96103-BAA

Whale Forestomach Anaerobic Microbes to Detoxify Oil Spills

OREGON STATE UNIVERSITY

COLLEGE OF VETERINARY MEDICINE

☐ Pre-Proposal ☒ Proposal

to

Exxon Valdez Oil Spill Trustee Council

Whale Forestomach Anaerobic Microbes to Detoxify Oil Spills

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Requested amount:	$350,810	Proposed Duration:	2 year
Cost Sharing:	n/a	Dates:	10/1/95 - 9/30/97

A. Morrie Craig Principal Investigator	Date	Norman E. Hutton Interim Dean	4-27-95 Date
for R. A. Scanlan Dean of Research	4/28/95 Date	R. L. Halvorsen Contract Administrator	4/28/95 Date

Project Title: Whale Forestomach Anaerobic Microbes to Detoxify Oil Spills Submitted Under the BAA

Project Number:	96103-BAA
Restoration Category:	Research
Proposer:	A. M. Craig - Oregon State University, College of Veterinary Medicine
Lead Trustee Agency:	
Cooperating Agencies:	
Duration:	2 years
Cost FY 96:	$171,131
Cost FY 97:	$179,679
Geographic Area:	
Injured Resource/Service:	Designated wilderness areas

ABSTRACT

Complete microbial bioremediation of oil spills in the environment is currently limited by oxygen availability. We have preliminary evidence that anaerobic bacteria from the forestomach of bowhead whales have the unique ability to metabolize a range of fuel oil components anaerobically. This project is to: isolate anaerobic bacteria or bacterial consortia responsible for this activity from this habitat, assess their ability to detoxify fuel-oil components, and optimize their growth for use in environmental bioremediation.

INTRODUCTION

The overall long-term goal of our research is the utilization of bowhead whale forestomach anaerobic microbes to aid in the restoration of marine coastal sites which are still contaminated with subsurface oil. The forestomach (rumen) of terrestrial ruminants frequently exposed to plant toxins has been a good source of anaerobic bacteria which detoxify harmful chemicals, particularly pyrrolizidine alkaloids and trinitrotoluene (Craig and Blythe, 1994; Craig et al. 1993a,b; Craig et al. 1992; Wachenheim et al., 1992a,b). Recently, sulphate-reducing bacteria in marine habitats are also responsible for some detoxification of alkanes (Rueter et al., 1994). The forestomach of bowhead whales is similar to the rumen of sheep and cattle, in that an anaerobic fermentation of the diet occurs before digestion in the rest of the alimentary tract. Sulphate-reducing bacteria are present which may have similar detoxification activities to those of marine origin. We have preliminary evidence that some marine pollutants are biodegraded by anaerobic microorganisms from this new, untapped source, the forestomach of bowhead whales. We now wish to further examine the biodegradation of fuel oils in the presence of these microorganisms, with a view to their utilization for bioremediation of the environment, particularly for use in anaerobic zones on beaches contaminated by oil spills.

Preliminary Research Utilizing Whale Forestomach Fluid

During the fall whaling season in both 1993 and 1994, through the cooperation of the North Slope

Borough Department of Wildlife Management and the Native Alaskan hunters, we were allowed access to freshly harvested bowhead whales from which we were able to obtain forestomach samples and colon samples. A portable anaerobic laboratory was set up at the Arctic Research Facility of the North Slope Borough's Department of Wildlife Management in Barrow. Supplies for the laboratory as well as personnel were flown to and from Barrow by Alaska Airlines. Whales were obtained at both Kaktovik and Barrow. Arco Oil supplied a twin-engine Otter plane with a chief pilot to fly our personnel to and from each of the whale harvest sites. In preliminary experiments, we tested the ability of the bowhead whale forestomach bacteria to metabolize a variety of marine pollutants ("target" compounds) under anaerobic conditions. These "target" pollutants included naphthalene, anthracene, PCB (2-chlorobiphenyl), alkanes (C10-C20), cholestane, TNT, picric acid, atrazine, and the group of aromatic hydrocarbons commonly known as BTXE (benzene, toluene, xylenes, ethylbenzene). The target pollutants were incubated with forestomach contents at 39° C in anaerobic synthetic-sea-water-based buffer for 1-2 weeks, with samples being taken after inoculation, at the midpoint, and at the end of incubation. Preliminary analysis indicated that samples from at least three different whales biodegraded one or more of the target pollutants. The compounds for which biodegradation was observed include naphthalene, 2-chlorobiphenyl and the BTXE compounds. We have these enrichment cultures in the laboratory for further examination. Confirmation that the forestomach was anaerobic was provided by the presence of volatile fatty acids; only in anaerobic fermentations are volatile fatty acids generated.

The initial research reported herein was partially funded by the Office of Naval Research (ONR). The objectives for the initial investigation were to see if "target" pollutants, representing the major classes of environmental contaminants, were degraded by the bowhead whale's forestomach microbes. The positive results obtained in these preliminary studies, the periodic contamination of cetacean habitats with fuel oils such as the *Exxon Valdez* spill, and natural leakage of oils from the north slope into river systems and subsequently the sea, have led us to focus our research on the ability of bowhead whale forestomach anaerobic microbes to metabolize the components of fuel oils.

NEED FOR THE PROJECT

A. Statement of Problem

Numerous resources and services have been harmed by the 1989 *Exxon Valdez* oil spill. The contamination of pristine wilderness areas by crude oil is continuing to effect the restoration of many of the biological resources in the area. Surface oil on many beaches has disappeared through aerobic microbial degradation, photo-oxidation, mechanical abrasion, and other means. The surface oil that does remain on some beaches has become stable and is showing little sign of degradation. Subsurface oil has also decreased at many sites since the oil spill, but some sites remain which are still heavily contaminated. Sites which have experienced the least decreases in subsurface oil are mainly in "low energy" areas (little wave action), and are located near the community of Chenega Bay. Safe, effective cleanup efforts of the still contaminated sites would assist in the restoration of the biological resources in the area. The research proposed herein would provide the foundation of knowledge necessary for future cleanup of these contaminated low energy sites utilizing whale forestomach anaerobic microbes.

B. Rationale

New sources of bacteria, particularly anaerobes, with biotransformational properties are needed for environmental bioremediation, and forestomach microbial populations are untapped sources of potentially useful anaerobic bacteria. Only terrestrial ruminants have been examined for that potential (Craig et al., 1993b; Wachenheim et al., 1992a&b). Bowheads are baleen whales (mysticetes) that have a three-stomach digestive system, while toothed whaled (odontocetes) have a monogastric gut system. The available information suggests that many aspects of baleen whale forestomach fermentation are similar, but not identical to, terrestrial ruminant forestomach fermentations (Herwig et al., 1984; Herwig and Staley, 1984, 1986). The baleen whale forestomach is structurally similar to that of terrestrial ruminant forestomachs, which are specialized for fermentation (Gaskin, 1978; Haldiman and Tarpley, 1993; Herwig et al., 1984; Stevens, 1988). Our work with ruminal flora combined with pilot studies discussed herein has provided evidence that forestomach bacteria are capable of useful anaerobic biotransformations. Bowhead whales are at the apex of a food chain (phytoplankton and zooplankton → krill → bowhead whale), where bioaccumulation of toxic chemicals is most likely because the animals consume large amounts of contaminated krill. Reports indicate that krill can contain up to 43 priority pollutants (Golovnya et al., 1982). At least eight research teams have detected levels of environmental contaminants in the blubber of toothed and baleen whales (Addison and Brodie, 1973; Byrne et al., 1985; Gaskin et al., 1974; Knap and Jickells, 1983; Martineau, et al., 1987; Massé et al., 1986; Saschenbrecker, 1973; Stone, 1992; Taruski et al., 1975). In particular, Geraci and St. Aubin (1990) measured high levels of naphthalene in small toothed whales (*Odontocetes*) but considerably lower levels of naphthalene in baleen whales (*Mysticetes*). Toxic chlorinated hydrocarbon residues have also been found in toothed whales (Addison and Brodie, 1973; Gaskin et al., 1974; Knap and Jickells, 1983; Martineau et al., 1987; Massé et al., 1986; Taruski et al., 1975), but not in bowhead whales from similarly polluted habitats (Bratton et al., 1993). Geraci et al. (1987) proposed that this difference in residue levels was due to differences in feeding patterns and habitats. As *Odontocetes* do not (as far as we know) have a fermentation forestomach, we propose that these differences may also be due to the different detoxifying abilities of each species of whales.

A simple calculation which takes into account relative size and position in the food chain shows that small odontocetes eat approximately the equivalent amount of krill (by consuming fish) as their larger cousin the mysticetes. If whales were rats, the amount of toxins they consume per day would exceed 100 times the amount which induces adenocarcinomas, kidney dysfunction, and lung neoplasms in rats, but veterinary pathologists have not observed these problems in bowhead whales (Geraci et al., 1987; Howard et al., 1983). In general, reports of cetacean tumors are infrequent (Geraci et al., 1987; Howard et al., 1983; Philo et al., 1993), though tumors have been reported in four out of thirteen beluga whales (a monogastric whale) stranded in polluted waters (Martineau et al., 1988). In contrast, only one tumor was found in over 130 bowhead whales over a nine year period (Migaki and Albert, 1980; Migaki et al., 1982; Philo et al., 1993). Initially we proposed that priority pollutants which cause these tumors are detoxified by forestomach anaerobic microbes. Preliminary findings have confirmed this hypothesis.

A unique set of circumstances has presented us with the opportunity to perform this research. This includes the ability to collect cetacean forestomach samples, a successfully operating portable anaerobic laboratory, staff with training and expertise in gastrointestinal tract (including forestomach) anaerobic bacterial isolation and culture, and analytical chemistry instrumentation and expertise with analysis for environmental contaminants. Specifically, the addition of Dr. Colin Orpin to our research team is of great benefit. His expertise as an anaerobic microbiologist adds great strength to our unit.

We are excited about our preliminary findings that environmental contaminants (naphthalene, BTXE and PCBs) can be biodegraded by anaerobic microbes and that the forestomach microbes in bowhead whales have adapted to combat pollutants in the Arctic environment. We believe a strong possibility exists that in the future these microbes may provide additional cleanup solutions to marine coastal environments, specifically those contaminated by oil spills such as the *Exxon Valdez*.

C. Summary of Major Hypotheses and Objectives

Anaerobic bacteria from the forestomach of bowhead whales are periodically exposed to fuel oil constituents and other marine toxins directly from the sea and through their diet. We have bacterial consortia from the bowhead forestomach which are able to destroy some monoaromatic compounds and also naphthalene, which occurs in crude oils. The probability exists that the same microbial population can also metabolize the other major components of fuel oils. These organisms may then be used to bioremediate environmental damage caused by fuel oils in difficult anaerobic situations.

Samples of forestomach digesta from the bowhead whale will be obtained in collaboration with the North Slope Borough Department of Wildlife. This digesta will be blended and used to inoculate enrichment bottles of anaerobic culture media containing the fuel oil components. The concentrations of fuel oil components in the inoculated media will be monitored quantitatively, and bacterial consortia transforming any components will be subcultured into fresh medium. Optimal conditions for the biotransformations will be elucidated, and individual consortium members isolated and tested for transforming the fuel oils components alone and in combination with other consortium members.

D. Completion Date

The reseach objectives proposed herein will likely be met in FY 97.

COMMUNITY INVOLVEMENT

Not applicable at this time.

FY96 BUDGET

Personnel	101.0
Travel	4.8
Contractual	0.0
Commodities	18.2
Equipment	0.0
Subtotal	124.0
Gen. Admin.	46.7
Total	170.7

PROJECT DESIGN

A. Objectives

In this project we are investigating a new source of microbes with the potential to aid in the cleanup of marine coastal environments. The overall long-term goal of our research is the utilization of bowhead whale forestomach microbes to aid in the restoration of marine coastal sites which are still contaminated with subsurface oil. To achieve this goal, several specific objectives must first be met:

1. To confirm that bowhead whale (*Balaena mysticetus*) forestomach bacteria biodegrade, transform, or detoxify components of fuel oil, including alkanes, aromatic hydrocarbons, polynuclear aromatic hydrocarbons and cholestane, and to identify degradation products (which may be more toxic than the original compound).

2. To isolate these potentially beneficial biotransforming bacteria or bacterial consortia from the bowhead forestomach and optimize the conditions required for biotransformation *in vitro* of the components of fuel oil.

