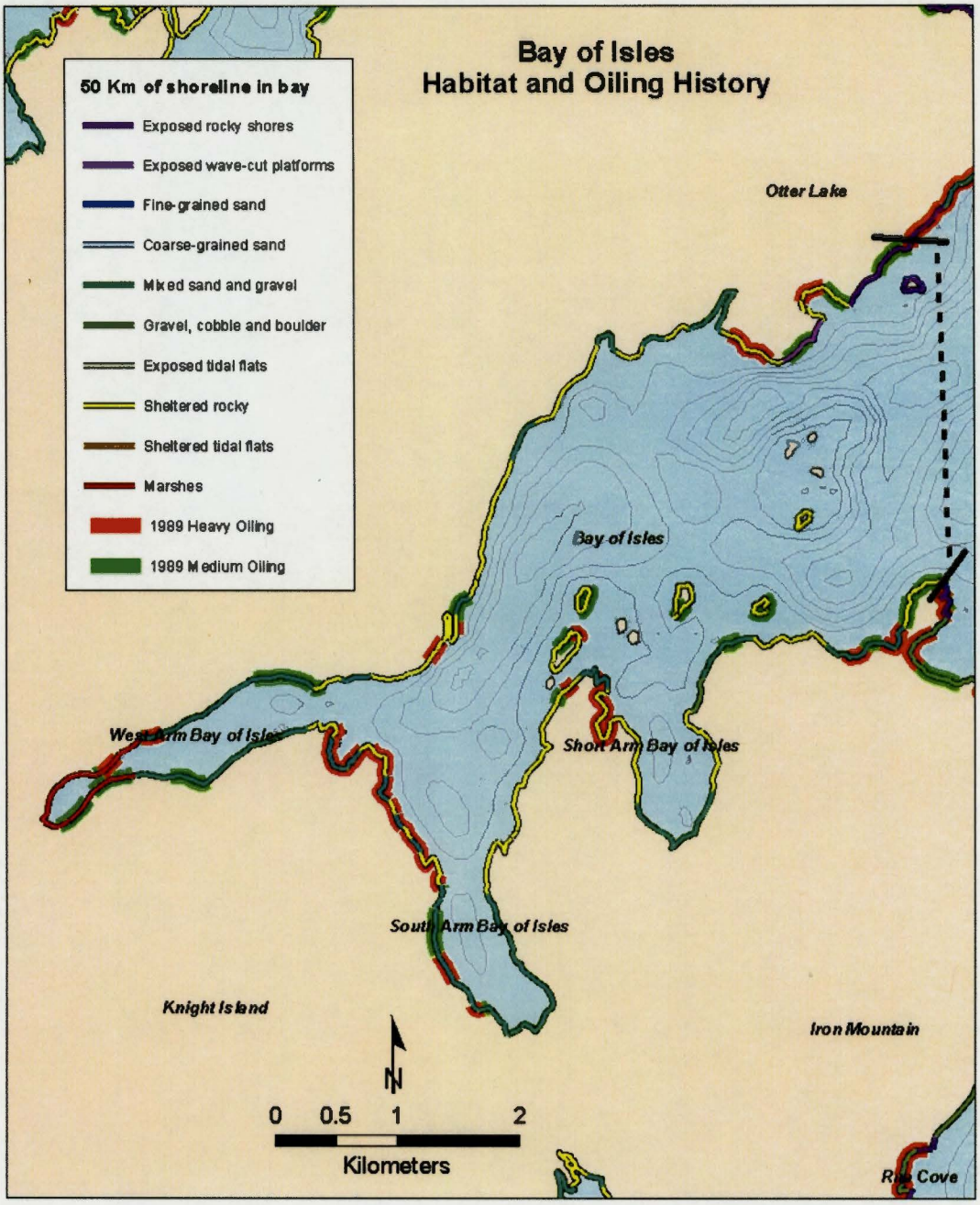

Figure 1. Map of Bay of Isles, Prince William Sound generated by EVOS GIS database showing shore types and oiling history.

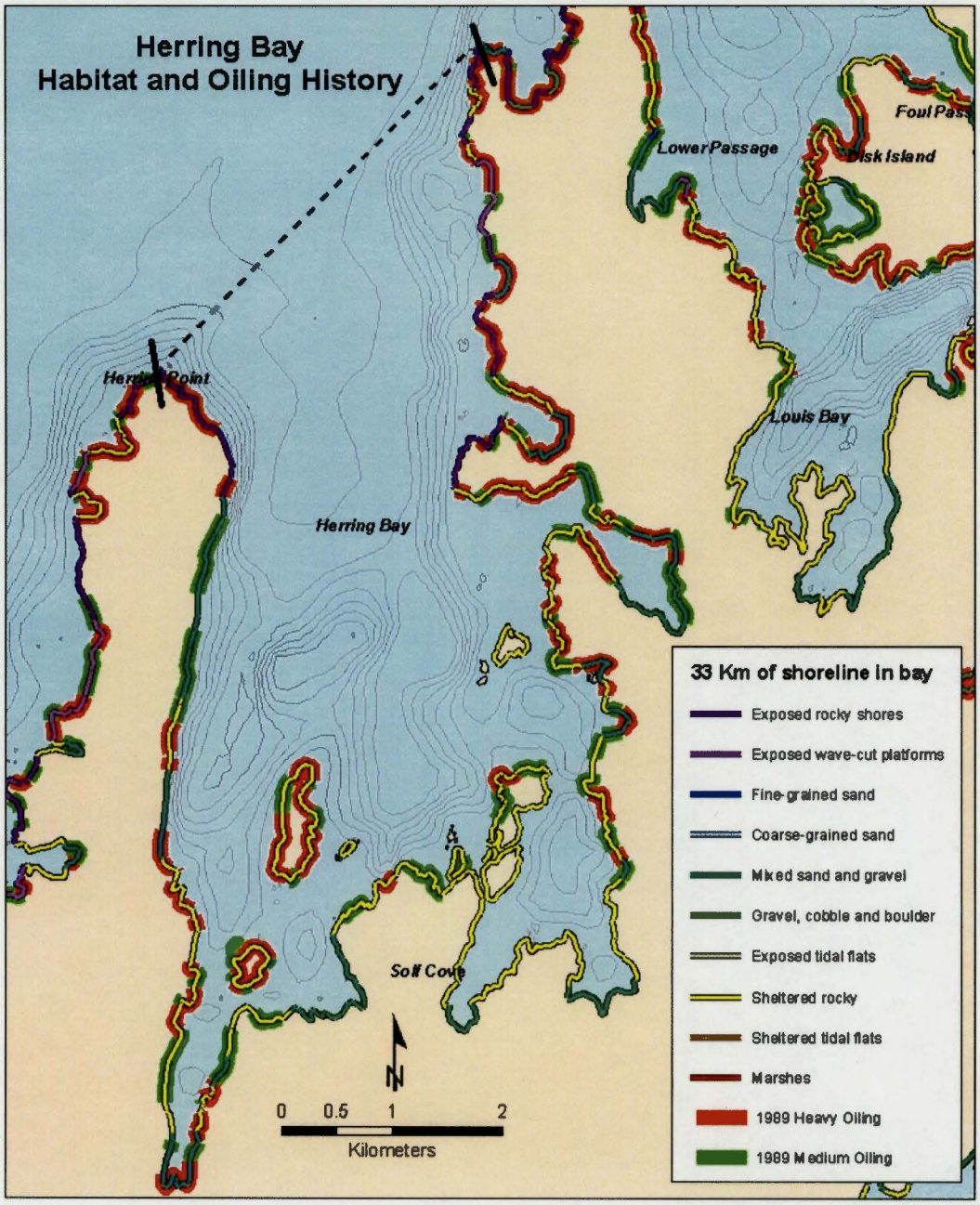

Figure 2. Map of Herring Bay, Prince William Sound generated from the EVOS GIS database showing shore types and oiling history.

Part II. Lingering Oil and Predators: Pathways of Exposure and Population Status
(DOI-USGS)

ABSTRACT

Accumulating evidence strongly implicates lingering oil as a factor constraining recovery of the nearshore ecosystem in western Prince William Sound (WPWS). Elevated levels of cytochrome P4501A (CYP1A), a biomarker of exposure to hydrocarbons, have been documented in fishes, birds and mammals that occupy high trophic level positions in the nearshore food webs of WPWS. In the heavily oiled areas, sea otters and harlequin ducks have failed to demonstrate population level recovery, which is at least in part attributable to elevated mortality rates. Continued exposure to hydrocarbons, expressed in elevated hydrocarbon tissue burdens, has been documented in clams and mussels in the heavily oiled areas of WPWS. These clams and mussels provide important foods for the sea otter and sea ducks (including harlequin, goldeneye and scoters), thus providing a potential pathway between lingering oil and exposure at the apex of the food webs. While potential links between lingering oil and constrained ecosystem recovery are becoming better understood, the evidence implicating a route of exposure is largely circumstantial. Because locations and extent of lingering oil were poorly documented, exposure routes of higher vertebrates to lingering oil were by necessity implied. However, in 2001 and 2002, extensive sampling was undertaken by NOAA to document the distribution, abundance, and bioavailability of lingering oil along those shorelines most heavily impacted by the 1989 spill. We propose to use the results of the NOAA shoreline sampling as a foundation to document routes of exposure of sea otters and sea ducks to lingering oil. The proposed work will (1) use the large sample of marked sea otters and harlequin ducks residing in the heavily oiled areas of Knight Island, with known CYP1A values, to test for differences in CYP1A levels between animals that forage in areas of lingering oil and those that do not, (2) test for differences in habitat use by sea otters and sea ducks between oiled and unoiled shoreline segments, and (3) monitor survival of sea otters at Knight Island and relate survival outcome to CYP1A level and liver condition. Aerial surveys for sea otters will provide a current measure of population status. The results of this work will provide current information on sea otter population status, and identify and prioritize those shoreline segments where restoration would be most beneficial to sea otters and sea ducks.

INTRODUCTION

In summer 2001, the NOAA Auke Bay Laboratory (ABL) shoreline assessment project identified about 20 acres of beach in Prince William Sound that were still contaminated with oil, and changed our perception of how much oil remains and where on the beach it is located (ABL, unpub. data). Further, the shoreline assessment provided evidence of a potential pathway of oil through the ecosystem to those top-level predators that are exhibiting delayed recovery, including sea otters and harlequin ducks. Oil was found at 58% of the 91 sites examined; 6,775 randomly stratified

sampling pits were assessed to have the linear equivalent of 7.8 km of oil-contaminated shoreline. The 20-acre estimate of oil-contaminated shore was more than twice the estimate coming from surveys in 1993 (1993 surveys covered more beaches, but dug far fewer holes) (Gibeaut and Piper, 1998a,b). Most of the oil found in 2001 was classified as "light", but was still readily located and observed. All the pits used in the assessment were dug by hand, and all the initial classifications were made from visual observations. Over a period of about 100 days, 91 sites were visited, each site picked randomly from a population of sites judged to be heavily or moderately oiled in one of the surveys from 1989-1993.

In 2001-2002, ABL is assessing bioavailability of lingering oil through deployment of LDPE's (low density polyethylene devices) at sites with and without lingering oil. Oiled patches discovered and mapped during the 2001 survey will be relocated (patches found in lower zones near the biological active zones will be targeted) and LDPE's placed in close proximity. These deployments are being made in both the winter and in the summer of 2002. In addition, mussels are being sampled for bioavailability of hydrocarbons at the locations of LDPE deployment. The research completed and underway by ABL provides the data layer necessary to ask the question of how sea otters and sea ducks (harlequin, goldeneye and scoters) are being exposed to lingering oil.

Sea otter recovery in the general spill area of WPWS is evident based on an increase of about 900 animals between 1993 and 2000 (Bodkin et al. in press). However, recovery of sea otters and harlequin ducks in the North Knight Island area has not occurred. Through 2001, there has been no increase in sea otter abundance at northern Knight Island, and the population remains at about half the estimated pre-spill number (Bodkin et al. in press). Surveys of sea duck abundance also indicate delayed recovery in this area. Oil exposure has been suspected as a factor constraining recovery, particularly in consideration of elevated levels of Cytochrome P4501A (CYP1A), a biomarker of aromatic hydrocarbon exposure, in sea otters and sea ducks from oiled areas (Ballachey et al. 2001a, Trust et al. 2000), and liver alterations observed in sea otters in the oiled area in 2001 (USGS, unpub. data, 02423 Annual Restoration Report). Higher mortality rates have been demonstrated for sea otters (Monson et al. 2000) and harlequin ducks (Esler et al. in press) residing in oiled areas of western PWS, but without confirming bioavailability and identifying exposure pathways, it has not been clear that lingering oil was responsible. Earlier studies showing significant oil concentrations in contaminated mussel and clam beds (Babcock et al. 1996, Fukuyama et al. 2000, Carls et al. 2001) suggested a pathway, but there was never an exhaustive survey of oiled prey populations to determine their distribution and potential significance to predators. The ABL survey indicates relatively more oil lower down on the beach, near the biological zone, and raises the possibility that oil deposits at high impact sites may be limiting recovery of sea otters and sea ducks.

Field studies in 2003 will focus on four primary questions:

(1) Is there evidence of sea otter population recovery in WPWS and in the heavily oiled northern

Knight Island Archipelago?

An aerial survey in WPWS and replicate aerial surveys at northern Knight will be conducted in 2003 to determine the current status of sea otter populations affected by, and not recovered from the EVOS.

(2) Is there any relation between the foraging activity of sea otters and sea ducks relative to the presence or absence of oil on shoreline segments?

Visual observations of the abundance and behavior of marked sea otters (with known CYP1A values) and sea ducks will be made at a sample of shoreline segments with, and without lingering oil at northern Knight Island.

(3) Do sea otters and harlequin ducks with known CYP1A values utilize nearshore habitats with known deposits of residual Exxon Valdez oil?

Remote recording of the presence or absence of sea otters and harlequin ducks with known oil exposure histories (based on an observed range of elevated CYP1A values) and instrumented with VHF transmitters will occur at shorelines with known residual oil and without residual oil.

(4) What is the survival rate of sea otters at Knight Island, and does survival of individual otters relate to CYP1A values and liver alterations?

Sea otters will be instrumented with VHF transmitters, and monitored to determine survival. Survival outcomes will be related to observations made on the animals at the time of capture (CYP1A and liver histology).

The results of the proposed work will identify areas where sea otters and sea ducks are being exposed to lingering oil. From these findings, it will be possible to prioritize patches of oiled habitat for restoration.

NEED FOR THE PROJECT

A. Statement of Problem

In 2001, lingering oil from the 1989 oil spill was identified, located and quantified at relatively small and accurate spatial scales in WPWS. In 2002, measures of bioavailability in seawater and mussel beds were obtained, relative to previously identified patches of oiled shoreline. While we have data identifying where lingering oil exists and compelling evidence of continued, chronic exposure to oil throughout the food webs, we have not yet identified the locations where top-level predators are being exposed. Not until we have such information can we make defensible

decisions on where to focus habitat restoration efforts.

Sea otters and sea ducks in the most heavily oiled areas of WPWS have not yet recovered from the *Exxon Valdez* oil spill, based on several lines of evidence from studies conducted as part of the NVP project (/025) and the continuing work as part of project /423. Significant and consistent results on sea otters and sea ducks include lack of population growth in the oiled study area (Bodkin et al. in press, Dean et al. 2000, USGS unpub. data), evidence of relatively poor survival rates from the oiled area (Bodkin et al. in press, Monson et al. 2000, Esler et al. in press), and increased induction of CYP1A in the oiled area in 1996-98, and again in 2001 for sea otters and 2000 for harlequin ducks (Ballachey et al. 2001a, USGS unpub. data) (CYP1A data for harlequin ducks in 2001 are pending). Although all sea otters sampled at Knight exhibit some degree of CYP1A induction relative to otters in the unoiled area, large variation is observed in the values, suggesting differences among the otters in the oiled area in their exposure to lingering oil. In 2001, livers of sea otters and sea ducks were biopsied for histopathology. Sea otters in the oiled area were observed to have a higher incidence and severity of lesions (see 2002 Annual Report for 02423), and for 2 of the 15 animals sampled, the alterations in the liver were severe and life threatening. Further, the two otters with the most severe liver lesions also had the highest CYP1A values; both were from Bay of Isles at Knight Island. Histopathology results on liver samples from the harlequin ducks are not yet available.

Elevations in CYP1A do not appear to be due to background or natural hydrocarbon sources, as these were found to be negligible in intertidal areas of PWS (Short and Babcock 1996), nor to differential contamination of areas by PCBs (Trust et al. 2000; USGS unpub. data). Continued exposure to residual *Exxon Valdez* oil is the most plausible explanation for CYP1A elevations. Residual oil is still stranded in intertidal areas of PWS (Babcock et al. 1996, Carls et al. 2001, Hayes and Michel 1999), providing a continuing potential source of contamination. However, the locations where sea otters may be acquiring continuing exposure to residual oil remained largely unknown until 2001/2002. With the data now available on distribution and abundance of lingering oil we can identify those locations where sea otters and sea ducks are most likely acquiring their continued exposure, and prioritize areas for restoration. Further, we can evaluate relations between exposure of those individuals, based on their foraging locations, their health and their subsequent survival.

B. Rationale/Link to Restoration

This research will provide a means to relate observed levels of CYP1A induction and liver histopathology in sea otters and harlequin ducks from heavily oiled areas of northern Knight Island to locations where those individuals forage. Although all otters sampled at Knight show at least a low level of induction, only a small proportion of the sea otters exhibit high CYP1A levels. Thus, it appears likely that exposure may result from a relatively small number of animals using areas where oil is persistent, as opposed to all animals using all habitats equitably. This research also

provides the opportunity to relate the abundance and behavior of sea otters and sea ducks to the proximity of lingering oil. Once sea otter and sea duck density and oil exposure history can be tied to known patches of lingering oil, and therefore exposure, direct restoration measures and locations can be identified and prioritized.

C. Location

The surveys will be conducted in western PWS and intensive replicate surveys at northern Knight Island. Sampling of oiled and unoiled shoreline segments for the abundance and behaviors of sea otters and sea ducks will be conducted at northern Knight Island. Oiled and unoiled shoreline segments identified from project 02585 (NOAA) and within this project (NOAA component) will serve as the foundation for our study design relating sea otter and harlequin duck oil exposure histories to their potential use of oiled shorelines.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

We will be available to interact with local communities in meetings to explain and discuss ongoing restoration projects (this effort coordinated with similar activities for project 03423).

PROJECT DESIGN

A. Objectives

1. Obtain current estimate of the WPWS sea otter population size.

2. Obtain current estimate of the northern Knight Island sea otter population size.

3. Identify locations of sea otters/sea ducks relative to known locations of lingering oil.

4. Identify those locations where sea otters and harlequin ducks with known blood and liver P450 values are residing and foraging relative to known locations of lingering oil.

5. Monitor survival of marked sea otters at Knight Island and relate survival outcome to CYP1A levels and liver alterations.

B. Methods

Sea otter population monitoring-

We will continue to use previously developed aerial survey techniques which employ counts along systematic transects, and intensive search units (ISU's) to estimate a correction factor for each survey (Bodkin and Udevitz, 1999). We will conduct a single survey of the entire WPWS in 2003. We will conduct replicate surveys (5 or more replications per survey) of the heavily oiled northern Knight Island study site (previously sampled in NVP and /243).

Sea otter and sea duck habitat use relative to lingering oil patches-

Sea Otters and Sea Ducks: In Oct./Nov. 2002 and April and July 2003, we will visually sample 20-40 oiled and 20-40 non-oiled shoreline segments (approximately 100 m in length), to determine the abundance and behaviors of sea otters and sea ducks at each segment. Shoreline segments will correspond to those identified and sampled by ABL under project //585, and will be categorized as either oiled or unoiled. We will employ shore-based scan sampling techniques (Altmann 1974), using high resolution telescopes to estimate the total number of sea otters and sea ducks and the proportions of each that are foraging and not foraging in each shoreline segment type. Each shoreline segment will be sampled for four continuous hours, in each of the three sampling periods. The resulting data will be used to test the hypothesis that sea otter and sea duck use of shoreline segments is independent of the presence of lingering oil.

Locations of sea otters and harlequin ducks with known oil exposure levels in relation to lingering oil patches--

Sea Otter telemetry: In 2001, fifteen sea otters were captured, visually marked, and blood and liver samples collected for CYP1A assays. In 2002, an additional 30 sea otters will be captured and similarly processed at northern Knight Island under project 02585. These animals will provide a sample of sea otters with measures of relatively recent (blood and liver CYP1A) and longer-term (liver histopathology) exposure to hydrocarbons. We propose to instrument the 30 sea otters captured in 2002 with VHF radio transmitters, to document use of oiled and unoiled nearshore habitats by individual otters, particularly in relation to their CYP1A values and foraging behaviors. In addition, a sample of harlequin ducks instrumented with VHF transmitters under project //423 (PI Dr. Dan Esler) in fall 2002 will allow us to document use of oiled and unoiled nearshore habitats by individual ducks, particularly in relation to their P450 values and foraging behaviors. We will establish remote VHF radio data loggers at 5 oiled and 5 nonoiled sites at northern Knight Island. Remote data logging stations will be established for three 4-week periods: in fall 2002, in late winter 2003 and in summer 2003. Continuous monitoring of oiled and unoiled shoreline segments during these three periods for the presence/absence of otters and ducks within monitored segments will allow us to identify the relative use of oiled versus unoiled shorelines by animals with known oil exposure histories (based on CYP1A). In addition, we will conduct intensive relocations (3/day) of instrumented animals during three 2-week periods in Oct./Nov. 2002, April

2003 and July 2003 (identified above) to test the hypothesis that P450 levels in individual sea otters do not vary in relation to distance from foraging locations to lingering oil locations. We will also monitor survival of the instrumented otters by weekly aerial tracking flights to locate individuals.

SCHEDULE

A. Measurable Project Tasks

FY02

July: -Capture, sampling, and implantation of sea otters with vhf radios. (under project 02585)

FY03

Oct/Nov: -Conduct sea otter/sea duck scan sampling of oiled and unoiled shoreline segments.
-Monitor locations and behaviors of radio-instrumented otters.
-Sample use of oiled and unoiled shorelines through VHF transmitters on sea otters and harlequin ducks.

April: -Conduct sea otter/sea duck scan sampling of oiled and unoiled shoreline segments.
-Monitor locations and behaviors of radio-instrumented otters
-Sample oiled and unoiled shorelines through VHF transmitters on sea otters and harlequin ducks.