Once these objectives have been met it will be necessary to develop an appropriate method to utilize these microbes in the restoration of marine coastal sites still contaminated with subsurface oil. This proposal does not address the development of specific utilization methods, but the demonstration that bowhead whale forestomach anaerobic microbes biodegrade components of fuel oils; that these bacteria can be isolated and their growth optimized for maximal degradation conditions. Future projects may take the form of introducing these microbes into a contaminated area, by using new enzymes from these microbes, or by some other method. The impact of whale's microbes could be far reaching.

B. Methods

<u>Methods for Objective 1</u>

Obtaining Samples

This proposal is designed to take advantage of a narrow window of opportunity provided to us by the cooperation of the North Slope Borough's Department of Wildlife Management (see attached letter), who assist in obtaining samples from the bowhead whales killed in the subsistence whaling by Native Alaskan hunters. Bowhead whales are traditionally harvested by Eskimos (Inupiat and Yupik) in late spring and fall in certain villages. In the fall of 1993, forestomach fluid was obtained from whales in both Barrow and Kaktovik (Figure 1). The samples were all obtained within 4-11 hours after the kill, with processing occurring within another 18-86 hours (Table 1). The logistics for obtaining whale samples was greater than

Figure 1. Whale harvest locations.

anticipated, but we were able to successfully collect and process samples. The credit for our success is due to the Department of Wildlife Management, help from concerned Eskimos, Arco Oil and Alaska Airlines. Logistics on the North Slope of Alaska at small Eskimo villages is non-trivial but possible with a team effort. We have made arrangements to be present in the fall of 1995 and the spring of 1996 when the whales are pulled onto the land and if needed make midline incisions so that we may obtain fresh forestomach contents. Samples of digesta will be removed and transported as soon as possible for processing and incubation at the North Slope Borough Department of Wildlife Management's Arctic Research Facility.

Table 1. Physical Properties of Forestomach Fluid Collected from Bowhead Whales in Fall, 1993.

Whale	pH	Redox Potential	Time Between Death & Ice	Time Between Ice & Processing
93KK2				
Solid	7.06	-220 mV	6 hrs	18 hrs
Liquid	6.0	-230 mV		
93KK3	6.5	-300 mV	4 hrs	18 hrs
93B18	6.3	-315 mV	11 hrs	85 hrs
93B21	6.53	-261.5 mV	10 hrs	86 hrs
93B23	6.37	-268 mV	6 hrs	66 hrs
93B17*	N/A	-265 mV	9 hrs	42 hrs

* Colon sample
N/A = not available
Ice = Sample removed from body of whale
Processing = Sample blended and incubated

Sample Processing

Preliminary arrangements have been made with the North Slope Borough Department of Wildlife Management, to again use their Arctic Research Facility in Barrow. Samples will be processed and incubated using a "portable anaerobic laboratory" (PAL), which consists of an anaerobic gassing system, anaerobic blender, incubator, balance, generator, refrigerator, and premeasured vials of anaerobic incubation media. Earlier use of PAL has involved the degradation of ergovaline alkaloids in cattle digesta, in the eastern Oregon high desert, and in Alaska in the fall of 1993 for the preliminary studies described herein.

Physical properties, such as pH, redox potential and temperature will be measured as soon as possible (see Table 1 for results from preliminary studies). At all times, samples will be kept anaerobic. Portions of digesta will be allocated into anaerobic blender containers, and the material will be blended with an anaerobic artificial seawater buffer, at high speed, for one minute. This method was optimal for testing biochemical activities of ruminal biotransformation of pyrrolizidine alkaloids (Craig, 1992; Wachenheim et al., 1992a,b). Additional portions of forestomach contents will also be blended, but these samples will be frozen with 20% glycerol as a cryoprotectant to minimize death of the forestomach population for subsequent work in Corvallis. Subsamples of whale forestomach bacteria will be preserved in formalin in order to examine the population as it exists in the animal, using direct microscopic observation. Several pounds of digesta will also be frozen for use in media and for microbial characterization.

Incubations

The blended digesta will be added (at 1% inoculum) to anaerobic vials, containing premeasured artificial seawater buffer with specific concentrations of pollutants. Four different classes of compounds will be studied which represent different fractions of fuel oils (Table 2). The group representing each individual class will be incubated separately. Enrichment incubations will contain one or more compounds from the specified group, while the biodegradation studies will contain the specified compounds. The vials will all be sealed with teflon stoppers, except for the set containing PAH compounds, which will be sealed with butyl-rubber stoppers lined with aluminum foil. All of the incubations will be performed in four sets of triplicates. The four sets will be a) viable with pollutants, b) viable without pollutants, c) sterile with pollutants and d) sterile without pollutants. The vials will be incubated for 2 weeks or longer at 39°C, and samples will be removed for analysis and frozen at the beginning of the incubation and at the end of the incubation. After incubation, the vials will have glycerol added as a cryoprotectant and frozen, so that any bacteria that transformed the pollutants can be examined further in the main laboratory at Oregon State University.

Table 2. Classes of Fuel Oil Components for Use in Biodegradation Studies with Whale Forestomach Microbes

BTXE Group	Alkane Group	PAH Group	Cholestane Group
benzene	C10 decane	benz[a]anthracene	cholestane
toluene	C11 undecane	fluoranthene	
ethylbenzene	C12 dodecane	naphthalene	
o-xylene	C13 tridecane	phenanthrene	
m-xylene	C14 tetradecane	anthracene	
p-xylene	C15 pentadecane	fluorene	
	C16 hexadecane	pyrene	
	C17 heptadecane		
	C18 octadecane		
	C19 nonadecane		
	C20 eicosane		

Chemical Analysis

Frozen samples will be transported by Alaska Airlines to Corvallis (Special arrangements have been made with Mr. Todd Wallace, Vice President of Alaska Airlines). After extraction, the fates of the various pollutants will be followed using appropriate chromatographic methods including GC/MS or GC with flame ionization detection (FID), high performance liquid chromatography, or thin layer chromatography at our analytical chemistry laboratory in Corvallis. In the preliminary studies, our samples contained 25% inoculum. As this whale forestomach fluid inoculum contains partially digested copepods and euphausiids, it is very high in lipids. The components of fuel oils are all hydrophobic in nature, and their extraction out of the oily whale forestomach fluid without extracting numerous interferences has initially proven to be challenging, and we are currently improving our extraction and analytical methods. Most of our methods have utilized liquid/liquid extraction, which has in some cases resulted in poor recovery rates (~50-65% for alkanes) as well as inconsistent results; improvements in liquid/liquid extraction have in some cases been obtained (i.e. ~90% for naphthalene), but other extraction methods will be investigated, including both solid phase extraction (SPE) and supercritical fluid extraction (SFE). A brief summary of the potential of these two extraction methods is described below, followed by specific extraction and analysis methods for each of the classes of compounds under investigation. Statistical analysis and quality control methods are also presented.

Solid phase extraction (SPE) is a method of extracting compounds from a liquid medium onto a sorbent. Ideally, interfering compounds either do not absorb onto the solid material, or they can be washed off using selective solvents. The compound of interest is then washed off the column, resulting in very selective extractions of highly purified and concentrated products for analysis. Several types of sorbents are available in SPE columns, ranging from highly polar to non-polar, as well as several types of ionic sorbents. Specifically, SPE columns containing silica gel have been used to separate diesel fuel into its various fractions (Bundt et al., 1991). Thus, separation of aliphatics (including alkanes), monoaromatics, diaromatics, and polyaromatics (PAH) can be achieved. SPE has also been used to cleanup extracts from lake sediments containing PAHs (Leeming & Maher, 1990). After the sediments were extracted with methylene chloride, the extract was passed through a silica gel SPE cartridge and the a C-18 SPE cartridge. This removes interferences and increases sensitivity. It is anticipated that a similar method may result in superior extraction of alkanes and/or PAHs from the whale forestomach samples. Due to the large number of potentially interfering compounds present in these samples, multiple extraction methods may be necessary. The wide variety of sorbents available, in combination with different solvents, offers high enough flexibility for us to anticipate success using this method.

Another potential extraction method is supercritical fluid extraction (SFE). SFE is a rapid, efficient, sensitive, selective, and quantitative technique for extracting many types of environmental pollutants from solid or liquid matrices (Houck & Levy, 1993). Supercritical fluids have high diffusion coefficients (similar to a gas) and viscosities between those of a gas and a liquid. These properties allow the mass transfer of solutes from the sample matrix into the supercritical fluid. Large volumes can be extracted and concentrated, providing maximum sensitivity. The most common supercritical fluid in use is carbon dioxide, which with the aid of modifiers (i.e. methanol), and good temperature and pressure control, can result in selective, quantitative extractions of purified compounds from complex matrices. SFE has been used to extract PAHs from soils, coal and biosludge, with excellent recovery and reproducibility (Hawthorne & Miller 1986; Lancas et al., 1991; Langenfeld et al., 1993; Levy et al., 1993). SFE has also been used to extract alkanes out of biosludge (Hawthorne & Miller, 1986). SFE could be performed at OSU to extract PAHs and/or alkanes from whale forestomach samples. Optimization of specific parameters would be necessary, but would result in highly purified extracts with removal of nearly all interfering compounds.

BTXE

The persistent components of gasoline that are most often the residue left from service station leaks are the BTXE compounds. The BTXE extraction and analysis described herein was developed in Dr. Lily Young's laboratory at Rutgers University to study the biodegradation of BTXE and other aromatic compounds in sediments, soils, effluents, sludges, and groundwater (Grbić-Galić & Young, 1985; Evans et al., 1990).

When samples are removed from the incubation vials, 1 ml aliquots will be placed directly into duplicate 1.5 ml glass vials containing 200 µg/ml fluorobenzene in 400 µl of pentane. The vials are capped with teflon/neoprene stoppers and frozen until the time of analysis. Fluorobenzene is the internal standard. After samples have been thawed they will be vortexed well, and then centrifuged for 5-10 minutes to separate the layers. The vials are placed directly in the GC autosampler which samples from the top layer. Analysis is on a DB-WAX column with the oven temperature being isothermal at 35°C. The injector and FID are at 250 and 300°C, respectively. For our preliminary studies, samples were extracted from both whale forestomach incubation media and pure water. Comparison of these results yields an average relative recovery (for all components) of 72 ± 2.3% ($\alpha = 0.05$). The relative standard deviations of benzene and toluene were 11 and 14%, respectively; the relative standard deviations of ethylbenzene and all the xylenes were each 20%.

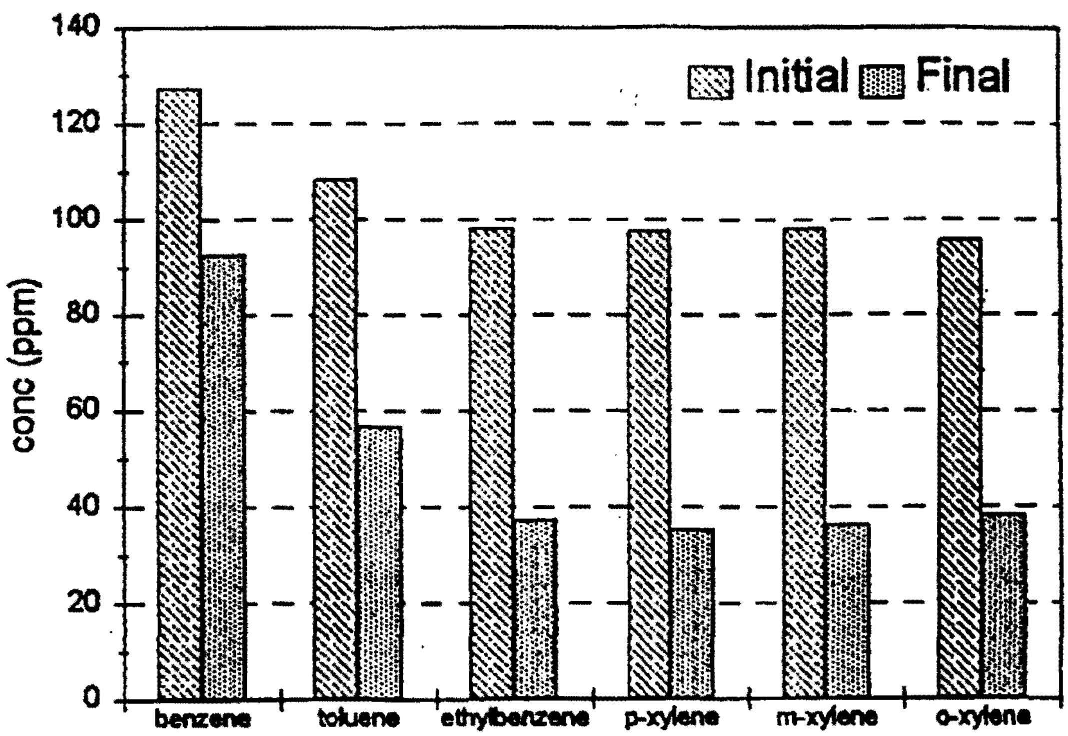

Figure 2. Results of GC/FID analysis of samples incubated with whale forestomach fluid and BTXE compounds. Initial = immediately after inoculation. Final = after one week of incubation.

In our preliminary studies with this analysis method, this group of aromatic hydrocarbons yielded positive biodegradation results. We found that after a two-week incubation period with only 1% inoculum, the concentration of the xylenes and ethylbenzene had decreased approximately 80%, while the concentration of benzene and toluene had each decreased approximately 30% (Figure 2). It is not unreasonable to consider that benzene and toluene would be intermediates in the degradation of xylenes and ethylbenzene. This could explain why after only two weeks of incubation, the lowest concentrations are seen for the xylenes and ethylbenzene. It should be noted that benzene and toluene are not building up to high concentrations, indicating that these compounds are also being degraded. Presumably, if the cultures were allowed to incubate longer, all of the BTXE compounds would be degraded.

Alkanes
The extraction and analysis used in our preliminary studies was modified from a method developed by Dr. Joe Suflita at the University of Oklahoma to study the biodegradation of hydrocarbons in sediments and groundwater (Mormile et al., 1994; Suflita & Mormile, 1993).

Duplicate 3-5 ml aliquots from each incubation vial are placed in 15 ml screw-top tubes with teflon lined caps. Methylene chloride (5 ml) is added and samples are vortexed and then rotated on a chemistry mixer for 3-24 hours. Samples are then centrifuged 5-10 minutes to separate the layers, and the organic layer is transferred to glass autosampler vials. Analysis is by GC/FID on an Rtx-5 column with the injector and detector temperatures being 200 and 250°C, respectively. The oven temperature held at 60°C for 3 minutes and then was programmed at 10°C/min to 250°C which was held for 3 minutes.

To date, this extraction method has resulted in recovery rates ranging from 50-65%. Improvements in this assay are currently ongoing and involve SPE techniques. It is anticipated that recoveries will be improved to 90%.

PAH
Polycyclic aromatic hydrocarbons (PAH) are cancer causing compounds found in crude oils. They are persistent in the environment and much attention has bee given to them by many researchers. The PAH extraction and analysis used in our preliminary trials was optimized for the light compound naphthalene. The overall recovery of naphthalene is 90%, and the assay is being tested and modified as necessary to achieve comparable recoveries for all of the chosen PAH compounds. In the preliminary experiments positive biodegradation results were obtained for naphthalene. We found that after a one-week incubation period with 25% inoculum, the concentration of naphthalene had decreased approximately

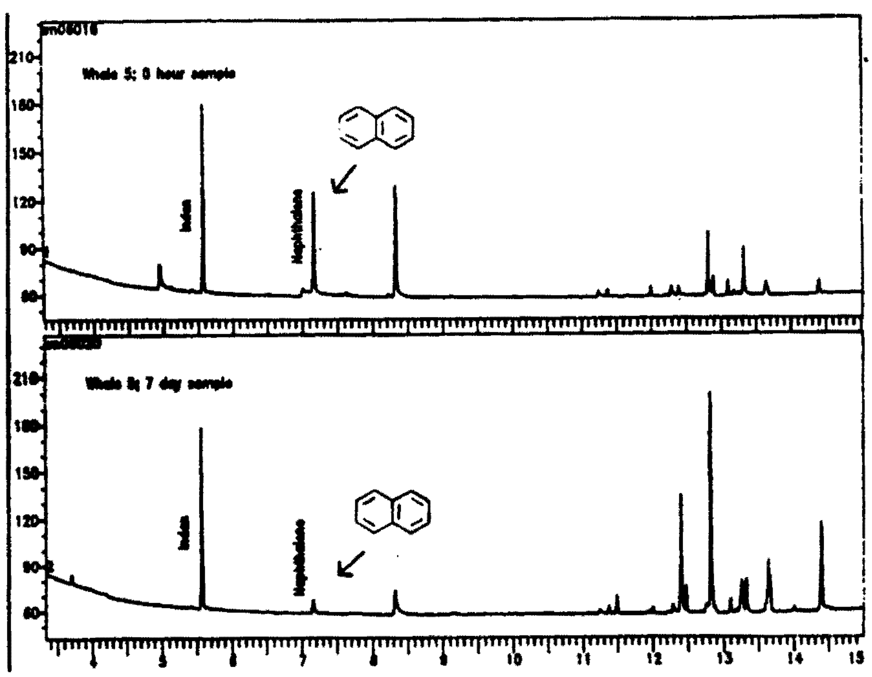

Figure 3. GC chromatogram of naphthalene extracted from whale forestomach samples. Internal standard is indan.

80% (Figure 3).

Duplicate 1 ml aliquots from each incubation vial are placed in 5 ml tubes. Indan is added (100 µl of 1 mg/ml) as the internal standard. Benzene (2 ml) is added and samples are vortexed well and then centrifuged 5-10 minutes to separated the layers. The organic layer is transferred to glass autosampler vials. Analysis is by GC/FID on an Rtx-5 column with the injector and detector being 270 and 300°C, respectively. The oven temperature held at 60°C for 2 minutes and then was programmed at 30°C/minute to 120°C, then at 10°C/minute to 160°C, and then at 30°C/minute to 300°C which was held for 5 minutes.

Cholestane

The cholestane samples are being analyzed by associates at EPA in Gulf Breeze, Florida. Preliminary results are not available at this time.

Statistical Analysis and Quality Control

To ensure the accuracy and precision of our data analysis; methods will be validated by several different procedures. To have confidence in a method, the percent recovery (of a batch of samples, n = 20-25) necessary is 70-120%, with a relative standard deviation of 20% or less. Whenever possible, an appropriate internal standard is utilized to compensate for differences in the extraction of individual samples. Standard solutions will be made in a matrix identical to that of all the samples. Samples, standards and matrix blanks will be treated identically throughout the extraction and analysis. To account for instrument drift over time, a set of standards is run at the beginning and end of the run and after every 20 samples. Peak areas are used for quantifying the compounds of interest using a best-fit linear regression of peak area vs. concentration. Statistical analysis includes linear-regression, parametric paired t-tests and SAS general linear models.

Methods for Objective 2

Where the *in vitro* incubations revealed biodetoxification ability, cryopreserved portions of appropriate cultures will be enriched by transferring through serial passages of medium containing the target chemical. At first, blended, sterilized digesta, collected in Alaska for use in media, will be used in the medium. Media similar to those described above will be further developed, so that the bacteria can be grown without whale digesta, and the subsequent enrichments with biodegradation capabilities will be plated out as described above to isolate the bacteria that are responsible for the biotransformations (Orpin & Joblin, 1988).

Enrichments with biodegradation capabilities will then be used in typical optimization experiments, similar to those we used earlier for PA and TNT biotransformation (Craig et al., 1992; Lee et al., 1994; Wachenheim et al., 1992b). Optimization is an iterative process wherein one substrate or additive is changed within the medium and evaluated as to whether it enhances growth and, for our purposes, improves or speeds up the biodegradation capabilities of the enrichment. Variations in the media that will be tested include nutrient composition (vitamins, yeast extract, tryptone), amendments (clarified whale juice, VFAs, hemin), redox state (cysteine), substrates (colloidal chitin, krill lipid extract, casein, pectin, xylose), etc. (Dehority & Orpin, 1988).

After ten subcultures under optimal conditions for biotransformation, the active bacteria in each enrichment will be sought. The mixed bacteria will be streaked onto biotransformation agar media under a CO_2/H_2 atmosphere in an anaerobic glove box. Individual colonies will be picked off and assessed for biotransformation ability, alone and mixed with the other members of the community. Individual organisms with biotransformation ability will be checked for purity, optimal conditions for biotransformation in pure culture determined, and characterized microbiologically using standard methodology (cellular morphology, gram stain, motility, oxygen relation, substrate profiles, and fermentation acids). Their biotransformation ability will also be assessed in the presence of other organisms isolated from the consortium to determine any synergistic effects, and the organisms providing maximal toxin destruction kept for latter assessment for survivability and activity in anaerobic soils and sediments.

C. Contracts and Other Agency Assistance

Not applicable

D. Location

The majority of the research will be done at Oregon State University, Corvallis, Oregon., with field work being conducted at Barrow, Alaska. Future projects utilizing the knowledge gained on this project, and the specific bacteria or bacteria consortia will follow the successful completion of this project. These future projects will involve the development of an appropriate method to aid in the cleanup of marine coastal environments, specifically ones still contaminated with subsurface oil from the *Exxon Valdez* spill. These contaminated sites, which are mainly low energy sites located near the community of Chenega Ba
would benefit directly from the development of effective cleanup methods utilizing whale forestomach anaerobic microbes.

SCHEDULE

A. Measurable Project Tasks for FY 96

Start-up to Oct. 1:	Arrange logistics for fall season field work (facilities, supplies, shipping, etc.)
Oct. 1 - Nov. 15:	Obtain forestomach samples and begin bioremediation incubations and enrichments
Nov. - Mar.:	Analyze samples from bioremediation incubations and determine what biotransformations are occurring
Dec. - Mar.:	Isolation of specific organisms and/or stabilize selected consortia with biotransformation capabilities
Mar. - Sept.:	Characterization of selected consortia, including optimizing conditions for biodegradation of specific fuel oil components Where biodegradation is occurring, analysis will be performed to identify products
Mar. - Apr.:	Arrange logistics for spring season field work (facilities, supplies, shipping, etc.)
May 1 - June 15:	Obtain forestomach samples and begin bioremediation incubations and enrichments
June - Sept.:	Analyze samples from bioremediation incubations and confirm results obtained with fall season samples
July - Sept.:	Continue work with specific oranisms or selected consortia
April 1997:	Annual report on FY 96

B. Project Milestones and Endpoints

Objective 1. Confirmation that bowhead whale (*Balaena mysticetus*) forestomach bacteria biodegrade, transform, or detoxify components of fuel oil, including alkanes, aromatic hydrocarbons, polynuclear aromatic hydrocarbons and cholestane, will be available by April 1996. The identification of degradation products, including both intermediates and endproducts, will begin at this time, and most likely will continue throughout FY 97.

Objective 2. The isolation of bacteria or bacterial consortia which biotransform components of fuel oils will be available by April 1996. Optimization of the biotransformation conditions will continue throughout FY 96, and be completed during FY 97.

C. Project Reports

April 1997: Annual report for FY 96 will address the confirmation that bowhead whale (*Balaena mysticetus*) forestomach bacteria biodegrade, transform, or detoxify components of fuel oil, including alkanes, aromatic hydrocarbons, polynuclear aromatic hydrocarbons and cholestane, and the isolation of the bacteria or bacterial consortia which are responsible for the biotransformation of fuel oil components.

April 1998: Final report will address the continued confirmation that bowhead whale (*Balaena mysticetus*) forestomach bacteria biodegrade, transform, or detoxify components of fuel oil, and the intermediates and/or endproducts which have been identified. Also, the isolation, characterization and optimization of bacteria or bacterial consortia responsible for the biotransformation of fuel oil components will be presented.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Not applicable at this stage of research.

ENVIRONMENTAL COMPLIANCE

Not applicable at this stage of research

PERSONNEL

A. Morrie Craig
BS in Mathematics, Ph.D. in Biophysics, Oregon State University. Professor in College of Veterinary Medicine, Oregon State University (1980-present). Held Predoctoral and Postdoctoral Fellowships in National Institutes of Health. Dr. Craig has unique capabilities and proven scholarship in three areas critical to the success of this project. These include analytical chemistry, anaerobic microbiology, and veterinary medicine. He has established a laboratory with state of the art equipment and highly trained personnel to complete the objectives.

Colin Orpin
B.Sc. (honors) in Biochemistry and Soil Science, Ph D. in microbial metabolism of pesticides in soil. Professor II in Biotechnology, University of Tromso, Norway (1986-91). He has spent some 26 years working in anaerobic microbiology, including culture, classification, biochemistry, genetics and molecular biology of rumen bacteria, fungi, protozoa and bacteriophages. Worked as consultant to the group in Tromso, Norway working on microbial aspects of digestion in minke whales, and on the ruminal metabolism of the plant toxins mimosine and indospicine (at CSIRO, Brisbane, Australia), and recently (at Oregon State University) on pyrrolizidine alkaloids.