June/July: -Conduct sea otter/sea duck scan sampling of oiled and unoiled shoreline segments.
-Monitor locations and behaviors of radio-instrumented otters.
-Sample oiled and unoiled shorelines through VHF transmitters on sea otters and harlequin ducks.

Oct/July: -Aerial tracking of sea otters with VHF transmitters to monitor survival.

B. Project Milestones and Endpoints

July 2002: Instrument 30 sea otters with radio transmitters. (capture supported under 02585)

Oct 2002: Commence data collection.

July 2003: Complete data collection.

August 2003: Commence data analysis.

April 2004: Report submission - April 15, 2004.

C. Completion Date

This is a one year project. Data collections and analyses will be completed in FY2003 and a final report submitted by April 15, 2004.

PUBLICATIONS AND REPORTS

We will provide a final report to the EVOSTC office by April 15, 2004.

PROFESSIONAL CONFERENCES

None planned for FY2003.

NORMAL AGENCY MANAGEMENT

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

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is dependent sea otter capture in 2002 for monitoring Cytochrome P450 as part of Project 02585; otherwise we cannot complete the stated objectives. Data loggers will be made available from prior EVOS Restoration Projects (PI Dr. David Irons). Sea otter transmitters (30) will be provided by USGS, but will require battery replacement. Access to Harlequin duck radio frequencies and marking locations will be provided by Dr. Dan Esler. We will provide Dr. Esler with reports of our findings as they are available to aid his survival tracking efforts.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

NA

PRINCIPLE INVESTIGATORS

James L. Bodkin, B.S., M.S. California State Polytechnic University in 1986. Research Wildlife Biologist, and team leader for coastal ecosystem research in Alaska for the Alaska Science Center of USGS. He has over 40 peer-reviewed scientific publications and directs an active coastal marine research program. He has studied and published on sea otter foraging ecology and community structuring since 1988 and has been a principal investigator for EVOS research projects //025, //423, and //585.

Dr. Brenda Ballachey is a Research Physiologist at the USGS Alaska Science Center in Anchorage. She was Project Leader for sea otter NRDA studies from 1990 through 1996, and has been involved in all aspects of post-spill research on sea otters, including the Nearshore Vertebrate Predator (NVP) project, with primary responsibilities for examining effects of residual oil on biomarkers and health of sea otters and other NVP study species. She has authored numerous peer-reviewed journal publications, reports and presentations. She received her M.S. in 1980 at Colorado State University, and Ph.D. in 1985 Oregon State University.

OTHER KEY PERSONNEL

LITERATURE CITED

ADNR. 1992. EVOS Geographic Information System (GIS) Database and Data Dictionary. EVOS Research and Restoration Information Project CD-ROM. Alaska Dept. of Natural Resources. Anchorage, AK.

Altmann, J. 1974. Observational study of behavior: sampling methods. Behavior 49:227-267.

Babcock, M., P.M. Harris, M.G. Carls, C.C. Brodersen, and S.D. Rice. 1998. Mussel bed restoration and monitoring, *Exxon Valdez* Oil spill Restoration Project Final Report Restoration Project 95090), National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Auke Bay Laboratory, Juneau, Alaska.

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

Ballachey, B.E., J.L. Bodkin, S. Howlin, K.A. Kloecker, D.H. Monson, A.H. Rebar and P.W. Snyder. 2001a. Hematology and serum chemistry of sea otters in oiled and unoiled areas of

Prince William Sound, Alaska, from 1996-98. Appendix BIO-01 in NVP Draft Final Report (Project 95025-99025).

Ballachey, B.E., J.J. Stegeman, P.W. Snyder, G.M. Blundell, J.L. Bodkin, T.A. Dean, L. Duffy, D. Esler, G. Golet, S. Jewett, L. Holland-Bartels, A.H. Rebar, P.A. Seiser, and K.A. Trust. 2001b. Oil exposure and health of nearshore vertebrate predators in Prince William Sound following the *Exxon Valdez* oil spill. Chapter 2 *in* NVP Draft Final Report (Project 95025-99025).

Brodersen, C.C., J.W. Short, L. Holland, M.G. Carls, J. Pella, M. Larsen, and S.D.Rice. 1999. Evaluation of oil removal from beaches 8 years after the *Exxon Valdez* oil spill. Proc. 22nd Arctic and Marine Oil Spill Program, Environment Canada, Calgary, June 1999, pp. 325-336.

Bodkin, J. L., E. E. Ballachey, T.A. Dean, A. K. Fukuyama, S. C. Jewett, L. McDonald, D. H. Munson, C. E. O'Clair, and G. R. VanBlaricom, "Sea Otter Population Status and the Process of Recovery from the 1989 *Exxon Valdez* Oil Spill", Mar. Ecol. Prog. Ser., in press (2002).

Bodkin, J. L. and M.S. Udevitz. 1999. An aerial survey method to estimate sea otter abundance. in: Garner, G.W., S.C. Amstrup, J.L. Laake, B.F.J. Manly, L.L. McDonald, and D.G. Robertson, (eds.) Marine mammal survey and assessment methods. Balkema Press, Netherlands pg. 13-26.

Bodkin, J.L., B.E. Ballachey, T.A. Dean, S. Jewett, L. McDonald, D. Monson, C. O'Clair, and G. VanBlaricom. In press. Sea otter population status and the process of recovery from the *Exxon Valdez* oil spill. Marine Ecology Progress Series.

Carls, M.G., M.M. Babcock, P.M. Harris, G.V. Irvine, J.A. Cusick, and S.D. Rice, "Persistence of Oiling in Mussel Beds after the *Exxon Valdez* Oil Spill", Marine Environmental Research, 51 pp. 167-190, 2001.

Dean, T.A., J.L. Bodkin, S.C. Jewett, D.H. Monson and D. Jung. 2000. Changes in sea urchins and kelp following a reduction in sea otter density as a result of the *Exxon Valdez* oil spill. Marine Ecology Progress Series 199:281-291.

Esler, D, T. D. Bowman, T. A. Dean, C. E. O'Clair, S. C. Jewett, L. L. McDonald, "Correlates or Harlequin Duck Densities During Winter in Prince William Sound", Condor Vol. 102, p.920, 2000.

Esler, D., T.D. Bowman, K.A. Trust, B.E. Ballachey, T.A. Dean, S. Jewett, and C. O'Clair. *In*

press. Harlequin duck population recovery following the *Exxon Valdez* oil spill: progress, process and constraints. Mar. Ecol. Prog. Ser. (*Also as:* Harlequin duck perspective: Mechanisms of impact and potential recovery of nearshore vertebrate predators. Chapter 4 *in* NVP Final Report (Project 95025-99025).)

Esler, D., J. A. Schmutz, R. L. Jarvis, and D. M. Mulcahy. 2000. Winter survival of adult female harlequin ducks in relation to history of contamination by the *Exxon Valdez* oil spill. J. Wildl. Manage. 64:839-847.

Fukuyama, A.K. 2000. The ecology of bivalve communities in Prince William Sound, Alaska: Influence of the *Exxon Valdez* oil spill and predation by sea otters. PhD. Thesis, University of Washington, Seattle, USA.

Fukuyama, A.K., G. Shigenaka, and R. Z. Hoff. 2001. Effects of residual *Exxon Valdez* oil on intertidal Prototheca staminea: Mortality, growth, and bioaccumulation of hydrocarbons in transplanted clams. Marine Pollution Bulletin 40: 1042-1050.

Garrott, R.A., L.L. Eberhardt and D.M. Burns. 1993. Mortality of sea otters in Prince William Sound following the *Exxon Valdez* oil spill. Mar. Mam. Sci. 9:343-359.

Garshelis, D. L. 1997. Sea otter mortality estimated from carcasses collected after the *Exxon Valdez* oil spill. Conservation Biology. 11(4):905-916.

Gibeaut, J. C., and E. Piper. 1998a. 1993 shoreline oiling assessment of the *Exxon Valdez* oil spill. *Exxon Valdez* oil spill restoration project 93038 final report.

Gibeaut, J. C., and E. Piper. 1998b. 1993 shoreline oiling assessment of the *Exxon Valdez* oil spill. *Exxon Valdez* oil spill restoration project 93038 data report, Volumes 1-6.

Halls, J., J. Michel, S. Zengel, and J.A. Dahlin. 2000. Environmental Sensitivity Index Guidelines Version 2.0. NOAA Technical memorandum NOS ORCA 115.

Hayes, M. O., and J. Michel. 1999. Factors determining the long-term persistence of *Exxon Valdez* oil in gravel beaches. Mar. Pollut. Bull. 38:92-101.

Irons, D. B., S. J. Kendall, W. P. Erickson, L. L. McDonald, B. K. Lance, "Nine Years After the *Exxon Valdez* Oil Spill: Effects on Marine Bird Populations in Prince William Sound, Alaska", Condor Vol. 02, pp. 723-737, 2000.

Lance, B. K., D. B. Irons, S. J. Kendall, L. L. McDonald, "An Evaluation of Marine Bird Population Trends Following the *Exxon Valdez* Oil Spill, Prince William Sound, Alaska",

Mar. Pollut. Bull. Vol. 42, p. 298, 2001.

Monson, D.H., D.F. Doak, B.E. Ballachey, A. Johnson, and J.L. Bodkin. 2000. Long-term impacts of the *Exxon Valdez* oil spill on sea otters, assessed through age-dependent mortality patterns. Proc. Nat'l. Acad. Sciences, USA 97(12):6562-6567.

O'Clair, C. E., J. W. Short, and S. D. Rice. 1996. Contamination of intertidal and subtidal sediments by oil from the *Exxon Valdez* in Prince William Sound. Am. Fish. Soc. Symp. 18:61-93.

Perterson, C.H. 2001. *Exxon Valdez* oil spill in Alaska: Acute, indirect, and chronic effects on the ecosystem. Advances in Marine Biology 39: 1-103.

Short, J.W. and M.M. Babcock. 1996. Prespill and postspill concentrations of hydrocarbons in mussels and sediments in Prince William Sound. Pages 149-166 in S.D. Rice, R.B. Spies, D.A. Wolfe, and B.A. Wright, editors. Proceedings of the *Exxon Valdez* Oil Spill Symposium, American Fisheries Society Symposium 18, Bethesda, Maryland.

Short, J. W., T. J. Jackson, M. L. Larsen, and T. L. Wade. 1996. Analytical methods used for the analysis of hydrocarbons in crude oil, tissues, sediments, and seawater collected for the Natural Resources Damage Assessment of the *Exxon Valdez* oil spill. Am. Fish. Soc. Symp. 18:140-148.

Short, J. W., and R. A. Heintz. 1997. Identification of *Exxon Valdez* oil in sediments and tissues from Prince William Sound and the northwestern Gulf of Alaska based on a PAH weathering model. Environmental Science & Technology 31:2375-2384.

Snyder, P.W., T. Kondratyuk, B.E. Ballachey and J. Vanden Heuvel. 2000. CYP1A gene expression in sea otters (Enhydra lutris): a quantitative reverse transcriptase-polymerase chain reaction to measure CYP1A mRNA in peripheral blood mononuclear cells. Appendix BIO-02 *in* NVP Draft Final Report (Project 95025-99025).

Trust, K. A., D. Esler, B. R. Woodin, and J. J. Stegeman. 2000. Cytochrome P450 1A induction in sea ducks inhabiting nearshore areas of Prince William Sound, Alaska. Marine Pollution Bulletin 40:397-403.

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2002	Proposed FY 2003	PROPOSED FY 2002 TRUSTEE AGENCIES TOTALS ADEC	ADF&G	ADNR	USFS	DOI	NOAA
							$94.8	$201.6
Personnel		$79.1						
Travel		$16.8						
Contractual		$185.8						
Commodities		$33.5						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$315.2			Estimated FY 2004	Estimated FY 2005		
General Administration		$24.8						
Project Total		$340.0			$0.0	$0.0		
Full-time Equivalents (FTE)		1.4						
Other Resources		$0.0			$0.0	$0.0		

Comments:

The Auke Bay Laboratory will lead the habitat and lingering oil surveys (Part I); USGS will lead the sea otter and sea duck surveys (part II).

FY03

Prepared: 4/12/2002

Project Number: 03620
Project Title: Lingering Oil and Predators: Pathways of Exposure and Population Status
Lead Agency: NOAA- Auke Bay Laboratory

FORM 2A
MULTI-TRUSTEE AGENCY SUMMARY

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2002	Proposed FY 2003	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$38.0						
Travel		$11.8						
Contractual		$69.0						
Commodities		$20.0						
Equipment		$0.0						
Subtotal		$138.8			Estimated FY 2004	Estimated FY 2005		
General Administration		$10.5						
Project Total		$149.3			$0.0	$0.0		
Full-time Equivalents (FTE)		0.5						
Other Resources								

Comments:

Supervision and participation by J. Rice and J. Short contributed.

FY03

Prepared: 4/12/2002

Project Number: 03___

Project Title: Lingering Oil and Predators: Pathways of Exposure and Population Status

Agency: NOAA - Auke Bay Laboratory

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
						0.0
						0.0
Mandy Lindeberg	Fisheries Research Biologist	GS-11	4.0	6.0		24.0
						0.0
Larry Holland	Chemist	GS-11	1.0	7.0		7.0
Marie Larsen	Chemist	GS-12	0.5	7.0		3.5
Josie Lunasin	Chemist	GS-13	0.5	7.0		3.5
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		6.0	27.0	0.0	
					Personnel Total	$38.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2002
2002 Fall Review Workshop	JNU-ANC	0.4	3	2	0.2	1.6
						0.0
Spring Habitat Survey	Juneau/Cordova	0.4	5	2	0.2	2.4
Summer Lingering Oil Survey I	Juneau/Cordova	0.4	5	2	0.2	2.4
Summer Lingering Oil Survey II	Juneau/Cordova	0.4	5	2	0.2	2.4
						0.0
Scientific Meeting - AMOP		1.0	1	4	0.2	1.8
EVOS Workshop - Jan. 2004	JNU-ANC	0.4	2	2	0.2	1.2
						0.0
						0.0
						0.0
						0.0
					Travel Total	$11.8

FY03

Prepared: 4/12/2002

Project Number: 03___
Project Title: Lingering Oil and Predators:
Pathways of Exposure and Population Status
Agency: NOAA- Auke Bay Laboratory

FORM 3B
Personnel
& Travel
DETAIL

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Contractual Costs:			Proposed FY 2002
Description			
Vessles Charter			
Spring Habitat Survey	10 days	1.3 K per day	13.0
Summer Lingering Oil Survey I	10 days	1.3 K per day	13.0
Summer Lingering Oil Survey II	10 days	1.3 K per day	13.0
Temporary labor (NOAA) -			
Field Work:			10.0
Chem lab:			20.0
When a non-trustee organization is used, the form 4A is required.		**Contractual Total**	$69.0

Commodities Costs:	Proposed FY 2002
Description	
Laboratory and Field Supplies	20.0
Commodities Total	$20.0

FY03

Prepared: 4/12/2002

Project Number: 03___
Project Title: Lingering Oil and Predators:
Pathways of Exposure and Population Status
Agency: NOAA- Auke Bay Laboratory

FORM 3B
Contractual &
Commodities
DETAIL

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002
			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
NOAA/NMFS- Auke Bay Laboratory		
Computer/Software		
HPLC		
GCMS		

FY03

Prepared: 4/12/2002

Project Number: 03___
Project Title: Lingering Oil and Predators:
Pathways of Exposure and Population Status
Agency: NOAA- Auke Bay Laboratory

FORM 3B
Equipment
DETAIL

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Budget Category:	Authorized FY 2002	Proposed FY 2003	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$41.1						
Travel		$5.0						
Contractual		$116.8						
Commodities		$13.5						
Equipment		$0.0						
Subtotal		$176.4			Estimated FY 2004	Estimated FY 2005		
General Administration		$14.3						
Project Total		$190.7			$0.0	$0.0		
Full-time Equivalents (FTE)		0.9						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

"as" refers to aerial survey, "hab" refers to exposure/habitat studies

8 K of data logger rental may be eliminated if we area able to use existing EVOS equipment.

FY03

Prepared: 4/12/2002

Project Number: 03___

Project Title: Lingering Oil and Predators: Pathways of Exposure and Population Status

Agency: DOI/USGS - Sea Otters and Harlequin Ducks

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2001 - September 30, 2002

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2002
B. Ballachey	Research Physiologist (hab)	GS-12/4	1.0	7.2		7.2
G. Esslinger	Zoologist (as 2.5, hab 3.0)	GS 9/2	5.5	4.2		23.1
H. Coletti	Fishery Biologist (hab)	GS 7/1	4.0	2.7		10.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		10.5	14.1	0.0	
					Personnel Total	$41.1

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2002
Travel (as)	Anchorage/Cordova/Anchorage	0.4	1	20	0.2	4.4
Travel (hab)	Anchorage/PWS/Anchorage	0.0		6	0.1	0.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$5.0

FY03

Prepared: 4/12/2002

Project Number: 03___
Project Title: Lingering Oil and Predators:
Pathways of Exposure and Population Status
Agency: DOI/USGS - Sea Otters and Harlequin Ducks

FORM 3B
Personnel
& Travel
DETAIL

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

Contractual Costs:	Proposed
Description	FY 2002
Cordova Air (80 hours of Scout @ 225/hr) as	18.0
Air charter, Fishing and Flying (200 hours @ 250/hr, radiotracking) (hab)	50.0
Data logger rental 200/mo x 4 mo x 10 (hab)	8.0
Vessel charters 2- 15 d charters Oct/Nov and April @ 1200/d (hab)	36.0
Vessel charter July, logger maintenance, 4 d @ 1200/d (hab)	4.8
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$116.8

Commodities Costs:	Proposed
Description	FY 2002
Batteries 12v deep cycle 20 @ 100 ea. (hab)	2.0
Telemetry equip. Cables and antennae (hab)	3.0
Telemetry equipment service (bench tests)	2.0
Fuel	3.0
Camp supplies, July	2.5
Shipping	1.0
Commodities Total	$13.5

FY03

Prepared: 4/12/2002

Project Number: 03___
Project Title: Lingering Oil and Predators:
Pathways of Exposure and Population Status
Agency: DOI/USGS - Sea Otters and Harlequin Ducks

FORM 3B
Contractual &
Commodities
DETAIL

2002 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2001 - September 30, 2002

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2002
			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

FY03

Prepared: 4/12/2002

Project Number: 03___
Project Title: Lingering Oil and Predators:
Pathways of Exposure and Population Status
Agency: DOI/USGS - Sea Otters and Harlequin Ducks

FORM 3B
Equipment
DETAIL

Prince William Sound Isotope Ecology Synthesis, Submitted Under the BAA

Project Number:	03625-BAA
Restoration Category:	Research
Proposer:.	Prince William Sound Science Center Cordova, Alaska
Lead Trustee Agency:	NOAA
Cooperating Agencies:	
Alaska SeaLife Center:	
Duration:	Two-plus year project
Cost FY 03:	$ 30.5 K (exclusive of agency overhead)
Cost FY 04:	$19.5K (exclusive of agency overhead)
Close-out FY 05:	$ 21.K (exclusive of agency overhead)
Geographic Area:	Prince William Sound
Injured Resource/Service:	Fishes and their Injured Consumers, Fisheries: Commercial, Recreational, and Subsistence

ABSTRACT

The proposed project will provide a 'big picture' synthesis of the present structure of the pelagic ecosystem of Prince William Sound through preparation of a scientific paper with the tentative title: "A stable isotope based trophic structure of the pelagic community of Prince William Sound, Alaska". The documentation of a 'before picture' will be of extreme high value because the recently documented regional change in species composition is likely to alter pelagic trophic structure during GEM.

INTRODUCTION

A crucial part of the scientific research process is synthesis and dissemination of the results to the scientific community. This come is the form of papers given at meetings and through publication in the open literature. The process generally requires a protracted schedule. This occurs for several reasons. One being that the process of reviewing, revising, and publication of a paper often takes from two to three years. Secondly, publication of one article may need to follow the publication of another. This has been the case for the P.I.'s stable isotope restoration research that has resulted in a number of papers (see below). None of these papers however, is comprehensive, providing the big picture synthesis of the structure of the pelagic ecosystem. It is important to document the present status of ecosystem because as shown through analysis of the past marine ecosystem by Brodeur and Ware (1992) and Anderson et al. (1998), changes in zooplankton abundance and species composition are highly likely future events. Accordingly, a paper with the tentative title: "A stable isotope based trophic structure of the pelagic community of Prince William Sound, Alaska" consisting of a synthesis of the EVOS stable isotope work conducted from 1994 to 2002 including data from the just completed project 393, the synthesis goal of which was terminated early. This will provide this much needed GEM-related synthesis, since it will describe the present state of the marine ecosystem using stable isotope reconstruction of the food web structure.

Results from prior work

The manuscript, 'Pacific salmon (*Oncorhynchus* spp.) early marine trophic shifts based on $^{15}N/^{14}N$ and $^{13}C/^{12}C$ in Prince William Sound, Alaska' authored by Thomas C. Kline, Jr. and T. Mark Willette, funded under the EVOS project 541, the previous dissemination project, has gone through the peer review process and has just been returned from the editor for minor revisions which will be submitted following the present proposal and annual writing period. A copy of which is attached in the form of an appendix to *hard copies* of this proposal. Electronic copies, however, are available from the P.I. in pdf format only via e-mail. Anticipated publication is late 2002.

The P.I.'s other contributions on stable isotope research to the scientific literature have included these EVOS-funded peer and non-peer-reviewed publications:

Peer-reviewed

2002 Kline, T.C., Jr. The Relative Trophic Position of *Cancer magister* Megalopae within the Planktonic Community of the Sub-Polar Northeastern Pacific Ocean. *In:* A.J. Paul, E.G. Dawe, R. Elner, G.S. Jamieson, G.H. Kruse, R.S. Otto, B. Sainte-Marie, T.C. Shirley, and D. Woodby (eds.). Crabs in Cold Water Regions: Biology, Management, and Economics. University of Alaska Sea Grant, AK-SG-02-01, Fairbanks. IN PRESS.

2001 Cooney, R.T., J.R. Allen, M.A. Bishop, D.L. Eslinger, **T. Kline**, B.L. Norcross, C.P. McRoy, J. Milton, J. Olsen, V. Patrick, A.J. Paul, D. Salmon, D. Scheel, G.L. Thomas and S.L. Vaughan. Ecosystem control of pink salmon (*Oncorhynchus gorbuscha*) and Pacific herring (*Clupea pallasi*) populations in Prince William Sound, Alaska. . Fish. Oceanogr. 10 (Suppl. 1):1-13.