A. Morrie Craig

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1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 199! tember 30, 1996

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FFY 1996
A. Craig	Principal Investigator		0.0	0	0	0.0
C. Orpin	Co-Principal Investigator		12.0	3,996	0	48.0
K. Walker	Medical Technician		12.0	1,852	0	22.2
J. Lotrario	Graduate Research Assistant		12.0	1,282	0	15.4
D. Gray	Graduate Research Assistant		12.0	1,282	0	15.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		48.0	8,412	0	
					Personnel Total	$101.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1996
Portland to Barrow, AK to collect samples	1,300	2	20	110	4.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.8

1996

Project Number:
Project Title: Whale Forestomach Anaerobic Microbes to Detoxify Oil Spills
Name: Oregon State University

FORM 4B
Personnel
& Travel
DETAIL

4/27/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	
HPLC systems with UV, flourescense or diode array detection	4	
Gas chromatographs equipped with autosamplers and an array of detectors	2	
A binary gradient HPLC with UV and 14C detection	1	
Finnegan 5100 GC/MS with EI, CI, and direct inlet capabilities	1	

1996

Project Number:
Project Title: Whale Forestomach Anaerobic Microbes to Detoxify Oil Spills
Name: Oregon State University

FORM 4B
Equipment
DETAIL

4/27/95

NORTH SLOPE BOROUGH
Department of Wildlife Management

P.O. Box 69
Barrow, Alaska 99723

: Central Office: (907) 852-2611 ext. 350
or (907) 852-0350
Arctic Research Facility: (907) 852-0352
FAX: (907) 852-0351

Warren Matumeak, Director

January 20, 1994

Dr. A. Morrie Craig
105 Magruder Hall
College of Veterinary Medicine
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Corvallis, OR 97331

Dear Dr. Craig,

This is a follow up to our recent phone conversations regarding our continuing to provide logistical support for your studies involving samples taken from Eskimo harvested bowhead whales. As discussed, we were pleased to assist your research group during their visit to Barrow this past fall (1993) to collect stomach contents from harvested bowhead whales. It is good to learn that the sampled materials have proven useful in your studies.

From our conversations, I understand that you are planning to continue the studies and are seeking support for your proposal "Biotransformation of hazardous wastes, using foregut bacteria from the bowhead whale". I have examined the draft proposal you sent to me and it seems a carefully considered continuation of your initial study. In your discussions with the prospective funding agency feel free to indicate to them that we will continue to provide logistical support to your project.

Our logistical support will include the following; 1) assistance in coordinating with Eskimo hunters in villages remote from Barrow, 2) direct support in Barrow, such as assistance in reaching harvested whales and obtaining samples, laboratory space (up to 300 square feet), lodging for project technicians (up to 3), and use of heavy clothing (boots, heavy coats and pants). The laboratory and lodging space noted above are within our departmental Arctic Research Facility (ARF) located here in Barrow. As in the past we expect your project's senior personnel to provide for their own lodging and meals at the nearby UIC-NARL Facility.

As you know, logistical support in an arctic area such as Barrow is critical to the success of research such as you are conducting. We will be pleased to continue to assist you as noted above, since we are vitally interested in learning more about the bowhead whale which is the most important subsistence use animal to the Eskimo people of the North Slope Borough. As discussed when we provide such logistical support we expect the contribution to be recognized in all reports, presentations and manuscripts resulting from the study. Since our support will be substantial we also expect the opportunity to review and comment upon such draft reports and manuscripts.

I hope this information is helpful and I wish you success in obtaining continued financial support for your research.

Sincerely,

Tom Albert

Thomas F. Albert, V.M.D., Ph.D.
Senior Scientist

96104

AVIAN PREDATION ON BLUE MUSSELS (*MYTILUS EDULIS*) IN PRINCE WILLIAM SOUND

Project Number:	96104
Restoration Category:	Research
Proposer:	Copper River Delta Institute, Pacific Northwest Research Station, U.S. Forest Service
Lead Trustee Agency:	U.S. Forest Service
Cooperating Agencies:	USFWS, UAF
Duration:	5 years
Cost FY 96:	$127.1
Cost FY 97:	$130.1
Cost FY 98:	$120.0
Cost FY 99:	$60.0
Geographic Area:	Prince William Sound
Injured Resource:	Sea otters, harlequin ducks, black oystercatchers, blue mussels

ABSTRACT

The nearshore vertebrate predator project, EVOS 95025, hypothesizes that prey availability and competition for prey such as blue mussels (*Mytilus edulis*) could be constraining recovery of sea otters and harlequin ducks. This project will document the impact of avian predators, including surf scoters, glaucous-winged gulls, black oystercatchers, and surfbirds on *Mytilus* populations at northwest Montague Island. Several thousand avian *Mytilus* predators occur each spring at this control site. This project will gather information on the numbers and distribution of avian predators, and how variable their use of *Mytilus* is.

INTRODUCTION

The Nearshore Vertebrate Predator Project (NVPP), EVOS 95025, hypothesizes that prey availability and competition for prey could be constraining recovery of sea otters (*Enhydra lutris*), river otters (*Lutra canadensis*), pigeon guillemots (*Cepphus columba*), and harlequin ducks (*Histrionicus histrionicus*). They suggest that important invertebrate prey species, including blue mussels (*Mytilus edulis*) have declined as a result of the *EXXON Valdez* oil spill. To test this hypothesis, the NVPP study will compare abundance and size-distribution of blue mussels in oiled areas (two sites at Knight Island) with those in unoiled areas (northwest Montague Island, from Port Chalmers to Graveyard Point). and determine the role of predation by sea otters and Barrow's goldeneye (*Bucephala islandica*) in structuring blue mussel populations. For the Barrow's goldeneye, stomach content analysis from collected wintering birds will be used to determine the abundance and size distribution of mussels in the diets. Complete counts of sea ducks will also be conducted at the Knight and Montague Island study sites to determine predation pressures (Holland-Bartels 1995).

Besides goldeneyes, black oystercatchers (*Haematopus bachmani*), glaucous-winged (GW) gulls (*Larus glaucescens*), surfbirds (*Aphriza virgata*), and surf scoters (*Melanitta perspicillata*) commonly forage on blue mussels in rocky intertidal habitat. Black turnstones (*Arenaria melanocephala*) and harlequin ducks also forage on mussels to a lesser extent. All of these species occur annually in relatively high numbers in the northwest Montague Island control area. Between Port Chalmers and Graveyard Point, GW gulls, surfbirds, surf scoters, and black turnstones occur in the thousands each spring, usually in association with Pacific herring (*Clupea pallasi*) spawn deposition (Bishop et al. 1995). Over the past 15 years in the Montague Island control area, spawn deposition has occurred during 13 years from Stockdale Harbor to Graveyard Point, and during 9 years from Port Chalmers to the south end of Stockdale Harbor. Currently EVOS 95166, Avian Predation on Herring Spawn, is examining the impact of avian predation on herring spawn. To date, however, no study in PWS has documented the impact of avian predators on the abundance and size distribution of blue mussel populations.

Previous studies outside of Alaska found that avian predators can significantly effect blue mussel size distribution. Marsh (1986) found that surfbirds, black oystercatchers, GW gulls and western gulls (*Larus occidentalis*) significantly reduced recruitment of juvenile mussels (mussels < 20mm) into populations inhabiting the outer Oregon coast. His exclosure experiments suggested that avian predation increases the patchiness of mussels in heterogeneous habitats, and decreases patchiness where habitat is sufficiently homogeneous. Wintering Eurasian oystercatchers (*Haematopous ostralegus*) in England removed 25% of the most productive size classes of blue mussels (30-60 mm) before they spawned (Goss-Custard and Durrell 1984) and selected larger mussels preferentially over smaller mussels (Cayford and Goss-Custard 1990).

In PWS three avian predators on *Mytilus* are common to abundant year-round residents: harlequin ducks, surf scoters, and GW gulls. These species are more numerous from mid-April through mid-May, due to an influx of migrants (surf scoters and GW gulls) or localized movements (harlequins). While harlequin ducks historically have wintered in the Port Chalmers-Graveyard Point area (S. Kendall, US Fish Wildlife Service, pers. comm.) large numbers of harlequins (>700) have also been documented between Graveyard Point and Montague Point as late as 15 May (Bishop et al. 1995). In PWS, approximately 12% of the harlequin diet consists of *Mytilus*; harlequins select mussels ranging in size from 5-15 mm (Patten et al. in review).

Approximately 50-100+ surf scoters have occurred regularly each March on two USFWS nearshore surveys in the northwest Montague control area. Large rafts of sea ducks, comprised primarily of surf scoters, occur regularly from late April through mid May. In 1989 and 1992 Martin (pers. comm.), recorded 1,500 and 600 surf scoters respectively during one day surveys of the northwest Montague NVPP control area. More recently, Bishop et al. (1995) documented 3,350-4,400 sea ducks in 1-3 rafts between Rocky Bay and Graveyard Point. Surf scoter diets at Montague Island have not been documented, although EVOS 95320Q will collect 20 surf scoters from herring spawn areas during May 1995. Patten et al. (in review) collected surf scoters in PWS between 1989-1990 and found Mytilus ranging in size from 10-40 mm in 38% (n=8) of the proventriculus samples. In British Columbia, Vermeer (1981) found that bivalves constituted the main food of surf scoters, except where herring eggs dominated the birds' diet in spring. Mytilus ranging in size from 6-40 mm were the primary prey and comprised 56-96% of the percent wet weight of prey items at four study locations. Daily net food consumption (minus shells) was estimated at 196 g/day.

Historically, large numbers of glaucous-winged gulls have been observed in areas with herring spawn at northwest Montague Island. Aerial surveys (n=3) conducted in spring 1994 by Bishop et al. (1995), documented gull numbers ranging between 15,600-25,700 prior to spawn initiation at Montague Island. Some 89-95% of the gulls were concentrated between Stockdale Harbor and Zaikof Bay where herring schools were located. Until now, GW gull diets have not been analyzed for PWS although EVOS 95320Q will be collecting 30 GW gulls feeding in herring spawn areas during May 1995. In Alaska, GW gull foraging behavior in the intertidal zone was investigated in the Aleutian Islands. Gulls concentrated foraging efforts in the lowest intertidal zones available and fed on a large variety of organisms: sea urchins, limpets, chiton, barnacles, and mussels (Irons et al. 1986). GW gulls swallowed whole *Mytilus edulis* ranging from 5-35 mm and selected larger, 20-35 mm blue mussels (Irons 1982). Sea otters appeared to effect GW gull foraging behavior in the Aleutian Islands. In areas where sea otters depressed invertebrate numbers in the intertidal zone, fish comprised a larger component of the GW gull diet (Trapp 1979; Irons et al. 1986).

Besides sea ducks and gulls, shorebirds are important *Mytilus* predators in PWS. Black oystercatchers are common throughout PWS in the summer and some remain year-round; 25% of the PWS breeding population remains in PWS in the winter. Two flocks numbering 40 and 30 black oystercatchers overwinter at Stockdale Harbor and Port Chalmers, . respectively (Andres 1994). In contrast to other Mytilus avian predators that swallow mussels whole, black oystercatchers stab gaping mussels and extract mussel meat from the shells. In PWS, mean size of Mytilus taken by breeding adults was 32.7 mm (n=1727, by shell collections (Andres and Falxa *in press*). While feeding observations on non-breeders are limited, Andres (unpubl. data) observed a flock of post-breeding oystercatchers in Port Chalmers foraging on Mytilus at a rate of 1.12 mussels/minute (n=15 birds, 82.8 minutes of observation) in August 1992.

Wintering ecology of black oystercatchers has not been studied in PWS. In British Columbia, flocks of wintering black oystercatchers fed exclusively on blue mussels ranging from 20-75 mm and tended to winter in areas of high mussel density. Birds moved among mussel beds in a predictable manner as they were exposed by a receding tide (Hartwick and Blaylock 1979).

In 1989, northern Montague Island was discovered to be a critical spring staging area for surfbirds and black turnstones (Norton et al. 1990; Martin 1994). Total numbers using the Montague area are not known, however, in May 1992 a single day count of almost 56,000 surfbirds and 25,000 black turnstones was recorded. As many as 11,460 surfbirds have been recorded at one time in the Stockdale Harbor area, 3,500 at Port Chalmers, and 20,352 around the Graveyard Point area (P. Martin, USFWS pers. comm.). Both surfbirds and black turnstones show a positive association with the presence of herring spawn (Bishop et al. 1995). Both species, however, have also been observed in high numbers in areas on northern Montague Island without herring spawn.

Whereas black turnstones are generalists, preying on mobile crustaceans, polychaetes, and infrequently on mussels (Connors 1968), mussels typically comprise a large portion of the surfbird diet. Martin (1994) and Bishop (unpubl. data) analyzed esphogagus contents from 12 and 8 surfbirds respectively collected while feeding in herring spawn areas at northern Montague. Blue mussels ranging from 4-15 mm were found in 90% (n=20) of the samples. In a study of surfbird diet in southern Chile, Navarro et al. (1989), found that mussels (*Semimytilus algosus* and *Perumytilus purpuratus*) predominated in the diet. Medium-sized mussels 6-12 mm were frequent, with 12-20 mm rare.

The importance of *Mytilus* in providing a high-energy food resource for migrant surfbirds has also not yet been determined. Compared to herring spawn, (0.9 Kcalories per gram of dry weight)(Sidwell 1981) , *Mytilus* has five times the caloric amount (4.8 Kcal/g) (Irons 1982). Whereas herring spawn may provide a ephemeral food source in most years, for some migrant surfbirds staging on northern Montague Island, *Mytilus* may be the most important source of energy to replenish fat reserves for their continuing migration.

NEED FOR THE PROJECT

A. Statement of Problem

The Nearshore vertebrate predator project (NVPP), EVOS 95025, hypothesizes that prey availability and competition for prey could be constraining recovery of sea otters (*Enhydra lutris*) and harlequin ducks (*Histrionicus histrionicus*). They suggest that important invertebrate prey species, including blue mussels (*Mytilus edulis*) have declined as a result of the *EXXON Valdez* oil spill. For the NVPP study to test their hypothesis that prey availability and competition for prey are constraining recovery of sea otters and harlequin ducks, NVPP needs to document the impact of these additional avian predators (surf scoters, GW gulls, black oystercatchers, surfbirds, and black turnstones) on *Mytilus* populations at the northwest Montague Island NVPP control site. To date we have no information on numbers and distribution of avian predators in the control area, nor how predictable or how variable their use of *Mytilus* is.

B. Rationale

Currently, data on mussel predation will be collected at the two NVPP study sites for only wintering sea ducks. As stated in the NVPP proposal, the wintering sea duck predation data, invertebrate prey abundance and size class information, and sea otter diet information will be used to determine the extent of mussel population structuring by sea duck predation and its potential confounding with sea otter mussel population structuring.

However, this approach overlooks the possibility of short-term massive predation on *Mytilus* at the control area each spring by the thousands of avian predators as well as sustained predation by wintering flocks of black oystercatchers. Given the potential or known predominance of *Mytilus edulis* in their diets, these birds could significantly decrease mussel density, decrease recruitment into larger size classes, and influence the overall distribution of *Mytilus* in the control area. At the same time, given the association of many of these species with herring spawn (Bishop et al. 1995), changes in the availability or location of herring spawn could lead to different foraging strategies of *Mytilus*. In areas with herring spawn, there could be higher predation on *Mytilus* due to the increased presence of birds attracted to the spawn.

The resources to be studied by this project are the avian predators on blue mussels (black oystercatchers, glaucous-winged gulls, surfbirds, black turnstones, surf scoters, harlequin ducks). Blue mussels, harlequin ducks, and black oystercatchers were injured species as a result of EVOS. Ecologically, blue mussels are an important forage base for large number of invertebrates, sea otters, and birds, including black oystercatchers and harlequin ducks.

C. Summary of Major Hypotheses and Objectives

Our research hypotheses are:

1. Avian predation significantly reduces mussel abundance in size classes <35 mm.

2. Avian consumption of blue mussels is a function of mussel density.

3. Mussel abundance and size class distribution will vary by year and with the dispersion of herring spawn. In years when herring spawn occurs in the Montague Island control area, mussel abundance will decrease due to increase presence of avian predators.

4. Patterns of mussel size class distribution are correlated with foraging habitats of avian predators.

5. The energetic value of *Mytilus* is greater than the energetic value of herring spawn provided to migrant surfbirds.

The objectives of this study are:

1. Determine the distribution and abundance of overwintering black oystercatchers, and each spring for surfbirds, black turnstones, glaucous-winged gulls, mew gulls, surf scoters, and harlequin ducks at the northwest Montague control site.

2. Determine rates of food intake and size selection in mussel beds for each species.

3. Evaluate the extent to which species-specific differences in distribution and foraging habitats are important in spatial variations in mussel population structure.

4. Determine and compare the contribution of *Mytilus* and Pacific herring spawn to energetic needs of migrant surfbirds.

D. Completion Date

This project is proposed to be in conjunction with EVOS 95025, the Nearshore Vertebrate Predator Project (NVPP). The expected duration of NVPP is 5 years. There will be winter and spring field seasons for 1996-1997. In December 1997, a full review of the first two years of NVPP will be conducted to assess the status of species recovery. Should all test species suggest recovery, the project would be recommended to move into final data analysis and report. It is more likely, however, that a full 1998 field season will be warranted, with full analysis and project completion by October 1999.

COMMUNITY INVOLVEMENT

To the extent possible, this project will hire local residents to assist with this project. This project would be part of the Nearshore Vertebrate Predator Project (NVPP). The NVPP was presented at January 1995 Trustees sponsored Restoration Workshop in Anchorage. This project would participate in any plans for community involvement that NVPP has.

FY 96 BUDGET

Personnel	73.9
Travel	4.0
Contractual	27.4
Commodities	8.8
Equipment	0
Subtotal	114.1
Gen. Admin.	13.0
Total	127.1

PROJECT DESIGN

A. Objectives

1. Determine the distribution and abundance of overwintering black oystercatchers, and each spring for surfbirds, black turnstones, glaucous-winged gulls, mew gulls, surf scoters, and harlequin ducks at the northwest Montague control site.

2. Determine rates of food intake for each species in mussel beds.

3. Evaluate the extent to which species-specific differences in distribution and foraging habitats are important in spatial variations in mussel population structure.

4. Determine and compare the contribution of Mytilus and Pacific herring spawn to energetic needs of migrant surfbirds.

B. Methods

1. Study area

The study area consists of the NVPP control study area at northwest Montague Island from Port Chalmers to Graveyard Point. Over the past 15 years, high densities of herring spawn deposition has occurred during 13 years from Stockdale Harbor to Graveyard Point, and during 9 years from Port Chalmers to the south end of Stockdale Harbor.

2. Data collection

a. Distribution, Timing, and Abundance of Avian Predators in Spring

The extent and substrate type of foraging areas used by wintering black oystercatchers in Port Chalmers will be delineated through boat shoreline surveys in November and early March. For each spring, the distribution, timing, abundance and species composition of birds foraging on *Mytilus edulis* beds will be determined using boat shoreline surveys. Shoreline surveys for surf scoters, harlequins, gulls, and shorebirds will be conducted by boat. Availability of mussels and size class distribution will be documented by the Mussel component of the NVPP study, EVOS 95025. The extent and distribution of herring spawn occurring in the control area's mussel beds will be documented from daily aerial flights conducted as a regular part of ADF&G commercial fisheries management.

Boat shoreline surveys will be conducted from 8 April (approximately one week prior to estimated initial herring spawn deposition) and will continue through 25 May. The survey will be conducted at low tide when the maximum amount the intertidal zone is available for foraging. The shoreline between Graveyard Point and Port Chalmers will be surveyed every other days, weather permitting.

An area within 120m of shore will be surveyed with the boat running a course 20m from shore at approximately 5 knots. The shoreline will be surveyed using methods adapted from the

USFWS marine birds and mammal surveys (USFWS 1991). While the boat is moving along the survey route, all birds are counted within the space that extends 100m on the seaward side, 20m+ on the shoreward side, 50m ahead, and 100m above the boat. One observer will be assigned to survey from the boat to shore, and the other from the boat seaward 100m.

Species surveyed include surf scoters, barrow's goldeneyes, harlequin ducks, surfbirds, black turnstones, GW gulls, and mew gulls. In 1994 spring, 1-3 large rafts of seaducks (estimates ranging from 500-3500 birds in each raft, primarily scoters and oldsquaw) were observed outside the survey boundaries (120-500m off shore). For the 1996 field season, all rafts of seaducks will be recorded whether or not they fall within the boundaries of the 120m survey area. Data collected for all boat surveys will include: number and species (or genus), location, herring spawn (presence, absence) shoreline type (exposed wave-cut platforms, gravel beaches, sheltered tidal flats), habitat (mussel bed, all other land, water, air), and behavior (forage, rest, fly). Locations of observations will be recorded on aerial photos using mylar overlays. Data will be recorded on Husky data loggers with Dictaphone voice recorders as a backup system. Data logger files will be downloaded onto a computer harddrive and diskettes.

b. Avian Mussel Consumption

Focal animal and scan observations will be used to determine the effects that surfbirds, black turnstones, GW gulls, and black oystercatchers have on mussel populations. Foraging observations of oystercatchers will be conducted in Port Chalmers, Montague Island during 10 days in early November 1995 and 10 days in early March 1996. For other species, observations will be from mid-April through 20 May at sites between Port Chalmers and Graveyard Point.

Foraging behavior of avian species in relation to blue mussel abundance and distribution across the intertidal zone will be determined from scan sampling and focal animal observations (Altmann 1974) of flocks around sites previously sampled for mussels by EVOS 95025 (see EVOS 95025 for description of mussel sampling). Wintering oystercatchers tend to frequent the same mussel beds (Hartwick and Blaylock 1979). Observations for oystercatchers will be in areas frequented, whether or not they were previously sampled for mussels by EVOS 95025.

Scan samples of flocks in spawn areas will provide information on distribution and activity of birds in relation to mussel bed density estimates (provided by EVOS 95025). The scan sample plot will be 50 x 100m, extending seaward from the upper boundary of the intertidal zone. Daily scan observations will be collected from a camouflaged blind every 30 minutes over a 6 hour period (1 tidal cycle) or 4 hours period (black oystercatchers only). For each scan sample, the following information will be recorded: habitat (rocky wave-cut platforms, gravel beaches, sheltered tidal flats), number and species of birds by activity, and their location in relation to the tideline. Activity classes include foraging and non-foraging. Location of foraging birds will be recorded as meters above or below the tideline.

In between scan samples, focal animal sampling (Altman 1974) will be used to gather information on food intake rates and mussel sizes taken. Individuals in foraging flocks will be randomly selected for observations; each focal individual will be observed for a minimum of 20 min or until the bird is lost. Activity (foraging, foraging while swimming, swimming, walking, flying, comfort, and rest), tidal zone location, substrate, and time intervals from the start of the foraging bout and between each prey attack will be recorded. When the focal animal discovers a prey item, the species and size (scaled to tenths of the bill) of the prey taken will be recorded. Size determination of musssels taken by oystercatchers is determinable in the field (Andres 1991, Cayford and Goss-Custard 1990).

In spring 1995 diets of avian Mytilus predators in the control area will be determined by collecting birds foraging in mussel beds. Collections will occur between 25 April and 15 May. Depending on the results from the collections made in 95320Q up to 20 birds of each species will be taken: GW gulls, mew gulls, surfbirds, and scoters. Birds will be shot from foraging flocks in mussel beds. Samples wil be removed from the digestive tract and stored in alcohol. Diet analysis will consist of sorting and identifying samples and quantifying: length, width, and wet mass of each item and wet mass, volume, and dry mass of each taxa per sample.

c. Exclosure Experiments

To directly assess the effect that avian predators have on mussel density and size distribution, we will exclude predators from a portion of the mussel bed. Ten exclosure-control pairs will be located in 1-3 primary foraging areas for black oystercatchers in Port Chalmers (the exact number will depend on the distribution and intensity of use by the foraging flock). In mid-March an additional 15 sites will be selected at Stockdale Harbor-Graveyard Point area. Treatment units will consist of a square exclosure, 50 x 50 cm, fixed 15 cm above the mussel bed. The exclosure "roof" will be made of 1.5-2cm wire mesh. The exclosure will have open sides to allow access to sea-star, whelk and crab predators but will exclude avian predators.

Exclosures will be randomly selected within the broad mid-intertidal zone on sheltered tidal flat shorelines of Port Chalmers. A control will be paired 2 m perpendicular to the tidal fall line with each treament unit. A 2m separation from the exclosure would ensure than foraging birds will use control sites. Exclosures will be placed on shorelines at the end of the November observation period. In early March, and again in mid-May after departure of spring migrants, all mussels will be counted and measured from treatment and control sites. Mussels will be collected from a central 30 x 30 cm area of all treatment and control pairs. A 10 cm buffer strip should elimnate effects of oystercatchers feeding on the periphery of exclosures. Ten random, 30 x 30 cm samples (not treatment-control areas) will be collected from each foraging area in November, March and May.

d. Mytilus contribution to Surfbird Migration

Total *Mytilus* contribution to surfbird energy requirements will be estimated using methods adapted from Castro and Myers (1993) study of shorebird predation on horseshoe crab eggs (*Limulus polyphemus*) at Delaware Bay. Three values must be determined: number of bird days in mussel beds, total energy requirements, and proportion of energy requirements derived from mussels. Surfbirds will be mist-netted near roosting areas and color banded. Based on resightings during boat shoreline surveys in the control area, a length of stay (bird days) will be determined. Estimates of total energy requirements (basal or field metabolic rate) will be modified from studies of similar species. Gut contents from surfbirds collected on spawn areas during spring 1995 will be compared with gut contents from surfbirds collected on mussel bed areas with no spawn. Gut contents will be analyzed for frequency of occurrence and dry weight of prey items. Energy values per average unit prey item will be determined from laboratory analyses or from previous studies.