2001 Norcross, B.L., E.D. Brown, R.J. Foy, M. Frandsen, S. Gay, **T.C. Kline, Jr.**, D.M. Mason, E.V. Patrick, A.J. Paul, and K.D.E. Stokesbury. A synthesis of the early life history and ecology of juvenile Pacific herring in Prince William Sound, Alaska. Fish. Oceanorgr. 10 (Suppl. 1):42-57.

2001 Eslinger, D.L., R.T. Cooney, C.P. McRoy, A. Ward, **T.C. Kline, Jr.,** E.P. Simpson, J. Wang, and J. R. Allen. Plankton dynamics: observed and modeled responses to physical conditions in Prince William Sound, Alaska. Fish. Oceanogr. 10 (Suppl. 1):81-96.

2001 Paul, A.J, J.M. Paul and **T.C. Kline, Jr.** Estimating whole body energy content for juvenile Pacific herring from condition factor, dry weight, and carbon/nitrogen ratio. *In:* F. Funk, J. Blackburn, D. Hay, A.J. Paul, R. Stephenson, R. Toresen, and D. Witherell (eds.), Herring: Expectations for a New Millennium. University of Alaska Sea Grant, AK-SG-01-04, Fairbanks. p. 121-133.

2001 Kline, T.C., Jr. The trophic position of Pacific herring in Prince William Sound Alaska based on their stable isotope abundance. *In:* F. Funk, J. Blackburn, D. Hay, A.J. Paul, R. Stephenson, R. Toresen, and D. Witherell (eds.), Herring: Expectations for a New Millennium. University of Alaska Sea Grant, AK-SG-01-04, Fairbanks. p. 69-80.

2001 Kline, T.C., Jr. Evidence of biophysical coupling from shifts in natural stable carbon and nitrogen isotopes in Prince William Sound, Alaska. *In:* Kruse, G.H., N. Bez, A. Booth, M.W. Dorn, S. Hills, R.N. Lipcius, D. Pelletier, C. Roy, S.J. Smith, and D. Witherell (eds.), Spatial Processes and Management of Marine Populations. University of Alaska Sea Grant, AK-SG-01-02, Fairbanks. p. 363-375.

1999 Kline, T.C., Jr. Temporal and Spatial Variability of $^{13}C/^{12}C$ and $^{15}N/^{14}N$ in pelagic biota of Prince William Sound, Alaska. Can. J. Fish. Aquat. Sci. 56 (Suppl. 1) 94-117.

1998 Kline, T.C., Jr. and D. Pauly. Cross-validation of trophic level estimates from a mass-balance model of Prince William Sound using $^{15}N/^{14}N$ data. *In:* Funk, F., T.J. Quinn II, J. Heifetz, J.N. Ianelli, J.E. Powers, J.F. Schweigert, P.J. Sullivan, and C.-I. Zhang (eds.), Fishery Stock Assessment Models.

Alaska Sea Grant College Program AK-SG-98-01. University of Alaska Fairbanks. p. 693-702.

Non-peer reviewed

1999 Kline, T.C., Jr. Monitoring changes in oceanographic forcing using the carbon and nitrogen isotopic composition of Prince William Sound pelagic biota. In: Ecosystem Approaches for Fisheries Management. University of Alaska Sea Grant, AK-SG-99-01, Fairbanks. p. 87-95.

1997 Kline, T.C., Jr. Confirming forage fish food web dependencies in the Prince William Sound ecosystem. *In*: Forage Fishes in Marine Ecosystems. Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems. Alaska Sea Grant College Program Report No. 9701. University of Alaska Fairbanks. p. 257 - 269.

NEED FOR THE PROJECT

A. Statement of Problem

The documentation of a 'before picture' will be of extreme high value because the recently documented regional change in species composition is likely to alter pelagic trophic structure during GEM.

B. Rationale/Link to Restoration

The GEM process should be based on valid empirical observations and syntheses of these observations. The publication process facilitates communication of new synthetic results, while the review process provides the credibility. The Trustee Council also gains credibility for its science through publication.

C. Location

Prince William Sound

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Community involvement and traditional ecological knowledge was incorporated into the sampling used to generate the results that will be synthesized. In addition to the product itself, the data and information on which the report is based will be provided to the scientific and local community through the Prince William Sound Science Center's

website: www.pwssc.gen.ak.us. The P.I. will undertake a continuing program of outreach and communications. The objective will be to involve stakeholders in addressing these topics, and to translate scientific knowledge into a form that is readily understood by all interested parties. The P.I. is presently a member of a Cordova–based fisheries research planning group, a project funded to local fishers, K. Adams and R. Mullins, by the *Exxon Valdez* Oil Spill Trustee Council. The P.I. thus has connections facilitating community involvement of the project. Furthermore, the P.I. will participate in other symposia that bring together scientists and policy makers to review new knowledge related to the science questions above, and to identify research priorities for the future. Additional contact with local stakeholders will be met through outreach programs conducted at the Prince William Sound Science Center in Cordova and elsewhere, in particular, those in Alaska, such as through the P.I.'s connections as a P.I. in a U.S. GLOBEC project.

PROJECT DESIGN

A. Objectives

1. A peer-reviewed scientific paper providing a synthesis of the pelagic ecosystem based on stable isotope ratio data from PWS biota samples analyzed by the P.I. during 1994 to 2002. *The proposed paper title is:* **'Astable isotope based trophic structure of the pelagic community of Prince William Sound, Alaska'.** *The author will be:* Thomas C. Kline, Jr. *Potential journals are:* Ecology, C.J.F.A.S., & M.E.P.S.

B. Methods

A draft manuscript will be sent to the journal for review during year 1 of project. Reviews expected back in 6-9 months from date of submission, which most likely will occur during year 2. Revision expected to take one month. The revised paper will be reviewed within 3-6 months. Final revision will take place near end of year 2. Publication is thus anticipated following year 2, depending on length of publication queue from date of final acceptance.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

N/A

SCHEDULE

A. MEASURABLE PROJECT TASKS for FYI (October 1, 1999 - September 30, 2000)

Oct. 02 - Sept. 03: Prepare draft and submit to journal

Dec. 03 - Jun. 04: Revise paper
Jan. 05 - Dec. 05: Paper published

B. Project Milestones and Endpoints

Sept. 2003:	Paper submitted to journal
Jun. 2004:	Revised paper sent to journal
Mar 2005:	Paper accepted by journal
Jan. 2003, 2004, 2005:	Attend Annual Restoration Workshops
Oct. 2002 - Dec. 2004:	Preparation for and dissemination of results at EVOS and other Symposia
Jan-April 2004:	Preparation of Annual Report (to consist soley of a manuscript drafts)
Jan-April 2005:	Draft Final Report preparation (to consist soley of a manuscript final draft)
April 2005:	Draft Final Report (to consist of soley of a manuscript final version)
September 2005:	Final Report (to consist of soley of a manuscript final version)

C. Completion Date

September 2005 (Final Report)

PUBLICATIONS AND REPORTS

See objectives

PROFESSIONAL CONFERENCES

NORMAL AGENCY MANAGEMENT

N/A

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Collaboration with other EVOS investigators will continue; workshops and meetings will facilitate exchange.

PROPOSED PRINCIPAL INVESTIGATOR

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P. O. Box 705
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907-424-5820 (f)
tkline@grizzly.pwssc.gen.ak.us

PRINCIPAL INVESTIGATOR

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

OTHER KEY PERSONNEL

LITERATURE CITED

Anderson, P.J., J.E. Blackburn, and W.R. Bechtol. 1996. APEX Project Component L - Synthesis and analysis of Gulf of Alaska small-mesh trawl data 1953 to 1995. Abstracts of 1996 Restoration Projects. *Exxon Valdez* Oil Spill Trustee Council. Anchorage, Alaska.

Brodeur, R.D. and D.M. Ware. 1992. Long-term variability in zooplankton biomass in the subarctic Pacific Ocean. Fish. Oceanogr. 1:32-38.

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 02	Proposed FY 03	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$21.0						
Travel		$1.1						
Contractual		$1.0						
Commodities		$1.0						
Equipment		$0.0						
Subtotal	$0.0	$24.1	Estimated FY 04	Estimated FY 05 (closedout)				
Indirect		$6.4						
Project Total	$0.0	$30.5	$19.1	$21.7				
Full-time Equivalents (FTE)		0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: Year two and close-out comprise principally of 1 month of P.I. time each, and one January EVOS workshop each

FY03

Prepared: 10 Apr. 02

Project Number: 03625-BAA
Project Title: Prince William Sound Isotope Ecology Synthesis, Submitted Under the BAA
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 03
Thomas Kline	P.I.		2.0	10.5		21.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.0	10.5	0.0	
					Personnel Total	$21.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 03
EVOS workshop	0.3	1	4	0.2	1.1
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.1

FY03

Project Number: 03___
Project Title: Prince William Sound Isotope Ecology Synthesis, Submitted Under the BAA
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 10 Apr. 02

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Contractual Costs:	Proposed
Description	FY 03
photocopy	0.2
network	0.2
shipping	0.1
phones	0.5
Contractual Total	$1.0

Commodities Costs:	Proposed
Description	FY 03
office and computer supplies	1.0
Commodities Total	$1.0

FY03

Prepared: 10 Apr. 02

Project Number: 03___
Project Title: Prince William Sound Isotope Ecology Synthesis, Submitted Under the BAA
Name: Prince William Sound Science Center

FORM 4B
Contractual & Commodities DETAIL

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 03
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	
Description	of Units	

FY03

Project Number: 03___
Project Title: Prince William Sound Isotope Ecology Synthesis, Submitted Under the BAA
Name:Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Prepared: 10 Apr. 02

GEM Transition: Top-down Process Synthesis, Submitted Under the BAA

Project Number:	03631-BAA
Restoration Category:	Research
Proposer:	Prince William Sound Science Center Cordova, Alaska
Lead Trustee Agency:	NOAA
Cooperating Agencies:	
Alaska SeaLife Center:	
Duration:	Two-plus year project
Cost FY 03:	$ 52.0 K (exclusive of agency overhead)
Cost FY 04:	$ 27.6 K (exclusive of agency overhead)
Geographic Area:	Prince William Sound
Injured Resource/Service:	Fishes and their Injured Consumers, Fisheries: Commercial, Recreational, and Subsistence

ABSTRACT

During GEM we may see a transition away from the natural top-process of pollock population in Prince William Sound (PWS). This project will synthesize information that suggests ontogenetic increases of the trophic position of the walleye Pollock such that they contribute to top-down processes when > 600mm in length, using stable isotope analysis of archived samples and data. Pollock feed at multiple trophic levels depending on their size, with larger pollock cannibalizing smaller pollock, especially those that are age-0. Preliminary analysis suggested that pollock of this size range has a high potential for cannibalism. Pollock of this size range are presently being removed from PWS since the discovery of a mostly undisturbed population during the SEA project. The proposed documentation of a 'before picture' will be of extreme high value for GEM, because fishing pressure may effectively remove the larger size class pollock from PWS as has happened in the Bering Sea.

INTRODUCTION

This project seeks to use an innovative approach to quantify the increased potential for cannibalism that comes about through their ontogenetic increase in the trophic position of wallye pollock, *Theragra chalcogramma*. This will be done by measuring the ontogenetic increase in trophic position of the pollock using nitrogen stable isotope abundance (NSIA) methods. Because of the dominating role of this fish species, gaining a realistic assessment of its natural trophic position in relation to life history is a critical element for increasing our understanding the dynamics of the North Pacific ecosystem and for its resource role. Failure to fully understand ontogenetic shifts in tropho-dynamics is without a doubt contributing to our present inability to maintain healthy and sustainable populations of fish and wildlife and concomitant human benefits. As both prey and predator, and in particular through the intra-species dynamic of cannibalism, pollock play a nexus role in structure in the marine ecosystem. This role has without a doubt been altered in the Bering Sea. But how? The pollock population in Prince William Sound has been spared the decades of fishing that have occurred in the Bering Sea and can thus serve as a model for a 'normal' population. However, this is likely to change during GEM because of commercial fishing that commenced about 1996. Documentation of the present status of PWS pollock will be of extreme high value for GEM, because fishing pressure may effectively remove the larger size class pollock from PWS as has happened in the Bering Sea. Therefore during GEM we may see a transition away from the natural top-process of pollock population in PWS.

NEED FOR THE PROJECT

A. Statement of Problem

The documentation of a 'before picture' will be of extreme high value because the recently documented regional change in species composition is likely to alter pelagic trophic structure during GEM. Walleye pollock, *Theragra chalcogramma,* play a crucial economic and ecological role in Alaskan marine ecosystems that has placed them in the center of controversy. The controversy surrounding the conjectured relationship of the walleye pollock fishery to the declines in marine mammal populations suggests the imperative nature of the need to further our understanding of the ecological of pollock. Furthermore, present day relationships may differ from those of the past. For example, pollock recruitment in the Bering Sea appears to have shifted from being controlled by environmental factors (those that determine the survival of juvenile fish) to control by predation (Bailey 2000). Cannibalism is an important constituent of predation on juvenile pollock and consequently pollock population dynamics (Dwyer et al. 1987, Bailey 1989).

B. Rationale/Link to Restoration

Pollock, even as adults, are facultative planktivores (TL = 3 to 4) as well as piscivores

(TL > 4) (Dwyer et al. 1987). This is suggested in the NSIA data by the > 1 TL range within each adult size class (Figure 1). Prey-switching may be a seasonal phenomenon, depending upon prey availability, particularly, the availability of zooplankton (Dwyer et al. 1987, Willette et al. 1999). The NSIA of adult fish size classes, however, reflects time-integrated feeding of > 1 year, thus seasonal TL variations (e.g. Dwyer et al. 1987) are not likely to be observed. Nevertheless, the NSIA data suggest a considerable range in this time-averaged TL within each size class with a gradual shift to higher TL with size. The most marked ontogenetic increases occurred during their first year, up to ~ 100 mm, then again as large adults. A small fraction of the population appears to make a transition to TL > 4 at size class 6. At size class 7 and above, about half the population appears to be > TL 4. Accordingly, it is this portion of the population that is most likely to be cannibalistic. The present data set though, is limited, particularly for largest size class. Further analysis would provide sufficient data to enable publishing these results. This is particularly so for the provocative implications about the largest size class. If this size class has been removed from the Bering Sea by fishing, and this size class was more likely to have been cannibalistic, then fishing has reduced the cannibalism population dynamic. A consequence could be the increased recruitment of juveniles. Their greater numbers may enable pollock to out-compete other species for food and space resources in the ecosystem. Thus fishing may have indirectly enhanced pollock population numbers but with a shift to smaller size classes. This may also have consequences for other fish species such as herring that may not be able to compete with greatly increased numbers of juvenile pollock. Thus increased pollock may prevent recovery of PWS herring that have crashed since EVOS.

Cannibalism is an important predation process affecting pollock in PWS (Willette et al. 1999). Pollock found in PWS tend to be larger than those found elsewhere in Alaska since there was no commercial exploitation of them until 1996 attaining lengths of > 700 mm (e.g., Fig. 1; B. Bechtol, ADFG, pers. comm.). The occurrence of large individuals thus reflects the relatively undisturbed nature of the PWS pollock population. The PWS pollock population may thus serve as a good model for revealing inherent ontogenetic shifts presently not possible for the Bering Sea. Stable nitrogen isotope analysis (NSIA) was preformed on pollock of varying size classes as part of the SEA project during 1994 to 1998. While the emphasis in SEA was on juveniles (e.g. Kline 1999) a number of immature and adult stage individuals were also sampled and analyzed (Fig. 1). NSIA data provided a means for estimating trophic level with very good precision (Kline and Pauly 1998, Kline 2001, 2002). Cannibalistic pollock would necessarily have a higher TL than non-cannibals. Measuring pollock TL would indicate their cannibalism *potential*. A high TL measurement would also come about from consuming other taxa with a TL similar to pollock size classes being cannibalized. However, a TL pollock would more likely be cannibalistic than a low TL pollock.

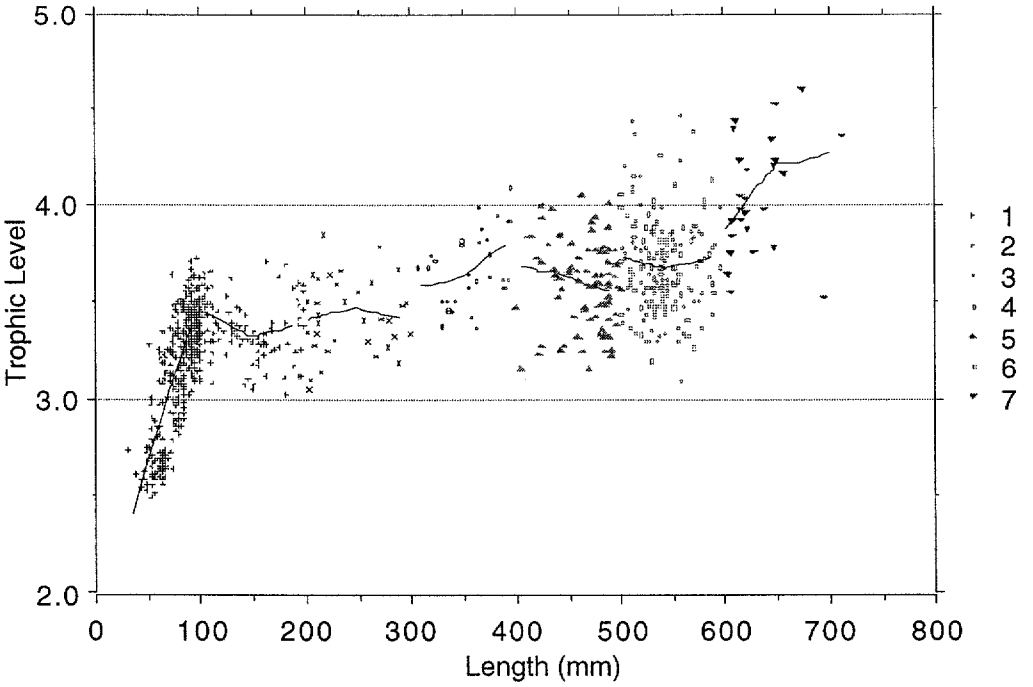

Figure 1. Trophic level of PWS pollock sampled during SEA. Separate Lowess plots were made for each 100 mm size class. Primary producers are defined as TL = 1, primary consumers (= herbivores) as TL = 2, primary carnivores as TL = 3, secondary carnivores as TL = 3, and tertiary carnivores as TL = 4. Size class 8 was merged with 7.

Table 1. Trophic level with *SE* of PWS pollock sampled during SEA. Black bars indicate size classes that were not significantly ($\alpha = 0.05$) for TL different using ANOVA Scheffe post-hoc test. Samples and estimated proportion of population with high potential for cannibalism; those with TL > 4 are also given.

Size class	Mean TL	*SE*		Number with TL ≤ 4	Number with TL > 4	Per cent with TL > 4
1	3.2	0.02		440	0	0
2	3.4	0.01		115	0	0
3	3.4	0.03		34	0	0
4	3.7	0.03		34	1	0.03
5	3.6	0.02		92	2	0.02
6	3.7	0.02		164	18	0.1
7+8	4.0	0.06		13	13	50

C. Location

Prince William Sound

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Community involvement and traditional ecological knowledge was incorporated into the sampling used to generate the results that will be synthesized. In addition to the product itself, the data and information on which the report is based will be provided to the scientific and local community through the Prince William Sound Science Center's website: www.pwssc.gen.ak.us. The P.I. will undertake a continuing program of outreach and communications. The objective will be to involve stakeholders in addressing these topics, and to translate scientific knowledge into a form that is readily understood by all interested parties. The P.I. is presently a member of a Cordova–based fisheries research planning group, a project funded to local fishers, K. Adams and R. Mullins, by the *Exxon Valdez* Oil Spill Trustee Council. The P.I. thus has connections facilitating community involvement of the project. Furthermore, the P.I. will participate in other symposia that bring together scientists and policy makers to review new knowledge related to the science questions above, and to identify research priorities for the future. Additional contact with local stakeholders will be met through outreach programs conducted at the Prince William Sound Science Center in Cordova and elsewhere, in particular, those in Alaska, such as through the P.I.'s connections as a P.I. in a U.S. GLOBEC project.

PROJECT DESIGN

A. Objectives

1. To unequivocally resolve the relative increase in trophic level with respect to length of what may be the only major undisturbed population of Pollock, those from Prince William Sound. Existing samples of adult pollock size classes are available resulting from collaboration between the P.I. and B. Bechtol of Alaska Department of Fish and Game. These were samples were collected during routine surveys that are run during the latter part of each winter in PWS. Because these samples are already on hand there are no associated collecting costs. However, further samples could be obtained during future pollock surveys. These samples could be used to monitor shifts in TL of the PWS pollock population since a small yearly fishery has commenced.

B. Methods

Approximately 0.4 % of the nitrogen in biological material consists of the 'heavy 'isotope, ^{15}N. The amount of ^{15}N varies slightly due to isotopic fractionation occurring in

biochemical reactions. For example, while isotopic composition is generally conserved in food chains, there is a predictable increase per trophic level (Minagawa and Wada 1984). The increase is 3.4 ± 0.4 (SD) $\delta^{15}N$ units (see materials and methods) per trophic level (TL) for carnivores (Vander Zanden and Rasmusen 2001) enabling TL estimation with precision of < 0.1 TL.

Sound Ecosystem Assessment (SEA; Cooney et al. 2001) project pollock samples consisted of juveniles sampled in conjunction with juvenile studies herring and immature and adult fish that were sampled with a trawl as part of a predation study in PWS. Preliminary TL analysis of the 926 SEA project pollock samples are shown as a Lowess plots in Figure 1. The data were divided into100 mm length range size classes such that those up to 100mm in length were in size class 1, those from 101 to 200mm in length were in size class 2, etc. Size classes 7 and 8 were merged for this analysis. Size class 1 consisted of young of the year pollock while other size classes most likely consisted of multiple year classes (based on length-age relationship, M. Willette, Alaska Department of Fish and Game pers. Comm.). The mean and SE of the TL of each size class is listed in Table 1. Data indicating the sample number from which was estimated the proportion of the population with high cannibalism potential, those with TL > 4 (i.e., > secondary carnivore) is also listed in Table 1.

Half of those pollock > 600 mm had high cannibalism potential. ANOVA and post hoc tests suggested that size class 7 to be statistically distinct from the other size classes regardless of the small sample size. Size class 1 pollock were also statistically distinct from the rest of the population. Intermediate sizes appear to increment in TL in two stages, because those that were in size classes 2 and 3 were distinct from those in size classes 4, 5, and 6. The data suggest that cannibalism potential commences with size class 4 (> 300 mm). This interpretation is generally consistent with the observation of Dwyer et al. 1987. They found that pollock > 400 mm were cannibalistic in six out of eight season-areas while pollock < 400 were cannibalistic in just one season-area.

Existing samples. This project is based upon using an existing sample collection. Over 600 individual pollock samples were collected during collaborations between the P.I. and B. Bechtol of the Alaska Department of Fish and Game during annual pollock surveys conducted from 1997 to 1999 (Table 2). These surveys were purposeful in their pursuit of the PWS pollock population. The area surveyed included western PWS, in particular, the western bays and passages between PWS and Resurrection Bay, east of Seward where this population aggregates for spawning. These samples, therefore, are assumed to be representative of the PWS pollock population.

Table 2. Summary of samples on hand and those to be run (analyzed) in the proposed project by year of sampling and size class (100 mm each, e.g. size class 3 = 201 to 300mm, as used in the preliminary analysis).

	Samples on hand	Samples to run	Samples on hand	Samples to run	Samples on hand	Samples to run	Total
Year	1997		1998		1999		
Size Class							
3	2	0	0	0	0	0	
4	35	0	52	0	7	0	
5	39	0	61	0	28	0	
6	266	25	326	25	50	25	
7	52	50	69	50	13	13	
8	3	3	3	3	0	0	
Year total	397		511		98		609
To run		78		78		38	194

Sampling design. From the samples on hand, the subsets indicated in Table 2 will be analyzed to maximize representation of each of the 100 mm size classes. Up to N=50 samples in each size class will be analyzed. A total of 194 analyzes will be preformed. This will provide better balance between the number pollock less than 400 mm and greater than 400 mm in the database. The data being split into 100 mm size classes enabled ANOVA in the preliminary analysis and will again enable ANOVA when the additional data of 194 fish are added to it. Although there are sufficient samples in size class 6 in the existing database, the inclusion of 25/year in the proposed analysis (Table 2) will be used to test if there are shifts among years to whether there was any systematic shift during the period of sampling 1994-1999. The larger number of samples within each size class will enable correlation assessment, which was only significant for pollock < 100 mm in the preliminary analysis (Kline unpublished).

Isotope analysis. The rationale for, and detailed description of methods that will be used to generate the isotopic database for this study were described extensively in Kline (1999) and so are only given briefly here. Fish samples will be freeze-dried and ground to a fine powder then sent out for NSIA. NSIA will be performed at the University of Alaska Stable Isotope facility using one two Finnegan Delta Plus (FDP) continuous flow isotope ratio mass spectrometers. Sub-samples, as appropriate for the mass requirements of the FDP, will be weighed to the nearest 1 µg and loaded into combustion boats for mass spectrometric analysis. Quality assurance and quality control protocols will include analyses of laboratory standards before and after every five samples as well as the sample duplication. Poorly replicated samples (N= 2 analyses performed on each sample; difference in delta values ≥ 0.6 ‰) will be run again. The delta ($\delta^{15}N$) notation used to express stable isotope ratios is reported as the per mil (‰) deviation relative to an international standard, air for nitrogen. By definition, the isotope standards have delta

values of zero, i.e. $\delta^{15}N = 0$ ‰ for atmospheric N_2. Instrument replication is typically within 0.2 ‰.

Data modeling. Trophic level is determined by comparing $\delta^{15}N$ values to a reference value. The $\delta^{15}N$ of higher trophic levels will be calculated by adding the trophic enrichment factor, 3.4 (Minagawa and Wada 1984, Checkley and Miller 1989, Kline 1997, Vander Zanden and Rasmussen 2001), to the reference value. The herbivorous, i.e., trophic level = 2, copepod *Neocalanus cristatus*, will be used as the reference (Kline and Pauly 1998, Kline 1999, Kline 2001, 2002). *N. cristatus* was chosen as the reference herbivore based upon observations that their carbon isotope values corresponded with those of PWS fishes (Kline 1999). The following formula will be used to calculate trophic level: $TL_i = (\delta^{15}N_i - \delta^{15}N_H / 3.4) + 2$, where TL_i is the trophic level of organism i, $\delta^{15}N_i$ is the mean $\delta^{15}N$ value of organism i, and $\delta^{15}N_H$ is the mean reference herbivore $\delta^{15}N$ value. *N. cristatus* are being collected and NSIA being preformed as part of the P.I.'s US GLOBEC project titled "GLOBEC 2000: LTOP-CGOA zooplankton source fluctuations in fishes", the abstract of which is posted on the NEP-GLOBEC homepage: http://globec.coas.oregonstate.edu/groups/nep/projs.html. These data will be used to verify the appropriateness of using the same reference $\delta^{15}N$ value or changing it accordingly. Thus far, this reference value has remained a constant value of +8.4 (Kline 2001, 2002).

C. Cooperating Agencies, Contracts, and Other Agency Assistance

N/A

SCHEDULE

A. MEASURABLE PROJECT TASKS for FYI (October 1, 1999 - September 30, 2000)

The following lists the milestones envisioned for the project, the responsible person (the P.I. or the technician), and when it will be accomplished:

Oct. 02 - Sept. 03:	Select samples for isotopic analyses- P.I. & Tech
Oct. 02 - Sept. 03:	Prepare samples for isotopic analysis- Tech
Jan. 03 - Oct. 03:	Send samples to Stable Isotope facility, UAF- P.I. & Tech
Sept. 03 - Jan. 04:	Receive raw isotope data- P.I.
Dec. 03 - Apr. 04:	Incorporate new isotope data into database- P.I.
Jan 03, 04:	Attend EVOS annual workshop – P.I.
Jan. 03 - Sept. 04:	Data and information evaluation- P.I.

Feb. 04:	Dissemination of results at scientific conference- P.I.
Oct. 02 - Sept. 04:	Desemination of results through other interactions- P.I.
Oct. 03 - Apr. 04:	Preparation of final report- P.I.
Sept 04:	Final report- P.I.

B. Project Milestones and Endpoints

Sept. 2003:	Samples sent to mass spectrometry lab
Jan. 2004:	Data received from lab
Jan. 2003, 2004:	Attend Annual Restoration Workshops
Feb. 2003	Present results at Ocean Sciences Meeting
Apr. 2004:	Draft Final Report
September 2004:	Final Report

C. Completion Date

September 2004 (Final Report)

PUBLICATIONS AND REPORTS

See objectives

PROFESSIONAL CONFERENCES

AGU/ASLO Ocean Sciences Meeting, February 2004, location unknown

NORMAL AGENCY MANAGEMENT

N/A

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Collaboration with other EVOS investigators will continue; workshops and meetings will facilitate exchange.

PROPOSED PRINCIPAL INVESTIGATOR

Thomas C. Kline Jr., Ph.D.
Prince William Sound Science Center

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PRINCIPAL INVESTIGATOR

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

OTHER KEY PERSONNEL

Signe Baumann: Technician who will prepare samples for mass spectrometry under supervision of the P.I.

LITERATURE CITED

Bailey, K.M. 1989. Interaction between the vertical distribution of juvenile walleye pollock *Theragra chalcogramma* in the eastern Bering Sea, and cannibalism. Mar. Ecol. Progr. Ser. 53:205-213.

Bailey, K.M. 2000. Shifting control of recruitment of walleye pollock *Theragra chalcogramma* after a major climatic and ecosystem change. Mar. Ecol. Progr. Ser. 198:215-224.

Cooney, R.T., J.R. Allen, M.A. Bishop, D.L. Eslinger, T. Kline, B.L. Norcross, C.P. McRoy, J. Milton, J. Olsen, V. Patrick, A.J. Paul, D. Salmon, D. Scheel, G.L. Thomas and S.L. Vaughan. 2001. Ecosystem control of pink salmon (*Oncorhynchus gorbuscha*) and Pacific herring (*Clupea pallasi*) populations in Prince William Sound, Alaska. . Fish. Oceanogr. 10 (Suppl. 1):1-13.

Checkley, D.M., Jr. and C.A. Miller. 1989. Nitrogen isotopic fractionation by oceanic zooplankton. Deep-Sea Res. 36:1449-1456.

Dwyer, D.A., K.M. Bailey and P.A. Livingston. 1987. Feeding habits and daily ration of walleye Pollock (Theragra chalcogramma) in the eastern Bering Sea, with special reference to cannibalism. Can. J. Fish. Aquat. Sci. 44:1972-1984.

Kline, T.C., Jr. 1997. Confirming forage fish food web dependencies in the Prince William Sound ecosystem using natural stable isotope tracers. Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems. Alaska Sea Grant College Program Report No. 9701. University of Alaska Fairbanks. p. 257 - 269.

Kline, T.C., Jr. 1999. Temporal and Spatial Variability of $^{13}C/^{12}C$ and $^{15}N/^{14}N$ in Pelagic Biota of Prince William Sound, Alaska. Can. J. Fish. Aquat. Sci. 56 (Suppl. 1):94-117.

Kline, T.C., Jr. 2001. The Trophic Position of Pacific Herring in Prince William Sound Alaska Based on their Stable Isotope Abundance. *In:* F. Funk, J. Blackburn, D. Hay, A.J. Paul, R. Stephenson, R. Toresen, and D. Witherell (eds.), Herring: Expectations for a New Millennium. University of Alaska Sea Grant, AK-SG-01-04, Fairbanks. p. 69-80.

Kline, T.C., Jr. 2002. The Relative Trophic Position of *Cancer magister* Megalopae within the Planktonic Community of the Sub-Polar Northeastern Pacific Ocean. *In:* A.J. Paul, E.G. Dawe, R. Elner, G.S. Jamieson, G.H. Kruse, R.S. Otto, B. Sainte-Marie, T.C. Shirley, and D. Woodby (eds.). Crabs in Cold Water Regions: Biology, Management, and Economics. University of Alaska Sea Grant, AK-SG-02-01, Fairbanks. IN PRESS.

Kline, T.C., Jr. and D. Pauly. 1998. Cross-validation of trophic level estimates from a mass-balance model of Prince William Sound using $^{15}N/^{14}N$ data. *In* Fishery Stock Assessment Models, *Edited by* F. Funk, T.J. Quinn II, J. Heifetz, J.N. Ianelli, J.E. Powers, J.F. Schweigert, P.J. Sullivan, and C.-I. Zhang. Alaska Sea Grant College Program Report No. AK-SG-98-01, University of Alaska Fairbanks. pp. 693-702.

Minagawa, M., and E. Wada. 1984. Stepwise enrichment of ^{15}N along food chains: Further evidence and the relation between $\delta^{15}N$ and animal age. Geochim. Cosmochim. Acta 48:1135-1140.

Vander Zanden, M.J., G. Cabana, and J.B. Rasmussen. 1997. Comparing trophic position of freshwater fish calculated using stable nitrogen isotope ratios ($\delta^{15}N$) and literature dietary data. Can. J. Fish. Aquat. Sci. 54:1142-1158.

Vander Zanden and Rasmussen. 2001. Variation in ^{15}N and ^{13}C trophic fractionation: Implications for aquatic food web studies. Limnol. Oceanogr. 46:2061–2066

Willette, T.M., R.T. Cooney, and K. Hyer. 1999. Predator foraging mode shifts affecting mortality of juvenile fishes during the subarctic spring bloom. Can. J. Fish. Aquat. Sci. 56: 364-376.

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 02	Proposed FY 03	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$30.2						
Travel		$1.1						
Contractual		$7.1						
Commodities		$3.0						
Equipment		$0.0						
Subtotal	$0.0	$41.4	Estimated					
Indirect		$10.6	FY 04					
Project Total	$0.0	$52.0	$27.6					
Full-time Equivalents (FTE)		0.3						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

FY03

Prepared: 11 Apr. 02

Project Number: 03631-BAA
Project Title: GEM Transition: Top-down Process Synthesis, Submitted Under the BAA
Name: Prince William Sound Science Center

FORM 4A
Non-Trustee
SUMMARY

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 03
	Thomas Kline	P.I.	2.0	10.5		21.0
	Signe Baumann	Technician	2.0	4.6		9.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	4.0	15.1	0.0	
					Personnel Total	$30.2

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 03
	EVOS workshop	0.3	1	4	0.2	1.1
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$1.1

FY03

Project Number: 03___
Project Title: GEM Transition: Top-down Process Synthesis, Submitted Under the BAA
Name: Prince William Sound Science Center

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 11 Apr. 02

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Contractual Costs:				Proposed
Description				FY 03
photocopy				0.2
network				0.4
shipping				0.2
phones	unit cost	units	$	0.5
freeze-dry	$3	194	$582	0.6
mass spectrometry	$27	194	$5,238	5.2
			Contractual Total	$7.1

Commodities Costs:	Proposed
Description	FY 03
office and computer supplies	1.0
lab supplies	2.0
Commodities Total	$3.0

FY03

Prepared: 11 Apr. 02

Project Number: 03___
Project Title: GEM Transition: Top-down Process Synthesis, Submitted Under the BAA
Name: Prince William Sound Science Center

FORM 4B
Contractual & Commodities DETAIL

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 03
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	
Description	of Units	

FY03

Project Number: 03___
Project Title: GEM Transition: Top-down Process Synthesis, Submitted Under the BAA
Name:Prince William Sound Science Center

FORM 4B
Equipment
DETAIL

Prepared: 11 Apr. 02

Commercial Fishing Management Applications, Submitted Under the BAA

Project Number:	03636-BAA, NOAA Contract # 50ABNF200060
Restoration Category:	General Restoration
Proposer:	Ken Adams & Ross Mullins, Cordova
Lead Trustee Agency:	NOAA
Alaska SeaLife Center:	No
Duration:	2nd yr. (pilot project continuation)
Cost FY 03:	$50,000
Cost FY 04:	
Geographic Area:	Prince William Sound
Injured Resource/Service:	Commercial fishing

Abstract

This project is intended to build a bridge between the scientific community, which is describing and attempting to predict variation in biological production, and the commercial fishing community, which is attempting to find management applications for this new information. In addition, the project seeks to provide a fisheries community presence to participate in development of GEM.

INTRODUCTION

The effort being proposed in FY 03 is a continuation of a project begun in FY 02 to aid the restoration of the commercial fishing industry in Prince William Sound. In FY 02 the process was started to bridge the gap from some of the fundamental ecosystem science supported by the EVOS Trustee Council to applications having potential benefit to the commercial fisheries community of Prince William Sound.

Unfortunately, the project was undertaken in FY 02 under severe time constraints which allowed only the initiation of the project. Due the PI's active involvement in the commercial fisheries until the fall of 2001, a deferment was requested and granted for further development of our proposal until December of 2001 since preliminary recommendations of both the Executive Director and Chief Scientist released in June 2001 encouraged development of this proposal. The applicants complied and subsequently developed iterations responsive to the requirements for both an increase in the focus and reduction in the budget requested. On February 20, 2002 notice was given of project approval by the Restoration Office. On March 4, 2002 approval was received from the NOAA Contracting Officer so that the project could begin to incur related expenditures.

In spite of the late start, two workshop meetings were conducted in Cordova in accord with the project objectives. The first meeting was on March 8, 2002 and the second meeting was conducted on April 2. Scheduling of additional meetings up to September 2002 is considered undesirable due to the direct involvement in the fisheries for many, conflicting responsibilities of resource management, and scientific field work for other participants. It is intended that the intensity of the Co-PI's involvement will be reduced during the time of active commercial fishing and resume full time in the fall when fishery activities conclude and community participants will again be available.

In addition to establishing a community fisheries forum through the workshop process the PI's have established an office in Cordova from which the ongoing business of this project are being conducted. The office will be staffed on a part time basis through out the year. This office will allow project continuity, a visible interface between the local fishing community and the Trustee Council and aid the development of a fisheries presence within the GEM plan.

NEED FOR THE PROJECT

A. Statement of Problem

From approximately 1992 the EVOS Trustee Council has funded a wide variety of projects most of which have been directed toward restoration of resources damaged during the EVOS event. Some of these projects have direct or indirect implications for commercial fisheries.

Throughout the oil spill impacted area, Prince William Sound was undoubtedly the most negatively affected area. The lingering presence of oil, concerns about the recovery of a number of oiled species and the run failures of pink salmon in 1992 and 1993, plus the herring failure in 1993 and subsequent years, prompted the development of several ecosystem investigations in the PWS area: The Sound Ecosystem Assessment (SEA), the Alaska Predator Experiment (APEX), and the Nearshore Vertebrate Predator Plan (NVPP).

For the most part, each of these plans sought to explain PWS ecosystem dynamics from their own particular perspectives, but none of them have addressed the needs or means for application of the scientific results or knowledge gained in the research process. The predictive models developed in the SEA plan are exceptions to this generality.

The PI's propose in FY 03 to continue the process begun in FY 02 for the identification of the fishery community issues and needs in PWS, to review the collection of EVOS TC funded fisheries relevant projects and to help build a bridge between the accomplished fundamental research and management applications needed to address the identified fisheries issues and needs.

Prince William Sound has emerged, post EVOS event as one of the most intensively studied bodies of water in the United States. Unfortunately, neither hatchery operators, fishermen and processors, or research managers have benefited from the increase in knowledge derived from this research. From the perspective of many in the local fisheries community, publication of the descriptive fundamental science results is not the final step in the process. Utilization of research results or assets remains to be accomplished. The following are some examples of activities where research results might be utilized: improved salmon return forecast capabilities; possible improvement of hatchery operations from gaining a more comprehensive understanding of zooplankton dynamics during time of fry release as well as gaining population estimates and location of potential predators of salmon fry. Also, herring biomass assessments and Stellar lion interactions are two additional items of importance to the local fisheries community. These subjects could very well utilize acoustic assessment tools developed during the active research phase of the SEA. The attempt to utilize some of the ecosystem research assets for the benefit of the local fisheries community comprises the basis for this proposal.

B. Rational/Link to Restoration

The initial work undertaken in FY 02 should be continued in FY 03. The economies of individual fishermen, processors, and by extension, the economies of this region's fishery dependent communities are in a depressed state. It would be a benefit to nearly everyone in our fisheries community if expenses involved in fisheries production and planning could be reduced. For example, if salmon return forecasting accuracy was improved, fishermen might be better able to decide whether to participate in a particular harvest or seek alternate employment. Likewise, processors could have better insights into the size of the work force and processing materials that might be required in a given year.

Identification of fishery community issues and needs developed in workshops conducted under the auspices of this project establish a foundation from which we can explore the EVOS TC previously funded research for aid in resolving community issues and needs.

C. Location

This project is being undertaken in Cordova. In this community, offices of some of the most important organizations, agencies and businesses relevant to the fisheries of PWS are located. Cordova District Fishermen United (CDFU), one of the most active and influential commercial fishing organizations in the state as well as Copper River Seafood Producers Association (CRSPA), are both located here. The management and research office for Alaska Department of Fish and Game, the Prince William Sound Science Center, Prince William Sound Aquaculture Corporation (PWSAC), the largest hatchery PNP corporation in the United States, the office of the Native Village of Eyak, Chugach ranger district offices of the U.S. Forest Service, Ocean Beauty Seafood Corp, North Pacific Processors Inc., Norquest Inc, Prime Select Seafood and Copper River Fine seafood processors are located here as well. Although the project is headquartered in Cordova, all the communities with interests and dependencies upon the fishery resources of PWS may be affected. This includes the communities of Valdez, Seward, Homer, Anchorage, Tatitlek and New Chenega.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

This effort consists entirely of local community involvement. As previously mentioned, offices of a wide array of fisheries related businesses and agencies are located in Cordova and also the largest concentration of PWS commercial fishers reside here as well. The degree of knowledge regarding the PWS fisheries present in the community of Cordova is extensive.

The development of the PWSFRAP forum process allows discussion from the extended fisheries community and other regional entities such as city government, town meetings, native organization as well as conservation groups. Further, in person presentations by the project PI's are done periodically at the BOD meetings of local fishery and hatchery organizations as well as frequent email updates to interested parties.

It is intended that former investigators from previous restoration projects will be involved to discuss their work in person or by teleconference at PWSFRAP meetings. All PWSFRAP meetings are advertised and are open to the general public.

PROJECT DESIGN

A. Objectives

In FY 02 we have established PWS Fisheries Research Applications and Planning (PWSFRAP) group forum for achieving the objectives of this proposal. Under the auspices of PWSFRAP the PI's have initiated the process of identification of important fishery community issues and needs. The process to achieve the objectives listed below will continue in FY 03.

1 Under the auspices of the PWSFRAP group:

a) provide criteria and guidelines for making and keeping information gathered by the Gulf Ecosystem Monitoring (GEM) plan relevant to fisheries management and shore based communities.

b) provide a forum for developing fisheries management applications for all interested entities, including Alaska Department of Fish and Game (ADF&G), Prince William Sound Aquaculture Corporation (PWSAC), Valdez Fisheries Development Association (VFDA), Cordova District Fishermen United (CDFU), Exxon Valdez Oil Spill Trustee Council / Gulf Ecosystem Monitoring (GEM) plan personnel, commercial fishers, and other groups.

#2 Under the auspices of the PWSFRAP group, continue a series of public workshops to develop the following products:

a) a statement of short-term and long-term fishery management issues and needs and what additional information resources could contribute to resolving the issues and needs.

b) a draft set of criteria and guidelines that can be used to identify information of use for constructing both short-term and long-term fisheries management applications that address the issues and meet the needs.

c) a final set of criteria and guidelines for identifying the information of use for constructing both short-term and long-term fisheries management applications that address the issues and meet the needs.

d) a fisheries management relevant subset of information selected from completed EVOS Restoration projects (SEA, APEX, NVPP, and others).

e) a plan that shows how PWSFRAP group will develop in FY 03 a cycle that moves from basic scientific information , to fishery management application concepts, through public involvement , regulatory processes, fishery management applications, evaluation of efficacy of fishery management applications, back to inform the development of more useful scientific information.

B. Methods

#1 Organization of PWSFRAP group:

a) PWSFRAP will proceed in accordance with the objectives and methods identified in this proposal. Group meetings are conducted on a consensus basis and we seek to avoid the development of a rigid set of rules of operation.

b) Meetings are held at the public library meeting room on 1st. Ave. in Cordova or other suitable locations.

c) Meeting dates are scheduled to avoid conflicts for participants in the PWSFRAP group with meeting schedules of the North Pacific Fisheries Management Council (NPFMC), the Alaska Board of Fisheries (BOF), and the annual meetings of the American fisheries Society (AFS), both Alaska chapter and the Western Division, as well as other potential conflicts. We attempt to accommodate individual participant's schedules as nearly as possible.

d). Dr. Phil Mundy, of the EVOS Restoration Office, will continue to participate in the general planning and scheduling of meetings of the PWSFRAP Group. Dr. Mundy is being provided with copies of correspondence and related working group materials.