3. Data analysis

Estimates for numbers and species composition for avian predators will be based on boat shoreline surveys. Bird days for each species will be calculated. Using data from boat surveys, the timing and abundance of avian predators in mussel beds will be graphically represented by plotting abundance by calendar date. Estimates of avian abundance between survey days will be interpolated.

A multivariate regression analysis will be performed to determine the relationship between bird densities and: shoreline type, location, mussel abundance (provided by mussel component of 95025) and presence or absence of herring spawn (provided from ADF&G aerial survey data),

Samples of mussel prey will be collected to construct length-weight regressions of observered lengths to mussel biomass. Because mussel weight may change between November and March, samples will be collected during each period. Numerical and biomass information will be used to determine seasonal consumption of mussels for each species. Comparisons of size selection of mussels by wintering individuals to that of breeding individuals will be made for black oystercatchers.

Size-frequency distributions of mussels will be compared using chi-square statistic between exclosures, controls, and wherever possible between areas previously sampled by 95025 to determine the impact of avian predators. Analysis of variance will be used to compare mussel abundances between exclosures and controls.

The total *Mytilus* ingested by surfbirds will be calculated using the following equation modified from Castro and Myers (1993):

$$\text{Total Mytilus Ingested} = (FMR * B * P_s) / C_s$$

FMR = field metabolic rate (kJ/day)
B = Total number of days per surfbird at northern Montague
P_s = Proportion of energy acquired from Mytilus
C_s = caloric content of Mytilus (kJ/g)

Modified field metabolic rates (FMR) will be based on weight differences between species (Kendeigh 1970). Basal metabolic rate (BMR) for Surfbirds will be based on equations developed by Kersten and Piersma (1987). The BMR will be multiplied by 2.5 to estimate the field metabolic rate of migrating shorebirds (Drent and Piersma 1990). Field metabolic rate per day will be multiplied by the number of bird days (based on resightings) at northern Montague to calculate the total energy required for each surfbird.

From surfbird gut contents collected during EVOS 95320-Q, number and size class of prey items will be averaged for each prey type to determine mean proportion in the diet. The energetic value of different prey items will be estimated from size/dry weight relationships and caloric values of edible body parts. Size to dry weight relationships will be estimated from data in Irons (1982). An oxygen bomb calorimeter will be used to determine energy (Kcal/g) of edible body parts. From these values, we will determine the proportion of energy derived from Mytilus, P_s.

4. Literature Cited

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C. Contracts and Other Agency Assistance

The U.S. Fish and Wildlife Service is a cooperating agency with this project. Brad Andres, a biologist with USFWS in Anchorage will conduct all field research and analysis on wintering black oystercatchers. Andres was the principal investigator for research on EVOS projects on black oystercatchers from 1990-1993.

Dr. Dan Roby, Assistant Unit Leader with the Alaska Cooperative Fish and Wildlife Research Unit at University of Alaska will be contracted to determine and compare the contribution of *Mytilus* and Pacific herring spawn to energetic needs of migrant surfbirds. S. Patrick Green will will conduct this portion of the study in fulfillment of his masters thesis requirement. Green has served as field supervisor for EVOS 95320Q Avian Predation on Herring Spawn and is familiar with this project's goals and logistics.

D. Location

The study area consists of the NVPP control study area at northwest Montague Island from Port Chalmers to Graveyard Point.
If herring spawn distribution requires moving our base of operations to the northwestern shore of Montague Island, we will establish a field camp at Stockdale Harbor (our 1994 base of operations). Parts of our alternate field camp will be placed at the beginning of the field season.

SCHEDULE

A. Measurable Project Tasks for FY96

Start-up	Receive mussel availability data from 95025
Start-up -April 1	Arrange logistics (boats, supplies, contracts)
Nov. 10-20	Field work on wintering black oystercatchers at Montague Island
Dec. 31	Complete cooperative agreement with Univ. Alaska Fairbanks
March 1-10	Field work on wintering black oystercatchers
	Hire personnel, order field supplies,
April 1-7	CPR/First Aid, and Boat Safety training
April 8-May 25	Field data collection
May 1	Complete Detailed Project Description for FY97
May 25-Sept 30	Data entry, diet analysis, begin data analysis
November 30:	Data analysis completed
April 1997:	Annual report on FY 96 work

B. Milestones

Objectives:

1. Determine the distribution and abundance of overwintering black oystercatchers, and each spring for surfbirds, black turnstones, glaucous-winged gulls, mew gulls, surf scoters, and harlequin ducks at the northwest Montague control site.

   Field work winter and spring 1996, 1997, 1998.
   Objective met 1999.
2. Determine rates of food intake and size selection in mussel beds for each species.

   Field work winter and spring 1996, 1997.
   Objective met 1998.

3. Evaluate the extent to which species-specific differences in distribution and foraging habitats are important in spatial variations in mussel population structure.

   Field work winter and spring 1996, 1997, 1998.
   Objective met 1999.

4. Determine and compare the contribution of *Mytilus* and Pacific herring spawn to energetic needs of migrant surfbirds.

   Field work spring 1996, 1997.
   Masters thesis submitted August 1998.

C. Project Reports

This project will be conducted as part of EVOS 95025 and will follow their reporting schedule. In April 1997 it will submitted the 1996 Progress Report along with all other project components.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

No federal or state agency program currently exists that could be described as an ecosystem framework for studying resources in Prince William Sound and the EVOS region.
For this project, all aspects of field work for this project are coordinated with EVOS 95025, the Nearshore Vertebrate Predator Project. Our study site is located at the northwest Montague Island control site for EVOS 95025. Information on harlequin duck, surf scoter, and barrow's goldeneyes numbers from boat shoreline surveys will be provided for the Sea Duck 95025 study. Data will also be provided on the size and species of invertebrates found in gut contents of gulls, scoters, surfbirds, and black turnstones. We will provide densities and species composition of birds in mussel beds as well as our estimates of mussels. All data from this project will be archived by the project staff in accordance with standardized procedures set up for handling the NVPP database. The field results from the avian predation study will be

integrated into the NVPP's numerical and analytical models of the PWS ecosystem that include predation parameters and animal distributions.

Each spring we will also coordinate closely with Alaska Department of Fish and Game Herring Natal Habitats (EVOS Project 95166). Information on herring spawn deposition including herring egg densities will be obtained from diver surveys. ADF&G commercial fisheries management will provide information on the timing and extent of spawn in the control area documented from ADF&G aerial spawn surveys.

During FY96 the Copper River Delta Institute will contribute resources in the form of personnel costs for the Project Leader (2 months in-kind) and Assistant Project Leader (1 month in-kind) as well as some field equipment (one inflatable skiff with motor, camping supplies). Ongoing spring shorebird migration studies on the Copper River Delta will provide additional information on the phenology and habitat use of surfbirds and black turnstones.

Other agency contributions to this project include equipment loans from the Cordova Ranger District, Chugach National Forest: one weatherport, one wall tent, and access to their administrative cabin at Port Chalmers.

ENVIRONMENTAL COMPLIANCE

This study primarily involves observations and infrequent collection of birds. A scientific collecting permit will be applied for with the US Fish and Wildlife Service and the State of Alaska to collect the gulls, waterfowl, and shorebirds. This study qualifies for a categorical exemption from the requirements of the National Environmental Policy Act.

PERSONNEL

<u>Project Manager,</u> Jim Sedell (U.S. Forest Service, Pacific Northwest Research Station, Corvallis Forestry Sciences Laboratory): Ensures that project deadlines are met by the project leader. Jim Sedell is the Program Manager for the Aquatic/Land Interaction program of the Pacific Northwest Research Station, U.S. Forest Service. The Copper River Delta Institute and its research program is a major component of the Aquatic/Land Interaction program.

<u>Project Leader,</u> Mary Anne Bishop: Oversees the project and coordinates with other members of the NVPP. Is responsible for project design, contract management, data analysis and completion of final products and data integration into NVPP models. Will conduct some field work. Bishop received a B.B.A. from University of Wisconsin in 1974, a M.S. in Wildlife and Fisheries Sciences from Texas A & M University in 1984, and her Ph.D. in Wildlife Ecology from the University of Florida in 1988. Dr. Bishop has been principal investigator for studies on cranes, swans, and shorebirds. She is the Principal Investigator for EVOS 905320Q, Avian Predation on Herring Spawn. Since 1989, Dr. Bishop has worked for the Pacific Northwest Research Station of the U.S. Forest Service including since April 1990 as the research avian ecologist with the Copper River Delta Institute in Cordova Alaska. Since 1994 she has worked for the Copper River Delta Institute through a cooperative agreement between the Center for

Streamside Studies, University of Washington and the Copper River Delta Institute. Bishop also served as the Institute's Acting Manager from May 1992 through April 1993.

Assistant Project Leader and Field Supervisor, S. Patrick Green: During the field season will be responsible for planning, data collection and logistics in the field. Responsible for purchasing equipment and organizing safety training for crew. Will be primary observer on boat shoreline surveys and on 100 x 300m transects. Post season duties include data compilation and analysis. S. Patrick Green received his B. Sc. in Wildlife Resources from West Virginia University in 1990. Since 1990 he has worked for the U.S. Forest Service first as a technician and then as a field supervisor at the Copper River Delta Institute in Cordova Alaska. For the past 3 years, he has been involved with the Copper River Delta Spring shorebird ecology study both in the field and as a data analyst. Green will enter the Masters program at Univ. Alaska-Fairbanks in June 1996 and will become the Masters student on the project.

Wildlife Biologist and Statistician, Larry Byrne. Will assist with data analysis. Byrne has a MS in Wildlife from University of Alaska Fairbanks and a MS in Statistics from Oregon State University. Before coming to the Copper River Delta Institute in December 1994, Byrne worked for several years as a statistician for Alaska Biological Resources.

Mary Anne Bishop, Ph.D

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/s/

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April 28 1995

April 28, 1995

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996	PROPOSED FFY 1996 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
						$119.9	$7.2	
Personnel	$0.0	$73.9						
Travel	$0.0	$4.0						
Contractual	$0.0	$27.4						
Commodities	$0.0	$8.8						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$114.1	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration	$0.0	$13.0						
Project Total	$0.0	$127.1	$130.0	$120.0	$60.0	$60.0	$0.0	0.0
Full-time Equivalents (FTE)	$0.0	$1.7						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	0.0

Comments:

Project would be a component of 96025, Nearshore Vertebrate Predator Project

1996

Project Number: 96????
Project Title: Avian Predation on Blue Mussels
Agency: Copper River Delta Institute, Pacific Northwest Research Station, USFS

FORM 2A PROJECT DETAIL

Prepared:

5/1/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel		$68.5						
Travel		$3.0						
Contractual		$27.4						
Commodities		$8.8						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$107.7	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration		$12.2						
Project Total	$0.0	$119.9	$130.0	$120.0	$60.0			
Full-time Equivalents (FTE)		1.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Project would be a component of 96025, Nearshore Vertebrate Predator Project

1996

Prepared:

Project Number: 96????