#2 Activities of the PWSFRAP group:

a) Minutes and transcripts of meetings will be recorded and retained as the official record of the PWSFRAP group's activities.

b). We foresee that utilization of a matrix format as a potentially valuable tool with which we can continue our work. . For example, a matrix format may be used to compare fishing community needs and issues to information assets that are available as well as information that yet needs to be developed.

c) Subsequent meetings of the group will benefit from participation and presence of principal investigators from previously EVOS funded projects to help explain aspects of their work. This project will fund teleconferencing or traveling expenses incurred for P.I.'s as well as expenses incurred by out of town area PWSFRAP group participants to the extent that is feasible within the projects budget.

d). Products developed during meetings of the PWSFRAP group will be reported to the EVOS Trustee Council and the Public Advisory Group (PAG) as required.

e). Presentations will continue to be made to the greater local community (fishery industry, city government, chamber of commerce, etc.) concerning the intentions and progress of this project as well as an overview of the GEM plan including its mission and objectives.

#3) Office establishment:

An office has been established and will be maintained as the headquarters for the PWSFRAP group at the Union Hall adjacent to the office of CDFU on 1st. Ave. in Cordova. That office provides high visibility to members of the fishing fleet and easy access to the offices of PWSAC, CDFU, ADF& G, and also the Prince William Sound Science Center (PWSSC).This office provides a visible presence for EVOS within the community at a location where fishers, resource managers, and others can interact with project personnel and address their related concerns.

We have hired a tech/admin assistant to help with a variety of duties related to this project and to occupy the office on an as needed basis for the duration of the project.

This proposal was considered a pilot project in FY 02 with additional funding anticipated from the Trustee Council in FY 03. We anticipate this project could become an ongoing component of the GEM program with funding from the Council in subsequent years.

C. Cooperating Agencies, Contracts and Other Agency Assistance

During the review of selected restoration plan results the PWSFRAP group will very likely need to confer with those in the agencies and those in the scientific and technical community who were responsible for the restoration plan results. Our budget includes funds for teleconferencing or travel when appropriate.

SCHEDULE

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

October:	Present project results to date at open community meeting.
November:	Continue PWSFRAP workshop and subgroup meetings.
December:	Continue as in November.
January:	Continue as November. Attend annual EVOS Workshop (2 days)
February:	Begin preparation of annual report for FY 02. Continue as November.
March:	Continue as in November
April:	Finish and submit annual report for FY 02.
May:	Resume fishing activities and part time project duties.
June:	Same as May.
July:	Same as May.
August:	Same as May.

September:	Resume project activities, conclude project.

B. Project Milestones and End Points

October:	Finalization of community issues and needs,
November:	Develop draft of final criteria and guidelines.
December:	Submit quarterly report to the Restoration office. Begin development of fisheries relevant subset from EVOS projects.
January:	Continue development of fisheries relevant subset from EVOS projects. Attend EVOS workshop.
February:	Finalize development of fisheries relevant subset. Develop criteria and guidelines for making and keeping information gathered by GEM relevant for fisheries management and shore based communities.
March:	Submit quarterly report to Restoration office. Give presentation at PWSAC spring Board meeting. Begin development of plan showing cycle of movement from basic science information to management application.
April:	Continue development of plan for management applications. Submit annual report for FY 02.
May:	Resume fishing activity. Project work on part time basis.
June:	Same as May.
July:	Same as May.
August:	Presentation of project accomplishment to date at CDFU annual meeting.
September:	Conclude project and begin preparation of final report to Restoration office.

C. Completion Date

September 30, 2003

PUBLICATIONS AND REPORTS

We do not plan to submit manuscripts for publication in FY 03. A final report comprised of a review of the fisheries relevant subset of PWS Restorations Plan results, along with meeting transcripts and work products of the PWSFRAP group meetings, will be provided to the Trustee Council by April 15, 2004.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

At present, we plan no coordination with other restoration efforts. This project is the only one which directly seeks to aid the restoration of commercial fishing, a damaged service in the spill impacted area.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

There are several changes to be made with the project for FY 03 compared to initiating this effort late in the FY 02 cycle. The most important change is the prospect of conducting this project in accord with a normal restoration project timetable and the prospect of realistic achievement of milestones and project end date. In addition, there are the advantages of having formed PWSFRAP which is the basis for our fisheries forum in FY 02, we have the advantage of having met with various community organizations describing this project and it's objectives, and have established our office as headquarters for PWSFRAP.

In view of the progress since project inception on March 4, 2002, we believe that the accomplishment of the project objectives is realistic in FY 03. The experience gained from the FY 02 effort has been very positive and provides insight as to how best to proceed and to more fully involve the fisheries community in the project.

CO-PRINCIPAL INVESTIGATORS

Ken Adams
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Brief Summaries of Professional Histories

Ken Adams has been a commercial fisherman for 25 years. During that time he has held permits and owned vessels in a number of fisheries in PWS. Currently Adams holds permits and is owner operator of vessels for the drift gillnet fishery and salmon purse seine fishery for PWS. He also hold IFQ halibut quota shares.

Adams obtained an MA degree in biology from San Francisco State College and a BA in Science from Trenton State College in Trenton, New Jersey. In addition Adams has completed approximately 30 credit hours toward a PHD degree in biology at the University of California, Santa Barbara.

Adams has held an active membership in all of the fishery organizations of the region. He held seats on the Boards of Directors of PWSAC, CDFU and PWSSC. He is currently serving as a Board member of the American Seafood's community advisory board. During 1993 Adams was a participant in the four month planning process that created the Sound Ecosystem science plan. That

plan was the guiding document for the SEA program. Adams served on the BOD of the PWSSC for nine years. During the period since the close of the SEA program Adams has remained involved in the review and assessment of the results and the technical assets and resources acquired through the SEA program. Adams has actively followed the progress of the overall restoration plan with the goal of identifying results which can now contribute to securing and sustaining the recovery of commercial fishing.

Ross Mullins has resided in Cordova since 1963 where he has pursued and active career in the varied commercial fisheries of the area, both as owner operator of various vessels and as a business man involved in export of herring products to Japan.

Mr. Mullins has been active in various fishery related organizations. He has served on the BOD and Executive Committee of PWSAC for many years since that organizations inception. Mullins has been a member of the BOD of CDFU and the former Cordova Aquatic Marketing Assn. He is also a member of the Copper River Salmon Producers Assn. Mullins served on the BOD of the Alaska Commercial Fishing and Agriculture Bank for 13 years. Mr. Mullins is the founder and chairman of the PWS Fishermen Plaintiffs Committee an organization that serves to provide an interface for information to the local community relating to the EVOS oil spill litigation. Mullins was a participant in the planning process that created the Sound Ecosystem science plan. That plan was the foundation document for the SEA program. During the period since the close of the SEA program Mullins has remained involved in attempting to understand the results of the technical assets and resources acquired through the SEA program.

Mr. Mullins attended the University of New Hampshire, the University of Michigan and obtained a BFA degree from the San Francisco Art Institute where he graduated in 1962.

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002- September 30, 2003

Budget Category:	Authorized FY 02	Proposed FY 03
Personnel	$32.2	$32.2
Travel	$5.5	$3.6
Contractual	$1.9	$4.7
Commodities	$1.6	$0.9
Equipment	$1.9	$0.0
Subtotal	$43.1	$41.4
Indirect	$3.6	$5.3
Project Total	$46.7	$46.7
Full-time Equivalents (FTE)		0.7
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
Estimated FY 04					
Dollar amounts are shown in thousands of dollars.					

Comments:

Indirect rate (13%) will cover office lease ($360/mo. X 12 mo. = $3.3) and utilities ($100/mo. X 12 mo. = $1.2) and liability Ins [12 mo. policy = $0.8]

NOAA GA of $3.3 will need to be added to this budget, bringing total project cost for FY 03 to $50.0.

FY03

Prepared:4/11/02

Project Number: 03636-BAA
Project Title: Management Applications: Commercial Fishing
Name: Ken Adams & Ross Mullins

FORM 4A
Non-Trustee
SUMMARY

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002- September 30, 2003

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 03
	Ken Adams	Co-PI	2.3	4.8		11.0
	Ross Mullins	Co-PI	2.3	4.8		11.0
	Liz Senear	Tech/Admin	3.4	3.0		10.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	8.0	12.6	0.0	
					Personnel Total	$32.2

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 03
						0.0
	Community workshops					2.7
	Co-PI's attend EVOS January 03 Anchorage workshop					0.9
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$3.6

FY03

Project Number: 03636-BAA
Project Title: Management Applications: Commercial Fishing
Name: K. Adams & R. Mullins

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/11/02

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002- September 30, 2003

Contractual Costs:	Proposed FY 03
Description	
Phones	0.9
Internet	0.8
Photocopying	1.0
Conference calls	1.6
Catering for meetings	0.4
Contractual Total	$4.7

Commodities Costs:	Proposed FY 03
Description	
Computer disks	0.3
Office supplies	0.6
Commodities Total	$0.9

FY03

Prepared: 4/11/02

Project Number: 03636-BAA
Project Title: Management Applications: Commercial Fishing
Name: K. Adams & R. Mullins

FORM 4B
Contractual & Commodities DETAIL

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002- September 30, 2003

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 03
			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
Computer equipment purchased in Mar. 02 will be utilized in this continuation project	2

FY03

Project Number: 03636-BAA
Project Title: Management Applications: Commercial Fishing
Name: K. Adams & R. Mullins

FORM 4B
Equipment
DETAIL

Prepared: 4/11/02

Reconstructing Sockeye Populations in the Gulf of Alaska over the Last Several Thousand Years: The Natural Background to Future Changes

Project Number:	03649
Restoration Category:	Research and monitoring
Proposers:	Mann and Finney, University of Alaska
Lead Trustee Agency:	ADFG
Cooperating Agencies:	none
Alaska Sea Life Center:	No
Duration:	Second year, three year project
Cost FY 03:	$90,800
Cost FY 04:	$24,900
Geographic areas:	Prince William Sound, Kodiak, Kenai Peninsula
Injured Resource/Service:	Sockeye salmon, GEM Transition, retrospective study

ABSTRACT

We are reconstructing changes in sockeye salmon abundance over the last 5000 years using the ^{15}N record left by salmon carcasses in the sediments of spawning lakes in Prince William Sound, the Kenai Fjords, the Kenai River watershed, and on Kodiak Island. Our research question is: *What is the normal variability in sockeye salmon populations in the Gulf of Alaska and how does it relate to climatic changes in the Gulf of Alaska region?* Our results provide a valuable background for future monitoring studies within the GEM program and for fisheries managers working to preserve and restore natural salmon runs.

INTRODUCTION

A. Laying a foundation for GEM

A priority for proposals solicited by EVOS for FY 03 is to establish a foundation for the GEM program. The primary mission of the Gulf Environmental Monitoring Program is to understand how natural and human-caused changes affect marine ecosystems in the northern Gulf of Alaska (GOA). We can learn a lot about present ecosystems by documenting their past responses to global changes and human activities. Information on ecosystem history can help us predict future changes. Here we propose a retrospective study of sockeye abundance in Prince William Sound and in the Kenai River watershed using the stable isotope tracers present in the sediments of spawning lakes. Our goal is to describe changes in sockeye salmon abundance over the last several millennia and to relate these changes to shifts in the climate/ocean system of the GOA and to human activities.

B. Sockeye salmon

Sockeye are an important for Native subsistence and for commercial and recreational fishing. The Trustee Council has previously made large investments in sockeye salmon recovery by purchases of stream bank, lakeside, and watershed habitats and by funding studies that detail the effects of over escapement caused by the spill. The over escapement impact was caused by the return of larger than normal numbers of spawning fish because of fisheries closures resulting from concern over oil contamination. Increased juvenile sockeye populations caused overgrazing of zooplankton stocks in spawning lakes, with consequent effects throughout the food chain. Growth rates were reduced during the freshwater part of the sockeyes' life history, and declines occurred in the health of adult fish. We have little idea about the relative severity of these over escapement effects relative to natural, prehistoric variations in sockeye populations.

C. The importance of retrospective studies

Retrospective studies like the one we propose here directly address the GEM program's goals of detecting and understanding of changes in the GOA ecosystem. To detect trends of change, we need historical data. To disentangle human-caused from nature-caused changes, we need historical data that extend back before the arrival of Europeans in the region (e.g., Finney et al., 2000; 2002). To understand the marine ecosystem, we need to describe the natural changes upon which human influences are superimposed. By understanding what happened in the past, we gain valuable perspectives on the present. In this time of global changes, learning how species and ecosystems responded to previous shifts in the environment can inform us about their future responses.

D. Previous retrospective studies of salmon populations

Finney et al. (2000; 2002) describe a 300-year record of sockeye population changes in seven lakes on Kodiak Island and the Alaska Peninsula using measurements of marine-derived nitrogen preserved in the bottom sediments of spawning lakes (Fig. 1). Marked changes in population size were found both before and after the start of intensive fisheries around AD 1900. The prehistoric changes are related to climate change (see next section), and the post-1900 changes to a combination of both climate change and fishery activity. The ^{15}N method provides a powerful tool for reconstructing changes in salmon populations in the GOA region.

E. Progress to Date on EVOS Project 649

In 2000 we collected sediment cores from Eshamy Lake in Prince William Sound. These cores were analyzed in 2001 and 2002 and results are shown in Figure 2. Rapid sedimentation in Eshamy Lake makes it possibly to reconstruct a high-resolution record of ^{15}N variations and organic-matter content. We are currently working on an age model for the sediments. From the initial data, it appears that sockeye numbers in Eshamy Lake are currently near a 2000-year high. Finer-scale sampling and more precise dating may allow us to describe population trends over the last century. Interestingly, variations in sockeye numbers in Eshamy Lake over the last 2000 years resemble the pattern of changes observed over the same period in Karluk and Red Lakes on Kodiak Island (Finney et al., 2000, 2002). We are currently running additional ^{15}N analyses on the Eshamy core, preparing samples for high-resolution ^{210}Pb dating of sediments at the core top, and ^{14}C dating four additional samples from the lower parts of the core. The Eshamy Lake promises to provide a high-resolution sedimentary record of sockeye abundance over the last 3500+ years.

BACKGROUND

A. Recent changes in the GOA atmosphere/ocean system

The northern Gulf of Alaska has seen dramatic environmental changes over the last several millennia, many of which resulted from shifts in the position and intensity of the Aleutian Low (Cayan and Peterson, 1989; Lackmann and Gyakum, 1996; Mock et al., 1998). The intensity of the Aleutian Low varies at all time scales, though only those within the span of the instrumental record (ca. 100 years) are known with any certainty (Francis et al., 1997). The best studied of these variations is the Pacific Interdecadal Oscillation (PDO), which is the coupled variation in sea surface temperature (SST) and sea level pressure (SLP) resulting from the alternation between two, self-reinforcing, and quasi-stable circulation regimes in the North Pacific climate system (Latif and Barnett, 1996; Minobe, 1997; Overland et al., 1999). The PDO has undergone two complete

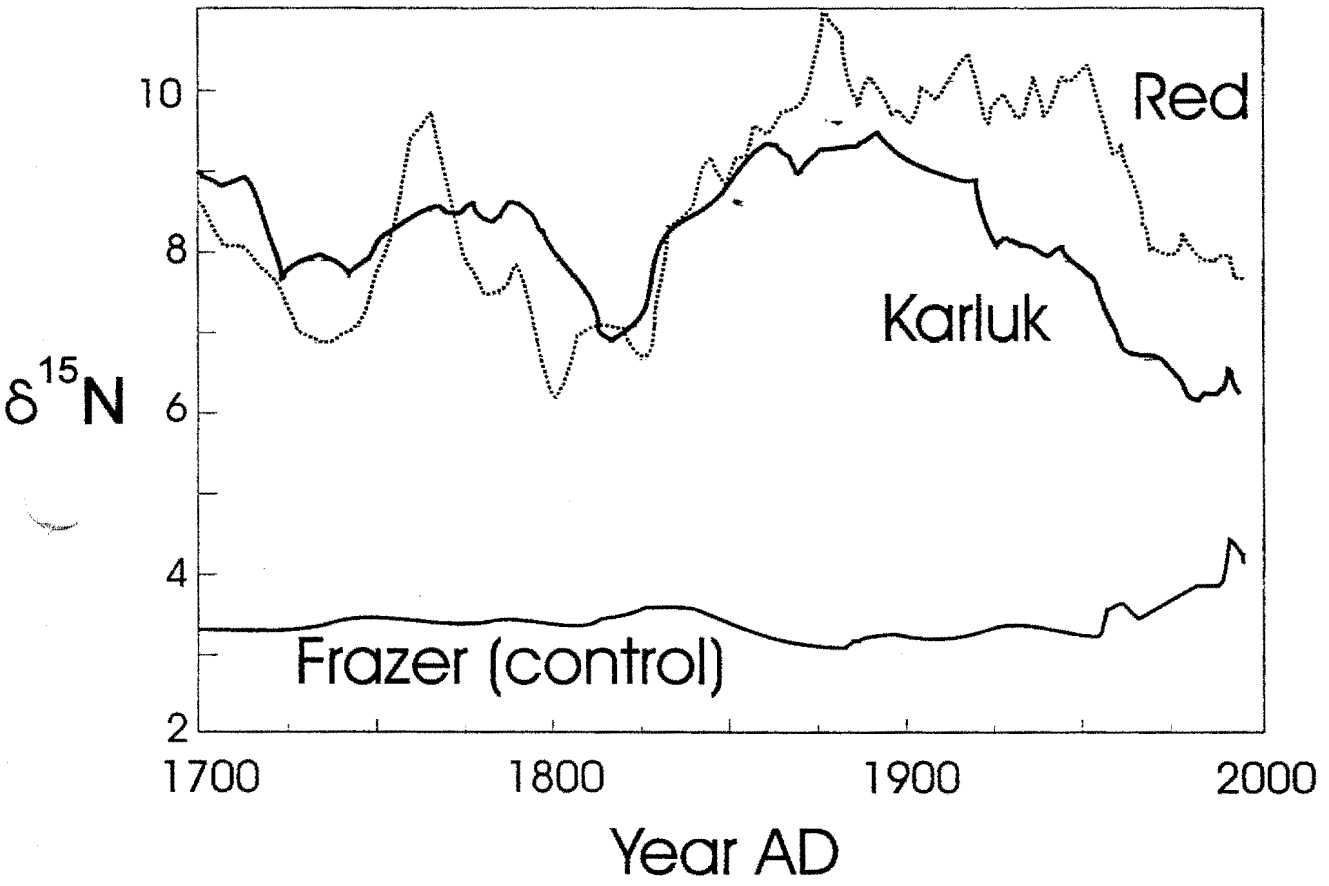

Figure 1. del^{15}N profiles from sockeye and control lakes on Kodiak Island over the past 300 years (Finney et al., 2000). Frazer Lake was barren of salmon until the 1950s, when a fish ladder was built.

oscillations since AD 1900 (Mantua et al., 1997). During positive phases of the PDO, the Aleutian Low moves eastward and intensifies, resulting in increased precipitation along the coast of the Gulf of Alaska. SSTs are cooler in the Alaska Gyre but warmer in nearshore waters. During negative phases of the PDO, the central northeastern Pacific warms, the Aleutian Low weakens, coastal precipitation lessens, and nearshore temperatures warm. Longer time-scale fluctuations (centuries to millennia) have occurred repeatedly in the North Pacific climate system (Mann et al., 1999). Studies of coastal tree rings extend the PDO record back to AD 1760 (Wiles et al., 1996, 1998, 199a).

Most of our proxy data for GOA climate prior to AD 1900 come from terrestrial sources (Mann and Hamilton, 1995). Both the Medieval Warm Period (ca. AD 900-1250) and the Little Ice Age (ca. AD 1250-1900) occurred in the GOA region, where they are evidenced by glacier fluctuations and by climatic changes recorded in tree rings (Wiles and Calkin, 1994; Wiles et al., 1998; Wiles et al., 1999 b). Fluctuations in summer temperature of several degrees centigrade are suggested (Wiles et al., 1996). The Medieval Warm Period is especially interesting for us today because it was the last time when global temperatures approached their post-1900 AD levels.

Moving further back in time, the Neoglacial interval (ca. 6000 BP – AD 1900) saw alternating cold and warm intervals each lasting several hundred years to one millennium (Calkin, 1988). Precipitation fluctuated as well, and in combination with temperature changes, caused snowlines to rise and fall by several hundred meters. Transitions from milder to colder conditions during the Neoglacial occurred rapidly in the space of several years to several decades. In general terms, the magnitudes and rates of natural climate changes occurring in the GOA over the last several millennia are similar to those predicted to occur over the next several centuries (Mann et al., 1999). In effect, nature has done a series of experiments in the past about how the GOA ecosystem may respond to future changes in the atmosphere-ocean system.

B. Salmon responses to changes in the atmosphere/ocean system

Climatic shifts have dramatic effects on the biota of the North Pacific, including salmon, at a variety of time scales (Finney et al., 2002). Climate variability is linked to ecosystem change in the North Pacific primarily through its forcing effects on lower trophic levels (Francis et al., 1997). These effects work their way through the food web and are modified as they proceed by species' life histories, subsistence strategies, and by top-down effects like predation. Intensification of the Aleutian Low during phases of positive PDO triggers increased zooplankton biomass in the Alaskan Gyre, probably in response to increased wind-induced upwelling and vertical mixing (Brodeur and Ware, 1992; Brodeur et al., 1996; Sugimoto and Tadokoro, 1997). Phytoplankton and zooplankton populations seem to have increased during the reorganization of

upper ocean circulation in response to the 1976/1977 regime shift (Francis et al., 1998).

Some of the most dramatic effects of climatic shifts on the marine biota are evident in the histories of salmon catches (Downton and Miller, 1998). Salmon catches in Gulf of Alaska waters closely track the PDO oscillation, with stock size positively correlated with the average winter/spring strength of the Aleutian Low (Beamish and Bouillon, 1993; Mantua et al., 1997). Northern (Alaskan) and southern (Oregon, California) salmon stocks vary roughly 180° out of phase (Francis and Sibley, 1991; Gargett, 1997).

There is no generally accepted explanation for how the Aleutian Low controls salmon populations in the North Pacific (Francis et al., 1998). One possible explanation is that increased wind mixing stimulates primary productivity in the Alaska Gyre, which provides more food for young salmon during the early marine stages of their lives. Gargett (1997) suggests that the critical link between physical forcing and salmon survival is the enhanced water-column stability in coastal areas during positive PDO phases, which increases primary productivity and subsequently food supply for salmon juvenile stages. Increased stream flow caused by increased rainfall in coastal areas during positive PDO phases may increase spawning success and hatchling survival. Probably all these factors interact to increase salmon stocks during positive phases of the PDO. Historical records are too short to tell us how climate/oceanographic parameters affect salmon populations.

C. Stable Isotopes in lake sediments as records of salmon abundance

Measurements of the natural abundance of stable isotopes make it possible to trace the flow of selected elements in ecosystems (Fry and Sherr, 1984; Owens, 1987; Peterson and Howarth, 1987; Wada et al., 1987). This has application in anadromous Pacific salmon systems because of the dichotomous nature of the two important nitrogen (N) sources, which are marine N from the decay of carcasses of returning adult salmon, and atmospheric N_2 (Kline, 1991). The two sources of N can be distinguished by del^{15}N, which is defined as the per mil difference in $^{15}N/^{14}N$ compared to an air N_2 isotope standard. The premise underlying the use of stable isotope abundance is the relative enrichment of ^{15}N in Pacific salmon (~ +12) in comparison with atmospheric N_2 (0). Food webs based on N_2 fixation tend to be low in ^{15}N (Minagawa and Wada, 1984; Owens, 1987; Wada and Hattori, 1991).

When Pacific salmon return to freshwater to spawn and die, they import significant quantities of marine-derived nutrients. Because these nutrients carry a distinctive signature of heavy nitrogen (^{15}N), the amount of ^{15}N present in the accumulating in the sediments of the spawning lake can be used as a proxy for escapement (Kline, 1991). Studies have quantified the proportion of marine-derived nitrogen (MDN) released by adult salmon as a result of spawning

migration (Kline et al., 1993). Measurable shifts in the MDN content of juvenile sockeye have been observed between years of strong and weak escapement. The N-isotope composition of lake biota reflects the recent history of MDN import into the lake ecosystem (Kline et al., 1993; 1994). In some lakes, this signal is transferred to the underlying sediments. Downcore changes in the abundance of MDN can reflect changes in the number of returning adult salmon (Finney et al., 2000).

D. Preliminary data for this study

Data from Karluk and Frazer Lakes on Kodiak Island indicate that sedimentary del^{15}N effectively tracks sockeye escapement (Fig. 1, Finney et al., 2000). We chose Frazer Lake as a test case for this method, as the lake was a "barren system" isolated by a waterfall from salmon prior to stocking in the late 1950s. Subsequently, a fish bypass was constructed and run size significantly increased, with an average escapement of about 200,000 since 1980 (Blackett, 1979; ADF&G, written comm., 1994). Such a large increase in escapement is clearly recorded by sedimentary del^{15}N (Fig. 1). The enrichment in del^{15}N is significant and strongly supports the hypothesis that sediment del^{15}N is influenced by salmon input of MDN. Similarly, data from Karluk Lake indicate a strong relationship between sediment del^{15}N and salmon escapement (Finney et al., 2000). Karluk Lake, one of the greatest sockeye systems in the world, had historical returns >5 million fish. Escapements averaged more than 1 million fish from the turn of the century until about 1935 but then fell to an average of less than 300,000 in the 1960s and 70s (Fig. 1; Koenings and Burkett, 1987a, ADF&G, written comm., 1994). The sedimentary del^{15}N in Karluk is significantly higher than Frazer, and it is consistent with greater salmon escapement. The large decline in sedimentary del^{15}N of about 3 parts per mil towards the top of the core reflects the decline in escapement in this system since the 1930s. These results indicate that sedimentary del^{15}N provides a valuable tool for reconstructing long-term changes in sockeye abundance.

In 2000 we retrieved four cores each from Solf and Eshamy Lakes in Prince William Sound. Solf is a "barren" lake into which salmon have been recently introduced, and Eshamy Lake naturally supports a vigorous sockeye run. Analyses of the Eshamy Lake cores in 2001 and 2002 show a striking del^{15}N record (Fig. 2). Solf Lake will serve as a control for possible changes in non-salmon (e.g., aerosol) input of del^{15}N into Prince William Sound lakes.

NEED FOR THIS PROJECT

A. The Problem: What is "normal" for sockeye populations?

The recovery objective set by the EVOS Trustee Council for sockeye salmon is that adult returns-per-spawner should regain normal levels. But what is normal?

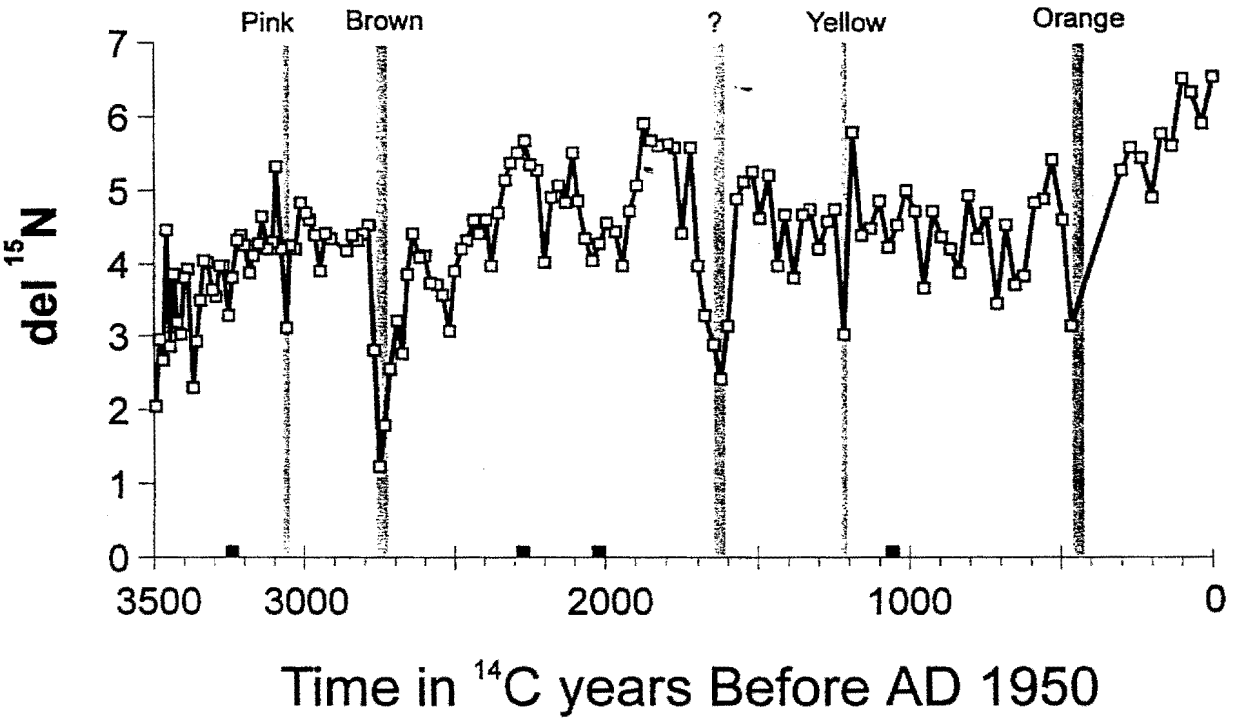

Figure 2. Preliminary data from Eshamy Lake, Prince William Sound. Vertical lines are volcanic ashes. Black boxes along x axis show positions of radiocarbon dates. These data suggest a complicated history of changes in salmon population size over the last 3500 years, with peak numbers occurring in the last several centuries. We are currently refining the age control and comparing this record to data from previous studies of glaciers, tree rings, and pollen.

If both the global environment fisheries management were stable then we might be able to define "normal". But change reigns in both nature and society, and what is normal for the last several decades may be unusual over longer time spans.

The retrospective studies we propose here can establish long-term, baseline records of changes in salmon populations in the GOA. We can use these records to define normalcy by estimating the frequency with which the observed population size occurred in the past. By knowing the extremes of natural population fluctuations in the past, we can identify abnormal population excursions as they occur in the future.

Understanding how environmental factors affect salmon populations is crucial for fisheries management in a time of global change. Also, sockeye may prove to be a useful indicator species for events within the larger GOA ecosystem. Before we can use sockeye as an indicator species, we need to understand how nonhuman factors control their numbers. From retrospective studies, we can generate testable hypotheses about how changes in the atmosphere/ocean system of the GOA will affect salmon populations in the near future. Nature has performed a series of experiments in past millennia, and we can gain access to the results of these experiments through analyses of del^{15}N in lake sediments.

B. Links: Giving GEM a time perspective

The goals of GEM are to detect, understand, and predict ecosystem changes in the GOA with the purpose of informing and assisting resource managers. Besides providing a more rigorous means of defining what is normal, our study will help lay the foundations for GEM by generating hypotheses that relate changes in the atmosphere/ocean system of the GOA to fluctuations in salmon numbers. The past is the key to the present, and climate has varied repeatedly over the last 2000 years. How did sockeye population respond to changes of several C° in the past? The last time temperatures were as warm as today was during the Medieval Warm Period (AD 900-1250). How did sockeye populations respond to this previous warm period?

C. Study Sites

This study involves sockeye lakes in the northern GOA region that were affected by over escapement after the 1989 oil spill (Eshamy and several lakes in the Kenai River watershed) and two recently formed lakes in McCarty Fjord (Delight and Desire Lakes). Detailed sediment chemistry has been completed in two Kodiak Island lakes, Karluk and Frazer (Fig. 2), though we plan to return to Karluk Lake this summer to obtain a longer core that could push the Kodiak sockeye record back into the early Holocene (ca. 9,000 year ago). Analysis is nearing completion for Eshamy Lake (Fig. 1) in Prince William Sound. We leave next week to retrieve cores from Upper Russian Lake. We plan on coring Delight

and Desire Lakes in Kenai Fjords and Skilak, Hidden, and a control lake in the Kenai River watershed during the late summer of 2002.

COMMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Archaeological records contain unsynthesized data concerning the interactions between humans and salmon populations during prehistoric times (see review in Mann et al., 1999). We suspect there is also a rich oral tradition in Native communities about the history and causes of changes in salmon abundance. Within the time constraints of this one-year project, our goals are to get data on sockeye population history and then to develop hypotheses about salmon-climate interconnections. Once we have the science figured out, we want to turn to the local people, the people actually living on the land, to share our ideas and get their ideas back. We anticipate asking EVOS for additional funds in FY 2004 to pay for several trips to Kodiak Island and to villages in PWS and on the Kenai Peninsula, where we will give brief presentations showing our results and initiate conversations about what factors control salmon populations in the GOA region.

PROJECT DESIGN

A. Objectives

We intend to reconstruct sockeye abundance in Eshamy, Upper Russian, Delight, and Desire Lakes using established methods of isotope analysis of lake-bottom sediments that are retrieved by coring. The specific objectives of this study are:

1) Develop sediment-core chronologies and measure downcore changes in lake-productivity indicators (organic C and C/N ratios) as well sedimentary del^{15}N.

2) Compare sediment data corresponding to the past few decades (e.g., the period of intensive investigations by ADF&G) to salmon population statistics. We then will develop calibration relationships between del^{15}N and salmon numbers.

3) Reconstruct paleolimnologic changes in each lake over the past several thousand years, using the results of Specific Objectives 1 and 2. Specifically, we will reconstruct time-series of lake productivity, input of marine-derived nutrients, and salmon escapement.

4) Compare del^{15}N records from PWS and the Kenai Peninsula to Finney's published and ongoing work on Kodiak Island. This synthesis will result in a valuable new perspective on changes in sockeye abundance in the GOA at decadal time scales over the last several millennia.

5) Compare reconstructed sockeye population fluctuations with published data sets on paleoclimatic changes in the GOA region. These data sets include tree rings, glacial records, and pollen records of vegetation change. From these comparisons, we will develop a series of hypotheses about how changes in the atmosphere/ocean system affect salmon populations.

B. Methods

1) Sediment cores

We already have cores from Eshamy, Solf, Karluk, and Frazer Lakes. Upper Russian Lake, Delight Lake, Desire Lake, Skilak Lake, Hidden Lake, and a control lake in the Kenai River watershed will be cored for the first time in this study. We hope to obtain a longer core from Karluk Lake.

Coring sites are identified from bathymetric maps, and sites are selected to avoid gravity-flow deposition and complicated bottom topography. We will obtain at least two, 1- 2 m long cores using the percussion corer that we built last year to obtain cores from each lake. High quality surface cores will be obtained with a device (Glew corer) designed for sampling unconsolidated sediments and obtaining an undisturbed sediment-water interface. The cores will be stored in a cold room and excess material archived for future studies.

Cores will be described for lithology, texture, color, and other properties, and photographed. Each core will be continuously scanned for magnetic susceptibility. Magnetic susceptibility, a measure of the abundance of magnetic minerals, provides important stratigraphic and sedimentologic information (e.g., King et al., 1983). For example, magnetic susceptibility is sensitive to volcanic ash abundance; visually undetected ashes often are easily detected in susceptibility profiles. Ash layers should be common in many of the lakes, given the close proximity to active volcanoes, and they are useful for correlating between cores and between different lakes. Sediment chronologies will be determined by a combination of ^{210}Pb-dating (Bruland et al., 1974) in the upper several tens of centimeters and by AMS-^{14}C dating of terrestrial plant macrofossils in sediments older than several centuries.

2) Reconstructing changes in sockeye salmon abundance

Changes in input of marine-derived nutrients (MDN) will be determined by analysis of del^{15}N. As discussed earlier, downcore changes in the abundance of MDN (from del^{15}N) reflect changes in the number of returning adult salmon, and thus is a proxy for escapement. Organic carbon content, C/N ratio, and del^{13}C also indicate changes in organic matter source (Hedges and Parker, 1976; Meyers, 1990). Time-series of organic C content, C/N ratios, and stable C and N isotopes will shed light on changes in the source and supply rate of organic matter. We will calibrate our MDN-based reconstructions in sockeye salmon escapement with recorded escapement records. The lakes we propose to study have had significant changes in escapement during the past few decades.

These variations allow us to determine how well sedimentary del^{15}N reflects escapement (e.g., Fig. 1). Using recent calibrations, we will estimate prehistoric escapements from downcore changes in del^{15}N.

C. Cooperating agencies, contracts, and other agency assistance

Though no formal collaborations are planned with federal agencies within this brief project, in fact we are collaborating closely with ADF&G and USFWS in ongoing, similar studies of salmon paleoecology (e.g., Schmidt et al., 1997).

SCHEDULE

A. Project Tasks and Endpoints

30 April, 2002:	Core Upper Russian Lake, Kenai Peninsula.
1 September, 2002:	Complete del^{15}N analyses on cores from Upper Russian Lake; submit samples from this lake and from Eshamy Lake for ^{14}C and ^{210}Pb dating. Core Delight and Desire Lakes in Kenai Fjords. Also core Hidden and Skilak Lakes (Kenai Peninsula) and obtain a new, long core from Karluk Lake (Kodiak Island).
November 1, 2002	Complete laboratory analyses of Upper Russian Lake and the two Kenai Fjords lakes
December 1, 2002:	Submit manuscript for publication in peer-reviewed journal concerning the Eshamy Lake ^{15}N records.
January 2003:	Present results and discuss implications for GEM projects at Restoration Workshop.
February 1, 2003	Complete laboratory analysis of Hidden and Skilak Lakes
April 15, 2003:	Annual report on results from FY2002
May 1, 2003:	Finish laboratory work on the Karluk Lake long core
July 1, 2003:	Submit manuscript for publication in peer-reviewed journal concerning nitrogen-isotope records from Kenai Peninsula lakes.

February 1, 2004: Submit our synthesis paper concerning climate-oceanographic drivers of salmon populations in the GOA region.

April 15, 2004: Submit final report to EVOS.

PUBLICATIONS AND REPORTS

We plan to submit a manuscript describing our results from Eshamy Lake to either *Fisheries Oceanography* or *Canadian Journal of Fisheries and Aquatic Science* in the autumn of 2002. A second publication concerning the Kenai Peninsula lakes will be submitted in November 2003 to a similar journal. Our final synthesis about the connections between salmon populations and climatic change in the Gulf of Alaska region will be submitted to a journal like the *Journal of Geophysical Research.*

PROFESSIONAL CONFERENCES

We will present our results at two scientific meetings.

December 2002: Present an oral or poster presentation describing our major findings related to salmon-climate interactions over the last 4000 years at the American Geophysical Union Fall meeting.

August 2003: Present oral or poster presentation at the Ecological Society of America meetings (location uncertain at this time).

EXPLANATION OF CHANGES IN THE CONTINUING PROJECT

We seek supplemental funding for the second year of the project to expand our work in the Kenai River watershed. With the anticipation of the development of the GEM project ***Nutrient cycling in the Kenai River Watershed: Detecting and understanding marine-terrestrial linkages in watersheds***, we have selected three additional lakes to core there. ^{15}N records from these additional lakes (Hidden, Skilak, and a yet unchosen control lake) will greatly expand our knowledge of long-term salmon variability and nutrient cycling on the Kenai Peninsula. Skilak Lake is a key sockeye nursery lake within the Kenai River system. Because it is a glacial lake, the responses of its sockeye population to changes in climate and to historical changes in fishing activity are likely to be different from clear water systems (e.g., Karluk or Upper Russian Lake). Hidden Lake is a lower elevation, clear water lake, with much different spawning

limitations and nutrient elemental ratios than Upper Russian Lake. Studies of these three contrasting lake systems, and their responses to climatic changes, will enhance our knowledge of the politically contentious, economically valuable, and biologically complex watershed of the Kenai River. We request supplemental funding for coring, dating, and laboratory analyses of ^{15}N and lake productivity proxies for three additional lake systems during the second year of our current EVOS project. Writing up the results of our project will extend into FY2004.

PRINCIPAL INVESTIGATORS (see curricula vitae below)

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DIVISION OF LABOR BETWEEN PRINCIPAL INVESTIGATORS

Dr. Mann will supervise most of the fieldwork and oversee core sampling and sedimentological descriptions in the laboratory. He will also take the lead in synthesizing Holocene climatic records for detailed comparisons with the salmon proxy records obtained in our project.

Dr. Finney will direct laboratory analyses at UAF, supervise the chronometric analyses done at other laboratories, and provide the fisheries and oceanographic expertise in the manuscripts summarizing the results of our project.

LITERATURE CITED

Beamish, R.J. and Bouillon, D.R., 1995. Marine fish production trends off the Pacific coast of Canada and the United States. Canadian Special

Publication in Fishery and Aquatic Science 121, 585-591.
Blackett, R.F.,1979. Establishment of sockeye (Oncorhynchus nerka) and chinook (O. tshawytscha) salmon runs at Frazer Lake, Kodiak Island, Alaska. J. Fisheries Res. Board Can. 36, 1265-1277.
Brodeur, R.D. and Ware, D.M., 1992. Long-term variability in zooplankton biomass in the subarctic Pacific Ocean. Fisheries Oceanography 1, 32-38.
Brodeur, R.D., Frost, B.W., Hare, S.R., Francis, R.C., and Ingraham, W.J., 1996. Interannual variations in zooplankton biomass in the Gulf of Alaska, and covariation with California Current Zooplankton biomass. CalCOFI 37, 80-99.
Bruland, K.W., Bertine, K., Koide, M., and Goldberg, E.D., 1974. History of pollution in the southern California coastal zone. Environ. Sci. Tech. 8: 425-432.
Calkin, P.E., 1988. Holocene glaciation of Alaska (and adjoining Yukon Territory, Canada). Quaternary Science Reviews 7, 159-184.
Cayan, D.R., 1992. Latent and sensible heat flux anomalies over the northern oceans: the connection to monthly atmospheric circulation. Journal of Climatology 5, 354-369.
Cayan, D.R. and Peterson, D.H., 1989. The influence of north Pacific atmospheric circulation on streanflow in the West. Gephysical Monographs 55, 375-397.
Downton, M.W. and Miller, K.A., 1998. Relationships between Alaskan salmon catch and North Pacific climate on interannual and interdecadal time scales. Journal of Fisheries and Aquatic Science 55, 2255-2265.
Finney, B.P., Gregory-Eaves, I., Sweetman, J., Douglas, S.V., and Smol, J.P., 2000. Impacts of climatic change and fishing on Pacific salmon abundance over the past 300 years. Science 290, 795-799.
Finney, B.P., Gregory-Eaves, I., Douglas, M.S.V.m and Smol, J.P., 2002. Fisheries productivity in the northeastern Pacific Ocean over the past 2,200 years. Nature (*in press*).
Francis, R.C. and Sibley, T.H., 1991. Climate change and fisheries: What are the real issues? *The Northwest Environmental Journal* 7: 295-307.
Francis, R.C., Hare, S.R., Hollowed, A.B., and Wooster, W.S., 1998. Effects of interdecadal climate variability on the oceanic ecosystems of the NE Pacific. Fisheries Oceanography 7, 1-21.
Fry, B. and Sherr, E.B.,1984. del^{13}C measurements as indicators of carbon flow in marine and freshwater ecosystems. Contr. Mar. Sci. 27:13-47.
Gargett, A.E., 1997. The optimal stability 'window': a mechanism underlying decadal fluctuations in North Pacific salmon stocks? Fisheries Oceanography 6, 109-117.
Hedges, J. I. and Parker, P. L. 1976. Land-derived organic matter in surface sediments from the Gulf of Mexico. Geochim. Cosmochim. Acta, 40: 1019-1029.
King, J.W., Banerjee, S.K., Marvin, J. and Lund, S.P. 1983. Use of small-amplitude paleomagnetic fluctuations for correlation and dating of

continental climate change. Palaeogeography, Palaeoclimatology, Palaeoecology, 42: 167-183.

Kline , T. C. Jr., J. J. Goering, O. A. Mathisen, P. H. Poe and P. L. Parker. 1990. Recycling of elements transported upstream by runs of Pacific salmon: I. del^{15}N and del^{13}C evidence in Sashin Creek, southeastern Alaska. Can. J. Fish. Aquat. Sci. 47:136-144.

Kline, T. C., Jr., 1991. The significance of marine-derived biogenic nitrogen in anadromous Pacific salmon freshwater food webs. Ph.D. Thesis, University of Alaska Fairbanks, Fairbanks, Alaska, 114p.