Project Title: Avian Predation on Blue Mussels

Agency: Copper River Delta Institute, Pacific Northwest Research Station, USFS

FORM 3A
AGENCY
PROJECT
DETAIL

5/1/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
	M.Bishop	Principal Investigator	GS-12-03	6.0	6071		36.4
	L.Byrne	Statistician	GS-09-01	3.0	2883		8.6
	P.Green	Bio. Technician	GS-07-01	6.0	2312		13.9
		Bio. Technician	GS-07-01	2.0	2312	500	5.1
		Bio. Technician	GS-05-01	2.0	2000	500	4.5
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		19.0	15578	1000	
Those costs associated with program management should be indicated by placement of an *.						**Personnel Total**	68.5

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
*	Cordova to Fairbanks (meet with UAF Contractors)	456	2	6	138	1.7
	Cordova to Anchorage (meet with NVP Cooperators)	224	2	6	138	1.3
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					**Travel Total**	3.0

1996

Project Number: 96????
Project Title: Avian Predation on Blue Mussels
Agency: Copper River Delta Institute, Pacific Northwest Research Station, USFS

FORM 3B
Personnel
& Travel
DETAIL

5/1/95

1996 EXXON VALDEZ TRUS... COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Contractual Costs: Description	Proposed FFY 1996
Air charter flights to transport staff to field site (12 hrs. at $250/hr)	3.0
Vessel Charter to Montague Island (2 @ $1000)	2.0
Contract with Univ. of Alaska-Fairbanks, Coop. Wildlife Research Unit	20.0
Shipping of samples	0.1
Publication/page charges	0.5
Communications (long distance phone & fax charges)	1.0
Training (CPR, First Aid, Cold water survival, Marine Safety)	0.8
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	27.4

Commodities Costs: Description	Proposed FFY 1996
Office supplies (copy paper, copier/laser printer cartriges & toner)	0.5
Sample bottles & bags	0.5
Personnell Equip. [rain gear (4 @ $110), waders (3 @ $48), immersion suit ($300), deck suits (2 @ $200), gloves (4 @ $12)]	1.3
Fuel [gasoline (350 gal @ $1.45), fuel oil (75 gal. @ $1.60 gal.), propane (20# @ $2.30/#), fuel barrels (2 @ $45)]	0.8
Software upgrades ($600)	0.6
Whaler repair, upgrade, and storage (fiberglassing, motor repair, tarp frame, general repairs, $600)	0.6
Exclosures (100 @ $25/ea.)	2.5
Food (3 persons for 40 days at $15/person/day)	1.4
Food (2 persons for 20 days at $15/person/day)	0.6
Commodities Total	8.8

1996

Project Number: 96????
Project Title: Avian Predation on Blue Mussels
Agency: Copper River Delta Institute, Pacific Northwest Research Station, USFS

FORM 3B
Contractual &
Commodities
DETAIL

5/1/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Whaler, 17'	1	USFS
Computer, 486	1	USFS
Zodiac	1	USFS
Outboard, 20hp	1	USFS

1996

Project Number: 96????
Project Title: Avian Predation on Blue Mussels
Agency: Copper River Delta Institute, Pacific Northwest Research Station, USFS

FORM 3B
Equipment
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel		$5.4						
Travel		$1.0						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$6.4	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration		$0.8						
Project Total	$0.0	$7.2	$8.0	$9.0	$5.0			
Full-time Equivalents (FTE)		0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Wildlife Biologist, Brad Andres will conduct two, 10 day field trips. USFS will arrange logistics and provide technicians.

1996

Prepared:

Project Number: 96????
Project Title: Avian Predation on Blue Mussels
Agency: US Fish and Wildlife Service

FORM 3A
AGENCY
PROJECT
DETAIL

5/1/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
	B.Andres		GS-11	1.5	3600		5.4
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		1.5	3600	0	
Those costs associated with program management should be indicated by placement of an *.						Personnel Total	5.4

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
	Anchorage to Cordova	224	2	4	138	1.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					Travel Total	1.0

1996

Project Number: 96???
Project Title: Avian Predation on Blue Mussels
Agency: US Fish and Wildlife Service

FORM 3B
Personnel
& Travel
DETAIL

5/1/95

Contractual Costs:	Proposed
Description	FFY 1996
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	0.0

Commodities Costs:	Proposed
Description	FFY 1996
Commodities Total	0.0

1996

Project Number: 96??
Project Title: Avian Predation on Blue Mussels
Agency: US Fish and Wildlife Service

FORM 3B
Contractual &
Commodities
DETAIL

5/1/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1996

Project Number: 96??
Project Title: Avian Predation on Blue Mussels
Agency: US Fish & Wildlife Service

FORM 3B
Equipment
DETAIL

5/1/95

Herring Bay Monitoring and Restoration Studies

Project Number:	96106
Restoration Category:	Closeout, Report Writing
Proposer:	Stephen Jewett
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	University of Alaska
Duration:	1 October 1995 - 30 September 1996
Cost FY96:	219,100
Injured Resource/Service:	Intertidal Eelgrass Community

ABSTRACT

The purpose of this project is to provide funds to write the final report for project 95106. The budget reflects projected costs of sample analysis, data analysis, and report preparation. The final report will incorporate and compare all data collected since 1991.

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel		$5.2						
Travel		$0.0						
Contractual		$228.3						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$233.5	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration		$16.8						
Project Total	$0.0	$250.3	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)		0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

This budget was revised on 7-19-1995 to incorporate revisions to the budget described in the letter from Molly McCammon to Stephen Jewett. In his response, Mr. Jewett presents two options: 1) No changes to the existing budget and incorporating the newly negotiated 25% overhead rate, ($250.3K), 2) Dropping the hemosiderosis analysis on selected nearshore forage fish and incorporating the newly negotiated 25% overhead rate ($236.9K). This budget reflects option 1. In both options ADF&G program manager cost now meet the one month per project program manager charge.

Please note that neither option has officially gone through the University budget office for signature. Mr. Jewett will push the selected option through as soon as he returns from the field in early August.

1996

Prepared:

Project Number: 96106
Project Title: Subtidal Monitoring: Eelgrass Communities - CLOSEOUT
Agency: AK Dept. of Fish & Game

FORM 3A
AGENCY
PROJECT
DETAIL
7/19/95
Revised

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
*	11-7064	Fishery Biologist III	18C	1.0	5,203		5.2
*	11-6110	Librarian II	17J	0.0	5,530		0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		1.0	10,733	0	
Those costs associated with program management should be indicated by placement of an *.						**Personnel Total**	$5.2

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					**Travel Total**	$0.0

1996

Project Number: 96106
Project Title: Subtidal Monitoring: Eelgrass Communities - CLOSEOUT
Agency: AK Dept. of Fish & Game

FORM 3B
Personnel
& Travel
DETAIL

7/19/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Contractual Costs:	Proposed
Description	FFY 1996
Contract with non-trustee agency	228.3
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$228.3

Commodities Costs:	Proposed
Description	FFY 1996
None	
Commodities Total	$0.0

1996

Project Number: 96106
Project Title: Subtidal Monitoring: Eelgrass Communities - CLOSEOUT
Agency: AK Dept. of Fish & Game

FORM 3B
Contractual &
Commodities
DETAIL

7/19/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
None			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
None		

1996	Project Number: 96106 Project Title: Subtidal Monitoring: Eelgrass Communities - CLOSEOUT Agency: AK Dept. of Fish & Game	FORM 3B Equipment DETAIL

7/19/95

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel		$117.8						
Travel		$4.8						
Contractual		$57.0						
Commodities		$3.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$182.6	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
Indirect		$45.7						
Project Total	$0.0	$228.3	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)		25.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1996

Project Number: 96106
Project Title: Subtidal Monitoring: Eelgrass Communities - CLOSEOUT
Agency: Contract

FORM 4A
Non-Trustee
DETAIL

Prepared:

7/19/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Personnel Costs:

Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1996
S. Jewett	Principal Investigator		7.0	7,803		54.6
Technician	Technician		5.0	5,133		25.7
Technician	Technician		4.0	4,908		19.6
Student Asst. II	Student Asst. II		4.0	571		2.3
Lab Asst. II	Lab Asst. II		5.0	3,129		15.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		25.0	21,544	0	
					Personnel Total	$117.8

Travel Costs:

Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FFY 1996
R/T Fairbanks - Anchorage	300	2	7	170	1.8
R/T Fairbanks - San Diego	800	2	12	115	3.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.8

1996

Project Number: 96106
Project Title: Subtidal Monitoring: Eelgrass Communities - CLOSEOUT
Agency: Contractor

FORM 4B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 1996
Subcontract to Coastal Resources Association - Data analysis/report	35.0
HC analysis - approximately 70 samples	7.0
Long distance phone, fax	0.5
Hemosiderosis analysis - approximately 165 samples	10.0
Sediment analysis - approximately 75 samples	4.5
Contractual Total	$57.0

Commodities Costs:	Proposed
Description	FFY 1996
Laboratory Supplies - Chemical Reagent	3.0
Commodities Total	$3.0

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	
None		

1996

Project Number: 96106
Project Title: Subtidal Monitoring: Eelgrass Communities - CLOSEOUT
Agency: Contractor

FORM 4B
Equipment
DETAIL

7/1[illegible]/95

ASSESSING THE EFFECTS OF THE EXXON VALDEZ OIL SPILL ON MUSSELS AND FISH: A NEW TECHNIQUE USING HIGH RESOLUTION STABLE ISOTOPE RECORDS FROM SHELLS AND OTOLITHS

Project Number:	96108-BAA
Restoration Category:	**Research, Monitoring**
Proposer:	**Dr. Scott J. Carpenter, University of Texas at Dallas**
Lead Trustee Agency:	**ADFG**
Cooperating Agencies:	**NOAA**
Duration:	**2 years**
Cost FY 96:	**$ 83,988**
Cost FY 97:	**$ 84,898**
Cost FY 98:	**$ 0**
Cost FY 99:	**$ 0**
Cost FY 00:	**$ 0**
Cost FY 01:	**$ 0**
Cost FY 02:	**$ 0**
Geographic Area:	**Prince William Sound**
Injured Resource/Service:	**Mussels, Pacific Herring, Rockfish, Intertidal Organisms**

ABSTRACT

Small portions of fish otoliths and mussel and barnacle shells will be sampled to provide a chemical record of the effects of the *Exxon Valdez* Oil Spill on the mussel and fish and populations of Prince William Sound. This will produce a near bi-weekly record of environmental conditions following the oil spill. These findings will be used to assess the degree of initial and ongoing contamination of these resources. These new techniques will provide a detailed indicator of both natural and anthropogenic stressors on these organisms and will increase our knowledge of their physiological activity (e.g., growth rate, spawning, food source variations and disease).

INTRODUCTION

A. Statement of Problem

Mussel and fish populations were severely injured by the *Exxon Valdez* Oil Spill. The mussel population is recovering, yet in many cases, is still contaminated. The fish population (herring, rockfish, salmon) have not recovered. Monitoring of these organisms is needed to assess to what extent *Exxon Valdez* Oil is persisting as an environmental stressor. In addition, there is a relatively poor understanding of the life histories of these organisms (e.g., growth rates, migration patterns, metabolic activity, etc.). To better understand how these organisms are recovering, a broader understanding of these processes is needed. Long term (5 to 10 year) chemical records which record pre- and post-spill conditions within individual organisms are needed to monitor the long term effects of oil contamination.

B. Rationale

The proposed work involves both monitoring and research. The chemical data obtained from these materials will provide data on: 1) the long term effects of the oil on the different organisms and 2) the normal (non-oiled) physiology and activities of these organisms. These efforts will compliment current and past research programs as it will utilize some materials already collected. Information gained from this study will augment current research as it may provide constraints on the organisms' life processes which have been poorly understood (e.g., growth rates, migration patterns, metabolic activity).

Micro-sampling of skeletal carbonates will yield a monitoring method with bi-weekly to monthly resolution of environmental conditions. In addition, long term (5 to 10 year) chemical records which record pre- and post-spill conditions within individual organisms can be obtained. These data will monitor the long term effects of oil contamination.

C. Summary of Major Hypotheses and Objectives

Oil is ingested by fish and metabolized. *Exxon Valdez* oil has a carbon isotope composition that is distinct from un-oiled marine plankton. The isotopically distinct carbon should be passed on to the composition of fish otoliths. By sampling otoliths across the 1988-1995 time interval, we will monitor the degree to which contamination was and is affecting fish populations. Oxygen isotope compositions will provide data on temperature and salinity of ambient seawater and therefore allow estimation of migration patterns during this time period. The composition of otoliths from both diseased and healthy fish will be measured to establish baseline differences within the different populations.

Mussels and associated barnacles have been heavily contaminated in some locations. To avoid killing contaminated mussel beds, oil was not removed from these beds. Therefore contamination is an ongoing problem at several sites. It is thought that mussels do not metabolize oil. On the other hand, barnacles may have that ability. Carbon isotope ratios of co-occurring mussel and barnacle shells will be used to test these hypotheses and to monitor oil-induced changes in metabolic activity. Oxygen isotope ratios from shells will also be used to determine water temperature and salinity changes which can affect shell growth. *Mytilus edulis* samples collected in 1993 from heavily oiled locations of Prince William Sound have growth rates that are approximately one third that of oil-free samples from Puget Sound. This diminished growth rate may be the result of oil contamination, food availability or natural stressors. We plan to measure the concentration of magnesium, strontium and cadmium in shell growth increments to quantify growth rates. Sampling across the 1988-1995 time interval in mussel and barnacle shells from oiled and non-oiled locations will establish a long term, high resolution monitor of the effects of oil on mussel shell growth and metabolic activity. Shells from heavily oiled locations will be examined to determine how much oil has been trapped in the shell during growth. This oil can potentially be extracted and analyzed for determination of its source.