Kline , T. C. Jr., Goering, J.J., Mathisen, O.A., Poe, P.H., Parker, P.L., and Scalan, R.S., 1993. Recycling of elements transported upstream by runs of Pacific salmon: II. del^{15}N and del^{13}C evidence in the Kvichak River watershed, southwestern Alaska. Can. J. Fish. Aquat. Sci. 50: 2350-2365.

Kline, T.C., Goering, J.J., and Piorkowski, R.J., 1994. The effect of salmon carcasses on freshwater systems. *In:* A. Milner and M. W. Oswood (Eds.) Alaskan Freshwaters. Springer-Verlag, New York.

Koenings, J. P. and Burkett, R.D., 1987a. Population characteristics of sockeye salmon (*Oncorhynchus nerka*) smolts relative to temperature regimes, euphotic volume, fry density, and forage base within Alaskan lakes. *In* H. D. Smith, L. Margolis and C. C. Wood (Eds.) Sockeye salmon (*Oncorhynchus nerka*) population and future management. Can. Spec. Publ. Fish. Aquat. Sci. 96, p.216-234.

Lackmann, G.M. and Gyakum, J.R., 1996. The synoptic- and planetary-scale signatures of precipitating systems over the Mackenzie River basin. Atmosphere-Ocean 34, 647-674.

Lagerloef, G.S.E., 1995. Interdecadal variations in the Alaska Gyre. Journal of Physical Oceanography 25, 2242-2256.

Latif, M. and Barnett, T.P., 1996. Descadal climate variability over the North Pacific and North America: dynamics and probability. Journal of Climate 9, 2407-2423.

Mann, D.H. and Hamilton, T.D., 1995. Late Pleistocene and Holocene Paleoenvironments of the North Pacific Coast. Quaternary Science Reviews 14, 449-471.

Mann, D.H., Crowell, A.L., Hamilton, T.D., and Finney, B.P.,1999. Holocene geologic and climatic history around the Gulf of Alaska. Arctic Anthropology 35, 112-131.

Mantua, N.J., Hare, S.R., Zhang, Y., Wallace, J.M., and Francis, R.C., 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the Meteorological Society 78, 1069-1079.

Meyers, P.A. 1990. Impacts of late Quaternary fluctuations in water-level on the accumulation of sedimentary organic matter in Walker Lake, Nevada. Palaeogeogr. Palaeoecol. Palaeoclimatol. 78: 229-240.

Minagawa, M., and Wada, E., 1984. Stepwise enrichment of ^{15}N along food chains: Further evidence and the relation between del^{15}N and animal age. Geochim. Cosmochim. Acta 48:1135-1140.

Minobe, S., 1997. A 50-70 year oscillation over the North Pacific and North

America. Geophysical Research Letters 24, 683-686.
Mock, C.J., Bartlein, P.J., and Anderson, P.M., 1998. Atmospheric circulation patterns and spatial climatic variability in Beringia. International Journal of Climatology 18, 1085-1104.
Namias, J., 1969. Seasonal interactions between the North Pacific Ocean and the atmosphere during the 1960s. Monthly Weather Review 97, 173-192.
Niebauer, H.J., 1998. Variability in Bering Sea ice cover as affected by a regime shift in the North Pacific in the period 1947-1996. Journal of Geophysical Research 103, 27,717-27,737.
Overland, J.E., Adams, J.M., and Bond, N.A., 1999. Decadal variability of the Aleutian Low and its relation to high-latitude circulation. Journal of Climate 12, 1542-1548.
Owens, N. J. P. 1987. Natural variations in ^{15}N in the marine environment. Advances in Marine Biology 24:389-451.
Peterson, B. J. and Howarth, R.W., 1987. Sulfur, carbon and nitrogen isotopes used to trace organic matter flow in the salt-marsh estuaries of Sapelo Island, Georgia. Limnol. Oceanogr. 32:1195-1213.
Schmidt, D.C., Kyle, G.B., Carlson, S.R., Geiger, H.J., and Finney, B.P. Alaska's Sockeye salmon management: can we learn from success? In: "Developing and Sustaining World Fisheries Resources: The State of Science and Management, 2nd World Fisheries Congress Proceedings". (D.A. Hancock, D.C. Sminth, A. Grant and J.P. Beumer, eds.), CSIRO, Collingwood, VIC, Australia, pp. 687-695.
Sugimoto, T. and Tadokoro, K., 1997. Interannual-interdecadal variations in zooplankton biomass, chlorophyll concentration and physical environment in the subarctic Pacific and Bering Sea. Fisheries Oceanography 6, 74-93.
Trenberth, K.E. and Hurrell, J.W., 1994. Decadal atmosphere-ocean variations in the Pacific. Climate Dynamics 9, 303-319.
Wada, E. and Hattori, A., 1991. *Nitrogen in the Sea: Forms, Abundances, and Rate Processes*. CRC Press, Boca Raton, 208pp.
Wada, E., Terazaki, M., Kabaya, Y., and Nemoto, T., 1987. ^{15}N and ^{13}C abundances in the Antarctic Ocean with emphasis on the biogeochemical structure of the food web. Deep-Sea Res. 34:829-841.
Wiles, G.C. and Calkin, P.E., 1994. Late Holocene, high resolution glacial chronologies and climate, Kenai Mountains, Alaskka. Geological Society of America Bulletin 106, 281-303.
Wiles, G.C., D'Arrigo, R.D., and Jacoby, G.C., 1996. Temperature changes along the Gulf of Alaska and the Pacific Northwest coast modeled from coastal tree rings. Canadian Journal of Forest Research 26: 474-481.
Wiles, G.C., D'Arrigo, R.D., and Jacoby, G.C., 1998. Gulf of Alaska atmosphere-ocean variability over recent centuries inferred from coastal tree-ring records. Climatic Change 38, 289-306.
Wiles, G.C., Barclay, D.J., and Calkin, P.E., 1999. Tree-ring dated 'Little Ice Age' histories of maritime glaciers from western Prince William Sound, Alaska. The Holocene 9, 163-173.

Wiles, G.C., Post, A., Muller, E.H., and Molnia, B.F., 1999. Dendrochronology and late Holocene history of Bering Piedmont Glacier, Alaska. Quaternary Research 52, 185-195.

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 02	Proposed FY 03	LONG RANGE FUNDING REQUIREMENTS					
Personnel	$0.0							
Travel	$0.0							
Contractual	$82.3	$84.9						
Commodities	$0.0							
Equipment	$0.0	$0.0						
Subtotal	$82.3	$84.9	Estimated FY 04					
General Administration	$5.8	$5.9						
Project Total	$88.1	$90.8	$24.9					
Full-time Equivalents (FTE)	3.0	3.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

FY03

Project Number: 03649
Project Title: Reconstructing Sockeye Salmon Populations
Name: D.H. Mann and B.P. Finney

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 02	Proposed FY 03
Personnel	$29.1	$31.0
Travel	$4.5	$5.8
Contractual	$26.2	$28.0
Commodities	$6.0	$3.1
Equipment	$0.0	$0.0
Subtotal	$65.8	$67.9
Indirect	$16.5	$17.0
Project Total	$82.3	$84.9
Full-time Equivalents (FTE)	0.3	0.3
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 04					
$24.9					

Dollar amounts are shown in thousands of dollars.

Comments:

1) The indirect rate is 25% as negotiated between the EVOS Trustee Council and the University of Alaska

2) Travel includes airfare from Fairbanks to study lakes and to scientific meetings in Anchorage and in Lower 48 States. We are uncertain what cities in the Lower 48 because the locations of some national meetings changes year-to-year.

3) The increased amount of our 2003 budget reflects the expansion of our project to include three new lake systems in the Kenai River watershed. These additions are detailed in the proposal's text. If the Trustees do not approve the expansion of this project, the original 2003 budget for this project was $18.8.

4) Our estimated costs in FY 04 cover personnel, communications, travel to a scientific meeting for one investigator (1.6) and two trips from Fairbanks to Anchorage for the Annual EVOS Workshop (1.4).
Personnel: 1.5 months of both Finney's and Mann's time for manuscript preparation ($16.4)
Communications and copy ($0.5)
Indirect costs: $19.9 x 0.25 = $5.0

FY03

Prepared:4-12-02

Project Number: 03649
Project Title: Reconstructing Sockeye Salmon Populations
Name: D.H. Mann and B.P. Finney

FORM 4A
Non-Trustee
SUMMARY

WMF 1-14-03

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 03
	Mann	PI	2.0	9.1		18.2
	Finney	co-PI	1.0	7.3		7.3
	Krumhardt	Technician	1.0	5.5		5.5
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	4.0	21.9	0.0	
					Personnel Total	$31.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 03
	Fairbanks to Anchorage	0.3	4	5	0.1	1.7
	Fairbanks to Hidden, Skilak Lakes, and control lake	0.5	3	2	0.5	2.5
	Fairbanks to Lower 48 city for nat'l meeting re. climate change & fisher	0.8	1	4	0.2	1.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$5.8

FY03

Project Number: 03649
Project Title: Reconstructing Sockeye Salmon Populations
Name: D.H. Mann and B.P. Finney

FORM 4B
Personnel
& Travel
DETAIL

Prepared:

WMF 4-18-02

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Contractual Costs:	Proposed
Description	FY 03
Laboratory analyses of N and C isotopes	6.0
AMS-radiocarbon dating, 20 samples (10 per lake) @ $500/each	15.0
210Pb analyses, three profiles @ $2000/each	6.0
boat charter fees from UAF	0.7
pickup truck and trailer mileage charges from UAF @ $0.40/mile x 800 miles	0.3
Contractual Total	$28.0

Commodities Costs:	Proposed
Description	FY 03
Materials for maintaining lake corer	1.0
Laboratory glassware, plastic vials, microscope slides, etc.	0.6
Publications (maximum allowable contribution towards page costs per project)	1.0
Communications and copy center	0.5
Commodities Total	$3.1

FY03

Prepared:4-12-02

Project Number: 03649
Project Title: Reconstructing Sockeye Salmon Populations
Name: D.H. Mann and B.P. Finney

FORM 4B
Contractual &
Commodities
DETAIL

FY 03 *EXXON VALDEZ* TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 03
			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

FY03

Prepared:4-12-02

Project Number: Project Number: 03649
Project Title: Reconstructing Sockeye Salmon Populations
Name: D.H. Mann and B.P. Finney

FORM 4B
Equipment
DETAIL

WMF 4-08-02

A 6,300-Year Old Window into the Past: Retrospective Analysis of Nearshore Marine Communities Based on Analysis of Archeological Material and Isotopic Analysis

Project Number:	03656
Restoration Category:	Research

Proposers:

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

Dr. Jeanne Schaaf
National Park Service
2525 Gambell St.
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Dr. Dan Mann
Institute of Arctic Biology, Irvine Bldg
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Fairbanks, AK 99775

Dr. John Southon
Earth System Science Dept
220 Rowland Hall
University of California
Irvine, CA 92697-3100

Lead Trustee Agency:	DOI--USGS
Cooperating Agencies:	
Alaska SeaLife Center:	No
Duration:	2nd of 2 years
Cost FY 03:	$ 55,000
Cost FY 04:	$ 0
Geographic Area:	Gulf of Alaska
Injured Resource/Service:	Intertidal communities, clams

ABSTRACT

The primary purpose of this proposal is to investigate long-term (6,300 year) patterns of productivity and relative species abundances in nearshore, intertidal communities via retrospective analyses. These analyses will focus on excavated midden remains of a very rich, well-dated archeological site along the Katmai National Park and Preserve coast.

Changes in nearshore marine communities will be assessed through examination of relative species abundances, size-frequency analysis, and other indicators of habitat changes. Isotopic analysis of shells will provide an assessment of long-term productivity patterns in the nearshore marine environment as related to major periods of climate change.

INTRODUCTION

Changes in marine ecosystems occur on multiple scales of space and time. In the near-term, recent biological information suggests that patterns in the abundances of marine organisms and productivity of their associated systems may change in a low-frequency cyclical manner (e.g., regime shifts; Francis et al., 1998; Hare and Mantua, 2000), or may undergo longer-term directional change (e.g., Bering Sea; Schell, 1998, 2000). Long-term changes may reflect changes in climate that have spanned decades, centuries or millenia. Such changes are known for coastal regions from a variety of data. Within Alaska, the coastal paleoenvironments and climate of the late Pleistocene and Holocene have been reviewed by Mann and Hamilton (1995) and Mann et al. (1998, 1999).

Long-term changes in marine ecosystems are difficult to investigate, and the entrees into such data are limited. Cores, isotopic analyses, pollen-grain analyses, tree-ring data, and archeological investigations have been used to examine long-term biological data. A combination of data may provide a multi-faceted approach that allows integration and interpretation of changes and processes occurring in nearshore marine environments.

A tremendous opportunity to gain long-term perspective on biological change in nearshore marine communities bordering the Gulf of Alaska is afforded by recent excavations of a coastal archeological site along the Katmai National Park and Preserve coast. This exceptionally rich site, excavated by a team lead by Dr. Jeanne Schaaf, has midden material dated to at least 6,300 radiocarbon years before present (BP). This site is unusual in its long history, excellent organic preservation, and well-defined stratigraphy, which allows layers to be related to dated occupation surfaces. The material at the site is quite abundant. The non-mixed nature of the material contributes to the clarity of the stratigraphy. There are at least 50 ^{14}C values for the site, determined from occupation surfaces and associated midden materials. The site appears to have been occupied pretty continuously over the last 6300 years except for a gap from approximately 2,000 to 4,000 years before present. This same gap has been noted from other sites across the whole region (the northern Alaska Peninsula and Kodiak). What sets this site apart from other sites along the Kenai Peninsula coast and SE Alaska is the abundance of the biological material and its excellent preservation. It is both the oldest identified and most extensively excavated site along the northern Alaska Peninsula.

In addition to the suite of ^{14}C values from the site, there are at least 50 other values from the Katmai coastal area that provide a broader context for the site. Paleoclimate data have been collected in nearby areas, including analysis of a peat deposit that spans 10,000 years and that contains a tephra (volcanic ash) stratigraphy and vegetational history of the

entire Holocene (Hilton, 2000). The combination of radiocarbon dates and paleoclimate information provides a context within which a more detailed analysis of nearshore species found in midden remains can be made.

We propose a retrospective analysis of midden material to determine long-term patterns in nearshore productivity, their relation to climate changes, and ecological changes in composition of nearshore marine communities.

NEED FOR THE PROJECT

A. Statement of Problem

The GEM program is focused on monitoring species and processes in order to describe and understand changes in the oceanic and nearshore environments of the Gulf of Alaska. As an early part of the program, it has espoused the need for retrospective analyses in order to enrich our understanding of long-term changes in this region. The shorter-term cyclical patterns in species abundances and climate that are a focus of much of GEM, must be understood against the broader spectrum of truly long-term (century to millenial) changes and more directional climate change (e.g., global warming). Retrospective analyses of archeological sites may allow development of such a perspective. The goals of the proposed project are to develop long-term patterns of productivity and relative species abundances in the nearshore and investigate their relationship to climate change.

B. Rationale/Link to Restoration

In order to understand the effects of the *Exxon Valdez* oil spill and other perturbations, we need to have an increased understanding of how species are changing through time. This project focuses on the nearshore environment, an area that was heavily injured by the *Exxon Valdez* oil spill. Developing an understanding of long-term change in nearshore marine communities and investigating the relationship between productivity and climate will aid in the development of the GEM monitoring plan.

C. Location

Study is focused on the Mink Island archeological site on the Katmai National Park and Preserve coast, bordering the Gulf of Alaska.

COMMUNITY INVOLVEMENT AND TRADITIONAL KNOWLEDGE

Retrospective analysis of archeological specimens involves the revealing of human use patterns of resources. This could enrich the cultural history of local native groups. Additionally, querying local groups about findings may reveal whether similar use of

nearshore species is made now or was in the recent past. We will be happy to discuss our findings with native groups.

PROJECT DESIGN

A. Objectives

1. Assess long-term patterns in nearshore productivity via isotopic analysis of shells of selected invertebrate taxa found in different, dated layers of middens.

2. Evaluate the paleoecology of the assemblages found in the middens via relative species composition, abundances, etc., and compare to patterns of productivity.

B. Methods

The hypotheses and methods used to address them are outlined below.

> H1: Changes in nearshore productivity, as evidenced by isotopic signatures of invertebrate shells, have changed in relation to major climate changes or trends in the Holocene.
>
> H2: Changes in species composition, sizes, etc., of midden species assemblages reflect changes in climate, habitat, or human use patterns.

The methods used to test each of these hypotheses are given below.

H1: Changes in nearshore productivity, as evidenced by isotopic signatures of invertebrate shells, have changed in relation to major climate changes or trends in the Holocene.

Recent analyses of stable isotope ratios of baleen of bowhead whales suggest declining productivity in the Bering Sea (Schell, 1998, 2000). In this case, analysis of carbon isotope ratios provided a means of indirectly assessing relative primary production. The bowhead whales feed on zooplankton that they filter with their baleen, and are thus one step removed from the phytoplankton primary producers. Bivalve molluscs, the dominant constituents of the middens at the Mink Island site, are also filter feeders, but feed more commonly on phytoplankton, thus responding more directly to patterns in primary productivity. Although the relationship of short-term changes in primary productivity may be reflected in annular growth rates of bivalves, this type of analysis is not appropriate for archeological material where the dating of the material is not sufficiently precise.

Thus, we propose a combination of carbon and nitrogen isotopic analyses ($\delta^{13}C$, $\delta^{15}N$, ^{14}C) of bivalve shells from the Mink Island midden to examine long-term changes in nearshore primary productivity. Carbon is transferred relatively conservatively in food webs and stable isotopic analysis of $\delta^{13}C$ gives excellent information on sources and magnitudes of productivity. Recent studies of the relationships between stable carbon isotope ratios in phytoplankton and the growth of diatoms (Laws et al., 1995) and for haptophytes inhabiting differing ocean productivity regimes (Bidigare el al., 1997) indicate a close relationship between $\delta^{13}C$ and algal growth rates (Schell, 1998, 2000). These findings provide a mechanism for linking $\delta^{13}C$ values and the magnitude of primary production, which can then be expressed in higher order consumers.

The addition of $\delta^{15}N$ analysis may allow finer discrimination of productivity differences, as changes in stable nitrogen isotope ratios also are related to productivity patterns, with higher $\delta^{15}N$ values related to higher productivity patterns (D. Schell, pers. comm.; Altabet and Francois, 1994). It must be recognized that these relationships and linkages are in their early stages of development. However, the approach here is to look for patterns in isotopic values that correlate with major climate periods experienced in the Gulf of Alaska (Fig. 2).

Another measure of productivity (via upwelling), and one that has broader implications for the dynamics of deep ocean circulation is ^{14}C analysis. Comparison of the ^{14}C age differences revealed by analysis of paired wood (terrestrial) and marine shell samples reveal differences in ^{14}C age of atmospheric and surface marine carbon reservoirs. In regions of upwelling, this is indicative of global thermohaline circulation. In subpolar regions, reservoir ages can provide information on the intensity of upwelling and mixing processes (Southon et al., 1990).

Our first hypothesis is that patterns of change in primary productivity, as evidenced by isotopic analyses, are correlated with changes in climate. Mann et al. (1998) have detailed the climatic history along the Gulf of Alaska (Fig. 1). We will select samples to analyze for natural stable isotopes ($\delta^{13}C$, $\delta^{15}N$) based on occurrence of radiocarbon dates (Fig. 2; Hilton, 2000) relative to the major climate periods. The well-defined stratigraphy of the Mink Island site, coupled with the abundance and fine-preservation of the material makes possible analytical approaches that tie ^{14}C dates closely to biological material. Bivalve material is extremely abundant through time. Bivalve shells tightly associated with the targeted radiocarbon dates will be analyzed. During the excavation of the Mink Island site, fine-grained recovery techniques were used to ensure that the occupations surfaces were linked to the faunal refuse outside the lived-upon surfaces. All excavation surfaces, artifacts, and select faunal elements were 3-point provenanced for tight control, leading to an extremely well-defined stratigraphy. The abundance of the biological material, and the presence through time of some abundant modern species (e.g., *Saxidomus giganteus* and *Mytilus trossulus*) should facilitate consistent analytical approaches. We estimate that 20 different time strata will be targeted, with an estimate of 20 bivalves analyzed for each radiocarbon date. Sample sizes will be based on the variability revealed by the isotopic analyses, coupled with availability of material.

Preliminary testing of techniques will target recent material. Cross-sections of shells will be analyzed in order to integrate the temporal isotopic signal, since shells cannot be dated precisely (e.g., radiocarbon dating of house floors has some error associated with it [approx. ± 50-100 years], and variously shaped shell fragments may need to be analyzed). Additional preparation of shell material prior to isotopic analysis will be needed to remove inorganic carbonate. This makes the analyses more difficult, but still feasible (Schell, pers. comm.).

^{14}C Analysis: Information obtained by Southon et al. (1990) from radiocarbon dating of shells and associated wood from coastal sediments in British Columbia suggest similar values to the present for reservoir age for most of the samples. However, data from a radiocarbon age of around 6,400 BP give a markedly different reservoir age than the older samples, suggesting that Holocene ocean circulation was much more variable than previously thought. Analysis of shell data from the exposed Mink Island site, when compared with associated charcoal dating of occupied surfaces (the latter ^{14}C data already obtained), would provide another time series of ocean mixing variability and the relationship of upwelling patterns across changing climate patterns of the Holocene. Additionally, such a time series, when compared with the British Columbia data would provide a broader view of long-term ocean circulation and its variability. This type of analysis cannot be done except at exposed sites, such as the Mink Island site bordering the Shelikof Strait, that are affected by coastal upwelling. A set of bivalve samples (estimated n=40) that are closely linked to radiocarbon-dated charcoal (from occupied surfaces) will be analyzed for ^{14}C via accelerator mass spectroscopy (AMS).

H2: Changes in species composition, sizes, etc., of midden species assemblages reflect changes in climate, habitat, or human use patterns.

An ecological analysis of the archeological midden material may reveal changes in the species composition and structuring of the populations through time. The temporal patterns in relative species composition of shell material at the site will be examined. Based on review of the relative abundance of the most common species (Foster, 1998, 2000) and the condition of the material, size-frequency data will be collected on one or a few species. These patterns will then be compared to known climate trends and productivity information provided by the isotopic analyses. Since many of the species abundant at the site (e.g., *Mytilus trossulus*, *Saxidomus giganteus*) are common present-day organisms, an ecological analysis of species shifts may suggest changes in climate, changes due to habitat shifts (perhaps due to sea level changes wrought by tectonic activity), or changes in human use patterns. Analysis of midden fauna in other locales (e.g., relative species abundance or size structure of abalones in the Channel Islands) has revealed changes thought to be caused by shifting ocean climate (Glassow, 1993) or alterations in predation intensity (Douros, 1993). Interpretation of the human use patterns of the site will be incorporated into the analysis of climate, species abundances, and habitat changes in order to evaluate the observed biological changes as comprehensively as possible.

Cooperating Agencies, Contracts, and Other Agency Assistance

We will continue interaction and cooperation with researchers doing natural stable isotope analyses (Dr. Tom Kline, Prince William Sound Science Center; Dr. Don Schell, University of Alaska, Fairbanks). Contracts for natural stable isotope analysis are expected with the University of Alaska, Fairbanks. Another contract will be arranged for ^{14}C analysis via accelerator mass spectroscopy (AMS).

SCHEDULE

A. Measurable Project Tasks for FY03 (October 1, 2002- September 30, 2003)

Oct 1– July 31:	Data analysis
Feb. 10 - 14:	Present findings at American Society of Limnology and Oceanography, Salt Lake City, Utah
Apr. 15-Sept. 30:	Synthesis, manuscript preparation
Sept 30, 2003:	Submit Draft Final Report

B. Project Milestones and Endpoints

FY02: Natural stable isotopic analyses of recent (test) bivalves and archeological midden shells (delayed until FY03)
Radiocarbon (^{14}C) analysis of selected clam shells
Data analysis
Ecological analyses of composition/size structure of selected midden species

FY03: Natural stable isotopic analyses of recent (test) bivalves and archeological midden shells
Data analysis and synthesis, draft final report (Sept. 30, 2003), manuscript preparation

C. Completion Date

A draft final report will be produced by Sept. 30, 2003.

PUBLICATIONS AND REPORTS

A draft final report will be produced Sept. 30, 2003. Manuscripts for publication will be produced in FY03. Three manuscripts are planned: one focused on the relationship between isotopic composition of shells and major climate patterns over the last 7,000 years, a second focused on the ecological analysis of the midden material through time, and a third examining the implications of the ^{14}C analysis for long-term ocean circulation.

PROFESSIONAL CONFERENCES

I plan to present the ecological analysis of midden materials to the Ecological Society of America (FY02); these meetings are held in August of each year. In FY03, I plan to present a paper on the isotopic analyses to the annual meeting of the American Society of Limnology and Oceanography.

NORMAL AGENCY MANAGEMENT

The work involved in this project is not part of normal agency management.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

As the research proposed is very multidisciplinary in nature, we will be coordinating and integrating information with other researchers using stable isotopic analyses, especially those involved in retrospective analyses. Additionally, we will integrate our paleoecological analyses with available information from other appropriate archeological sites bordering the Gulf of Alaska.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

In response to scientific peer reviewer comments, we have added the following expertise to this proposal for FY03:

Paleoceanographer
Quaternary geologist (paleoclimatology)

Also, in FY02, because the NPS contract for identification of the lower midden material will not be completed until Sept. 30, we will be letting the analysis time for this material (3 months salary for a GS-9 Biologist) lapse. While this reduces the cost of this project in FY02, we are now requesting this salary time during FY03 to complete the analyses.

PROPOSED PRINCIPAL INVESTIGATORS

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Fax (949) 824-3874

PRINCIPAL INVESTIGATORS

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

Dr. Schaaf is Director of the Lake Clark-Katmai Studies Center of the National Park Service. She has organized and spearheaded the archeological excavations occurring over the last four years at Mink Island, Katmai National Park and Preserve. In her previous position as an archeologist in the Regional Office of the NPS, she was responsible for

managing the Shared Beringian Heritage Program, the National Archeological Survey Initiative Gulf of Alaska Coastal Survey and the Alaska region Cultural Sites Inventory. Jeanne has been both editor and author of publications concerning cultural traditions and archeological studies in Alaska.

Dr. Mann is a Research Associate at the University of Alaska, Fairbanks, with degrees in Anthropology, Forest Entomology, and Soil Science and Quaternary Studies. His research has focused on Holocene glacial histories, paleoclimate reconstructions, dynamics of coastal systems (geologic), dynamics of developing plant assemblages, and oil spill studies. He has published at least 12 papers on the paleoclimate of Alaska, with additional publications having different geographic focus.

Dr. John Southon is a researcher with the Earth System Science Department at the University of California at Irvine. Until recently he was head of the AMS Geosciences radiocarbon group at Lawrence Livermore National Laboratory. His research interests include uses of radiocarbon as a chronometer and a tracer for understanding the climate and carbon cycle of the past. An understanding of fundamental processes involved in past changes is essential for building a robust and credible predictive capability for any future variations. Since the subarctic North Pacific represents one end of the global ocean convection cell, understanding how air-sea gas exchange and ocean upwelling and advection processes determine ocean radiocarbon distributions in the region is of great interest. Southon has used natural radiocarbon archives such as shell and archaeological materials to study how these processes may have changed over time.

LITERATURE CITED

Altabet, M. A. and R. Francois. 1994. Sedimentary nitrogen isotope ratio as a recorder for surface ocean nitrate utilization. Global Biogeochemical Cycles 8:103-116.

Bidigare, R.R., A. Fluegge, K.H. Freeman, K.L. Hanson, J.M. Hayes, D. Hollander, J.P. Jasper, L.L. King, E.A. Laws, J. Milder, F.J. Millero, R. Pancost, B.N. Popp, P.A. Steinberg, and S.G. Wakeham. 1997. Consistent fractionation of ^{13}C in nature and in the laboratory: growth-rate effects in some haptophyte algae.. Global Biogeochemical Cycles 11:267-278.

Douros, W.J. 1993. Prehistoric predation on black abalone by Chumash Indians and sea otters. In: F.G. Hochberg (ed.). Third California Islands Symposium: Recent Advances in Research on the California Islands. Santa Barbara, California, pp. 557-566.

Foster, N. 1998. Fauna remains from the Mink Island XMK 030 shell midden. Report to the Lake Clark Katmai National Park and Preserve Studies Center, National Park Service, Anchorage, Alaska.

Foster, N. 2000. Shellfish remains from the Mink Island XMK 030 site, Katmai National Park, Alaska. Report to the Lake Clark Katmai National Park and Preserve Studies Center, National Park Service, Anchorage, Alaska.

Francis, R. C., S. R. Hare, A. B. Hollowed, and W. S. Wooster. 1998. Effects of interdecadal climate variability on the oceanic ecosystems of the NE Pacific. Fish. Oceanogr. 3:1-21.

Glassow, M.A. 1993. The occurrence of red abalone shells in Northern Channel Island archaeological middens: Implication for climatic reconstruction. In: F.G. Hochberg (ed.). Third California Islands Symposium: Recent Advances in Research on the California Islands. Santa Barbara, California, pp. 567-576.

Hare, S. R. and N. J. Mantau. 2000. Emperial indicators of climate variability and ecosystem response since 1965. Prog. Oceanogr. (in press).

Hilton, M.R. 2000. Environment and archaeology on the Upper Alaska Peninsula: Toward a better understanding of human ecology. Alaska Anthropology Association 27th Annual Meeting, Anchorage, Alaska.

Laws, E.A., B.N. Popp, R.R. Bidigare, M.C. Kennicutt, and S.A. Macko. 1995. Dependence of phytoplankton carbon isotope composition on growth rate and $[CO_2]_{aq}$: Theoretical considerations and experimental results. Geochim Cosmochim Acta 59: 1131-1138.

Mann, D. and T.D. Hamilton. 1995. Late Pleistocene and Holocene Paleoenvironments of the North Pacific Coast. Quaternary Science Reviews 14: 449-471.

Mann, D., A.L. Crowell, T.D. Hamilton, and B.P. Finney. 1998. Holocene geologic and climatic history around the Gulf of Alaska. Arctic Anthropology 35(1): 112-131.

Schell, D.M. 1998. Isotope ratio evidence of declining primary productivity in the Bering Sea. Testing Conceptual Models of Marine Mammal Trophic Dynamics Using Carbon and Nitrogen Stable Isotope Ratios, Final Report, pp 65-82. OCS Study MMS 98-0031. University of Alaska Fairbanks.

Schell, D. M. 2000. Declining carrying capacity in the Bering Sea: isotopic evidence from whale baleen. Limnology and Oceanography 45(2):459-462.

Southon, J.R., D.E. Nelson, and J.S. Vogel. 1990. A record of past ocean-atmosphere radiocarbon differences from the Northeast Pacific. Paleoceanography 5(2): 197-206.

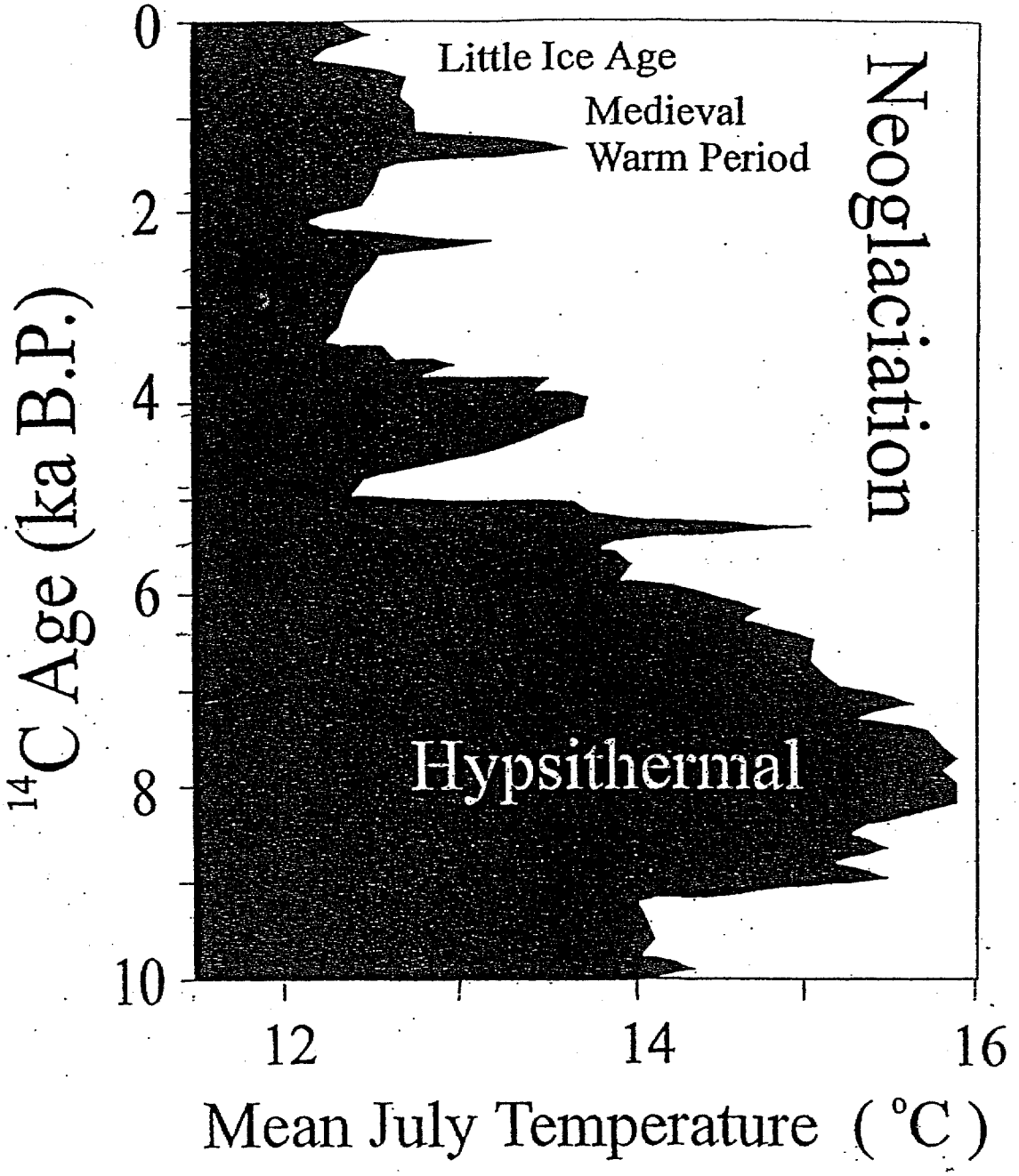
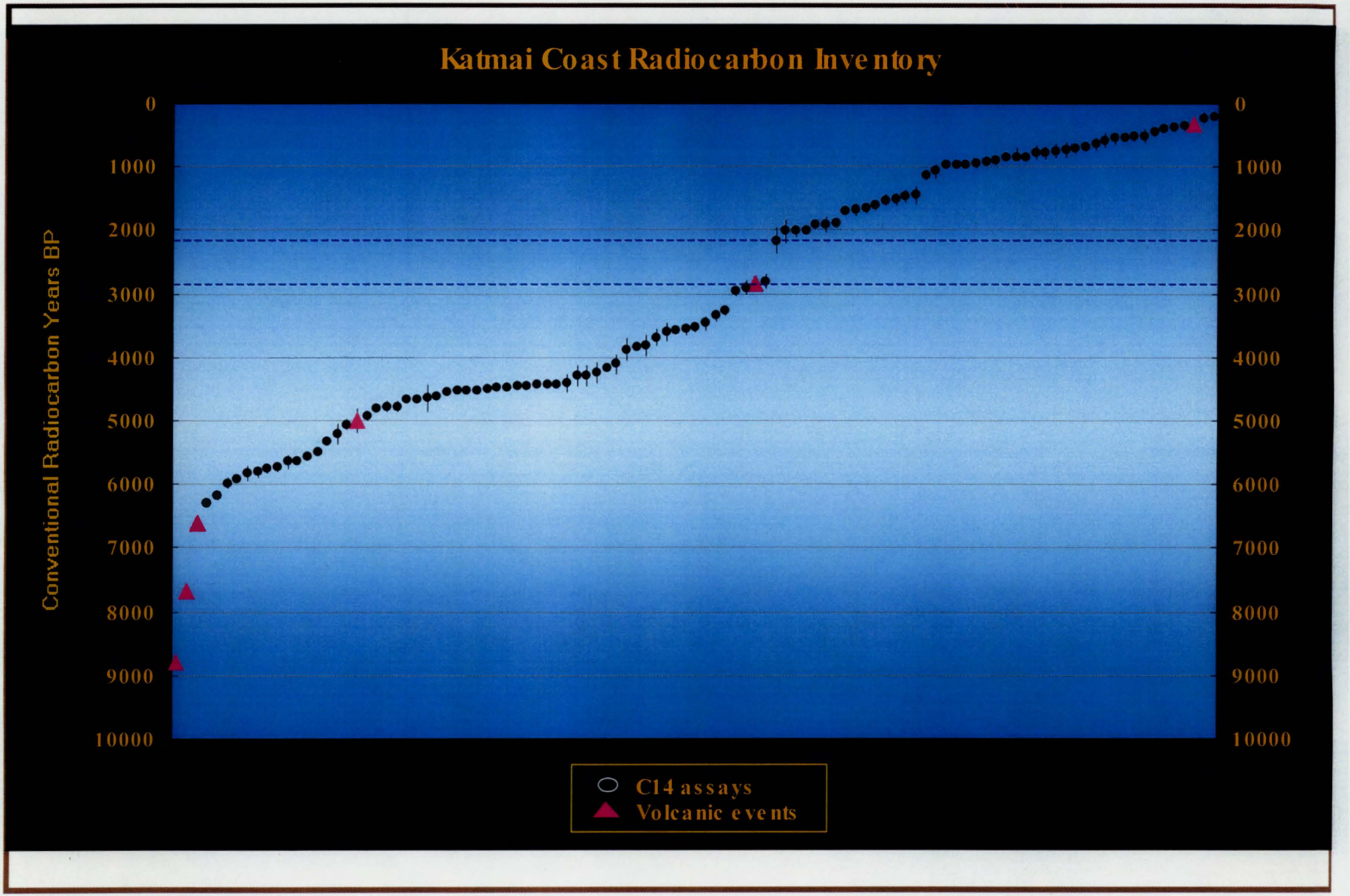


Figure 1. History of summer temperature in southern Alaska during the Holocene inferred from pollen transfer functions (redrawn from Heusser et al. 1985). The warmest period of the Holocene occurred between 9 and 6 ka, and was followed by Neoglaciation after 5-6 ka (from Mann et al. 1998).


Katmai Coast Radiocarbon Inventory
Conventional Radiocarbon Years BP
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
C14 assays
Volcanic events

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 2002	Proposed FY 2003	PROPOSED FY 2003 TRUSTEE AGENCIES TOTALS				
			ADEC	ADF&G	ADNR	USFS	DOI
							$56.3
Personnel	$48.4	$31.5					
Travel	$3.4	$2.6					
Contractual	$47.5	$15.2					
Commodities	$0.0	$0.0					
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS				
Subtotal	$95.1	$49.3			Estimated FY 2004		
General Administration	$10.0	$5.7					
Project Total	$105.1	$55.0					
Full-time Equivalents (FTE)	0.7	0.4					
	Dollar amounts are shown in thousands of dollars.						
Other Resources	$0.0	$0.0			$0.0	$0.0	

Comments:

Original projection of FY03 costs at $18K have been increased in response to scientific peer review comments suggesting the project would benefit from adding expertise in paleoceanography and paleoclimatology. The following additional costs have been added to this proposal:

Paleoceanographer: $4.7 K + $0.3K GA
Quaternary geologist (paleoclimatology): $10.5 K + $0.7 GA

In addition, since the NPS contract for identification of the lower midden material in FY02 will not be completed until Sept. 30, 2002, in FY02 we will be lapsing salary time for analysis of this material (GS-9 Biologist; $13.8 + $2.1 GA). We are requesting here this same salary projection ($15.9K), to accomplish this component of the project during FY03.

Federal salaries have increased 3.6%.

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Lead Agency: DOI--USGS

FORM 2A
MULTI-TRUSTEE
AGENCY SUMMARY

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 2002	Proposed FY 2003
Personnel	$44.2	$27.2
Travel	$3.4	$2.6
Contractual	$47.5	$15.2
Commodities	$0.0	$0.0
Equipment	$0.0	$0.0
Subtotal	$95.1	$45.0
General Administration	$10.0	$5.1
Project Total	$105.1	$50.1
Full-time Equivalents (FTE)	0.7	0.4
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Dollar amounts are shown in thousands of dollars.

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Agency: DOI-USGS

FORM 3B
Personnel
& Travel
DETAIL

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2003
Gail Irvine	Marine Ecologist	GS 12/9	1.5	8.9		13.4
Vacant	Biologist	GS 9/1	3.0	4.6		13.8
	Subtotal		4.5	13.5	0.0	
					Personnel Total	$27.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2003
Present results to American Society of Limnology and Oceanography Annual Meeting, Salt Lake City, UT					2.6
				Travel Total	$2.6

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Agency: DOI-USGS

FORM 3B
Contractual & Commodities DETAIL

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Contractual Costs:	Proposed
Description	FY 2003
	0.0
Research Work Order to UAF, Dan Mann	10.5
	0.0
Contract to Univ of CA Irvine, John Southon	4.7
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$15.2

Commodities Costs:	Inventory
Description	Agency
Commodities Total	

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Agency: DOI-USGS

FORM 3B
Equipment
DETAIL

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2003

Comments:

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Agency: DOI-USGS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 2001	Proposed FY 2003	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$4.3						
Travel		$0.0						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0						
Subtotal	$0.0	$4.3						
General Administration		$0.6						
Project Total	$0.0	$4.9						
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Agency: DOI-NPS

FORM 3B
Personnel
& Travel
DETAIL

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 2003
Jeanne Schaaf	Archeologist	GS 12/9	0.5	8.6		4.3
						0.0
	Subtotal		0.5	8.6	0.0	
					Personnel Total	$4.3

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 2003
				Travel Total	$0.0

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Agency: DOI-NPS

FORM 3B
Contractual & Commodities DETAIL

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

Contractual Costs:	Proposed FY 2003
Description	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	

Commodities Costs:	FY 2003
Description	
Commodities Total	

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Agency: DOI-NPS

FORM 3B
Equipment
DETAIL

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 2002	Proposed FY 2003	LONG RANGE FUNDING REQUIREMENTS					
Personnel	$9.1	$9.1						
Travel								
Contractual								
Commodities								
Equipment								
Subtotal	$9.1	$9.1						
Indirect	$1.4	$1.4						
Project Total	$10.5	$10.5						
Full-time Equivalents (FTE)	0.1	0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Indirect rate for USGS Research Work Orders with UAF is 15%

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Lead Agency: USGS contract to UAF

FORM 4A
Non-Trustee
SUMMARY

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2002
Dan Mann	Quaternary geologist: paleoclimates and geomorphology		1.0	9.1		9.1
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		1.0	9.1	0.0	
					Personnel Total	$9.1

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2002
						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

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Lead Agency: USGS contract to UAF

FORM 4B
Personnel
& Travel
DETAIL

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Contractual Costs:	Proposed FY 2003
Description	
Contractual Total	$0.0

Commodities Costs:	Proposed FY 2003
Description	
Commodities Total	$0.0

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Lead Agency: USGS contract to UAF

FORM 4B
Contractual & Commodities DETAIL

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2003
			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	

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Lead Agency: USGS contract to UAF

FORM 4B
Equipment
DETAIL

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Budget Category:	Authorized FY 2002	Proposed FY 2003	LONG RANGE FUNDING REQUIREMENTS					
Personnel		$3.1						
Travel		$0.0						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0						
Subtotal		$3.1						
Indirect		$1.6						
Project Total		$4.7						
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Indirect rate for University of California at Irvine is 51.5 %

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Lead Agency: USGS contract to Univ. of CA-Irvine

FORM 4A
Non-Trustee
SUMMARY

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FY 2003
John Southon	Paleoceanographer		0.3	10.3		3.1
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.3	10.3	0.0	
					Personnel Total	$3.1

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FY 2003
						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

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Lead Agency: USGS contract to Univ. of CA-Irvine

FORM 4B
Personnel
& Travel
DETAIL

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2002 - September 30, 2003

Contractual Costs:	Proposed FY 2003
Description	
Contractual Total	$0.0

Commodities Costs:	Proposed FY 2003
Description	
Commodities Total	$0.0

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Lead Agency: USGS contract to Univ. of CA-Irvine

FORM 4B
Contractual & Commodities DETAIL

2003 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2002 - September 30, 2003

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 2003
			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	

FY03

Prepared: April 8, 2002

Project Number: 03656
Project Title: A 6,300-Year Old Window into the Past...
Lead Agency: USGS contract to Univ. of CA-Irvine

FORM 4B
Equipment
DETAIL