The shells of living mussels and barnacles from selected sites will be notched and collected after one year of growth. During this year, water samples will be collected on a monthly basis to monitor local conditions (temperature, salinity, isotopic compositions, degree of oil contamination). Animals will then be harvested and shells analyzed for comparison with previously collected water data.

D. Completion Date

This project will be completed during the 1998 FY. Sample collection and analytical work will be conducted during the 1996 and 1997 FY.

COMMUNITY INVOLVEMENT

Collection of samples for monitoring will involve the assistance of area residents, members of the ADFG and the NOAA laboratory. Assistance in water and mussel bed monitoring will be needed.

FY 96 BUDGET

Personnel	29.2
Travel	8.0
Contractual	15.5
Commodities	5.0
Equipment	0
Subtotal	57.7
Gen. Admin.	0
Indirect Costs (45.5%)	26.2
Total	83.9

PROJECT DESIGN

Introduction

Most skeletal carbonates record incremental growth through the interlayering of organic matter and $CaCO_3$ or by abrupt changes in calcification style and/or rate. These increments correspond with daily to sub-monthly time periods (e.g., Lutz and Rhoads, 1980; Bourget, 1980; Pannella, 1980). Biologists and environmental chemists have not utilized this persistent, temporal record to monitor pollution in marine and estuarine sites. Instead, the tissues of sentinel organisms (i.e., bivalves) have been monitored to assess contamination by hydrocarbons and heavy metals (e.g., Lee et al., 1972; Koide et al., 1982; Borchardt, 1985; Short and Babcock, in submission). These materials do not provide a detailed historical record of contamination for a given location or region. Furthermore, the residence time of some toxins in tissue may be on the order of a few weeks to months (e.g., Morse et al., 1993). As a result, constant monitoring of shellfish tissue is required. In contrast, isotopic and minor/trace element analyses taken from the skeletal carbonate record provides a long-term (5 to 10 year) record that persists even after the death of the organism. Because of their crystal chemistry, the two common polymorphs of $CaCO_3$ (aragonite and calcite) have the ability to incorporate metallic cations and fractionate carbon and oxygen as a function of variables such as (ambient conditions, fluid compositions, growth rate (related to carbonate precipitation rate) and metabolic activity (e.g., Lorens, 1981; Morse and Bender, 1990; McConaughey 1989 a; b; Carpenter and Lohmann, in press). Most tracers occur in abundance and can be measured by standard analytical techniques.

Recent technological advances in micro-sampling and analytical methodologies now allow high-resolution sampling of incremental growth in a variety of biological and geological specimens (e.g., bivalves: Dettman and Lohmann (1993); otoliths (Patterson et al. (1993); barnacles: Killingley (1980); vertebrae: Koch et al. (1992); teeth (e.g., Koch et al., 1994); calcite crystals: Frank and Lohmann, (in submission)). A majority of these studies have focused on determining paleo-climates and pore fluid evolution in geologic systems. In contrast, we propose to use similar micro-sampling techniques to monitor the effects of oil pollution in Prince William Sound, Alaska, the site of the Exxon Valdez Oil Spill on March 24, 1989. These methods will involve a coordinated, multi-tracer analysis of $d^{13}C$, $d^{18}O$, Sr, Mg, Cd in mussel and barnacle shells and in fish otoliths.

The intertidal invertebrate (mussels and barnacles) and fish populations (herring and salmon) were severely injured by the Exxon Valdez Oil Spill. The mussel population is recovering, yet in many cases, is still contaminated due to the decision to avoid lethal oil cleaning methods. The fish population (herring, rockfish, salmon) has not recovered. The reason for this recovery is unexplained.

Exxon Valdez oil has an average $d^{13}C$ value of -29.3 ‰ (± 0.1) (Kvenvolden et al., 1993). This is significantly lower than the particulate organic carbon (POC) from this area (-19 to -26 ‰; Goericke and Fry, 1994). Goericke and Fry (1994) report virtually no difference between POC and copepod $d^{13}C$ values. If this isotopically distinct oil is introduced into the food chain (via ingestion of contaminated zooplankton (e.g., copepods)) the $d^{13}C$ value of *Exxon Valdez* Oil may prove to be a useful tracer. To be monitored, the oil must first be metabolized and incorporated in the skeletal carbonate of the various organisms in Prince William Sound.

Oil ingestion has been reported in most types of organisms in Prince William Sound (Environmental Impact Statement - Exxon Valdez Oil Spill Restoration Plan). Fish, mussels and barnacle have all been contaminated by oil. It appears that *Mytilus edulis* lacks the digestive enzymes necessary to metabolize aromatic hydrocarbons. In contrast, vertebrates have such enzymes (Lee et al., 1972). Although DeVillez and Buschlen (1967) have reported digestive enzymes in barnacles, our preliminary examination of this topic leaves us unclear on the fate of hydrocarbons in barnacles. Regardless of metabolic uptake of hydrocarbons, oil contamination may also induce stress (e.g., decrease filtering efficiency, decrease growth rates, etc.). Such stress may, in turn, yield changes in isotopic and minor element compositions of shell material via changes in metabolic activity and/or growth rates (e.g., Carpenter and Lohmann, in press).

Oil that is ingested by fish and metabolized should produce $d^{13}C$ values in otoliths and bone collagen that are distinct from pre-spill time periods. The several per mil difference between non-oiled plankton and *Exxon Valdez* oil should be passed on to the composition of fish otoliths. By sampling otoliths across the 1988-1995 time interval, we will monitor the degree to which contamination was and is affecting fish populations. Oxygen isotope compositions will also provide data on the temperature of ambient seawater and therefore allow estimation of migration patterns during this time period. The composition of otoliths from both diseased and healthy fish will be measured to establish baseline differences within the different populations.

Mussels and associated barnacles have been heavily contaminated in some locations and contamination is an ongoing problem at several sites. It is thought that mussels do not metabolize oil. On the other hand, barnacles may have that ability. Carbon isotope ratios of co-occurring mussel and barnacle shells will be used to test these hypotheses and to monitor oil-induced changes in metabolic activity. Oxygen isotope ratios from shells will also be used to determine water temperature and salinity changes which can also affect shell growth. *Mytilus edulis* samples collected in 1993 from heavily oiled locations of Prince William Sound have growth rates that are approximately one third that of oil-free samples from Puget Sound. This diminished growth rate may be the result of oil contamination, food availability or natural stressors. We plan to measure the concentration of magnesium, strontium and cadmium in shell growth increments to quantify growth rates.

Sampling across the 1988-1995 time interval in mussel and barnacle shells from oiled and non-oiled locations will establish a long term, high resolution monitor of the effects of oil on mussel shell growth and metabolic activity. Shells from heavily oiled locations will be examined to determine how much oil has been trapped in the shell during growth. This oil can potentially be extracted and analyzed.

The shells of living mussels and barnacles from selected sites will be notched/marked and collected after one year of growth. During this year, water samples will be collected on a monthly basis to monitor local conditions (temperature, salinity, isotopic compositions ($\delta^{13}C_{DIC}$, $\delta^{18}O_{water}$), and degree of oil contamination). Animals will then be harvested and shells analyzed for comparison with previously collected water data.

Previous Research

The fractionation of carbon and oxygen isotopes between CO_2, H_2O and carbonate minerals is relatively well understood (e.g., Tarutani et al., 1969; Friedman and O'Neil, 1977; Romanek et al., 1992). The temperature dependent fractionation of oxygen is a precise indicator of water temperature and salinity (e.g., Mook, 1971; Killingley and Newman, 1982; Kline et al., 1994). Provided that the fractionation factor is known and constant for a given organism, the $\delta^{18}O$ values of biogenic carbonates can be used to estimate the temperature or $\delta^{18}O$ value of ambient seawater. Likewise, carbon isotope ratios can be used to estimate the $\delta^{13}C$ value of dissolved inorganic carbon (DIC) or ΣCO_2 of ambient fluids (e.g., Kroopnick, 1974; 1980; Romanek et al., 1992). In general, the isotopic composition of biogenic carbonates reflect some degree of modification due to the organism's metabolic activity. These deviations from isotopic equilibrium are known as vital effects. If minimal or if known and consistent, these vital effects pose no problem in estimating the composition of ambient fluids.

Among otoliths, barnacles and mussels, mussels have received the most attention with respect to stable isotope measurements of carbonate (e.g., Mook, 1971; Killingley and Berger, 1979; Kline et al, 1994; all calcite analyses). Otoliths are a distant second (e.g., Mulcahy et al., 1979; Wefer, 1985; Radtke et al., 1987; Kalish, 1991; Patterson et al., 1993) and barnacles are the least studied (e.g., Killingley, 1980; Killingley and Newman, 1982). The more recent work of Kline et al. (1994) and Patterson et al. (1993) have provided the highest resolution sampling to date. Minor/trace element distribution in biogenic carbonates have also been studied (e.g., Lorens, 1981; Morse and Bender, 1990; Carpenter and Lohmann, 1992). The minor element composition of both mussels and otoliths are well studied (e.g., Koide et al., 1982; Kline et al, 1994); Gunn et al., 1992). The minor element content of barnacles is poorly documented (Milliman, 1974).

A. Objectives

Mussels and Barnacles

1. Examine the utility of skeletal carbonate as proxy indicators of oil pollution (mussel and barnacle shells). If successful, these materials will provide a persistent, long-term, high-resolution data set which will record pre- and post-spill environmental changes. This will provide a reliable method of long term monitoring for future oil spills.
2. Monitor the isotopic and minor element compositions of shells that lived pre- and post-spill. Analyze shells from organisms that were collected at a known time and count annuli backward to determine timing of events. Mature specimens that lived through the spill would be the best materials as the entire record would be in one specimen. This will require multiple samples from various localities to prove that isotopic variations are the result of oil contamination. Temperature and salinity variations will need to be constant between sites. Analysis of a non-oiled control group will be required.
3. Monitor specific mussel bed sites to assess recovery progress. This will involve monitoring of water

samples for a one year period and the *in situ* marking of mussels for future harvesting and analysis.

4. Examine coordinated stable isotope compositions and minor/trace element contents of shell growth increments to quantify variations in growth rates.

Otoliths

1. Examine the utility of fish otolith $\delta^{13}C$ values as proxy indicators of oil pollution. Otoliths should record a decrease in the $\delta^{13}C$ value of the oil contaminated food source (zooplankton) as *Exxon Valdez* Oil is approximately 5 ‰ lower than normal plankton (Kvenvolden et al., 1993; Goericke and Fry, 1994). Otoliths will provide a persistent, long-term, high-resolution data set which will record pre- and post-spill environmental changes.
2. Examine fish migration and activity patterns modified by the Exxon Valdez Oil Spill
3. Examine metabolic responses to oil ingestion and associated diseases.

Mytilus edulis

Previous stable isotope studies of *Mytilus* calcite indicate that it is precipitated in oxygen isotope equilibrium with ambient fluids (e.g., Mook, 1971; Killingley and Berger, 1979). Stable isotope ratios and minor element contents in *Mytilus* calcite have been used as an indicator of salinity (e.g., Malone and Dodd, 1967; Mook, 1971; Eisma et al., 1976). More recently, Kline et al. (1994) have determined that both the $\delta^{18}O$ value and Mg content of calcite growth increments are accurate indicators of temperature. Their unpublished data also show a linear relation between Sr contents and $\delta^{13}C$ values. This relation may be a function of shell extension rates (Kline, pers. comm.). The $\delta^{13}C$ values of DIC from major estuary systems indicate that *Mytilus* calcite is precipitated near equilibrium with ambient DIC (Romanek et al., 1992; Coffin et al., 1994).

We currently have approximately 30 specimens of *Mytilus edulis* shells, collected in June, 1993 from three locations in Prince William Sound (samples provided by M. Babcock, Auke Bay Laboratories). These specimens are from a non-oiled, control group (Barnes Cove), and from two beds in Foul Bay (one with moderate contamination and one with heavy contamination). Specimens from the control group are larger and have thinner shells. Specimens from the oiled locality are smaller and have thicker shells. Initial age estimates from annual growth increment counting, indicates that these shells grew through the oil spill (3/24/89).

Preliminary stable isotope data from pre- and post-spill portions of shell from each of the three populations indicate that pre-spill portions of the oiled specimens have $\delta^{18}O$ and $\delta^{13}C$ values that correspond with control group compositions ($\delta^{18}O$ values from -4.8 to -0.6 ‰ (PDB) and $\delta^{13}C$ values from -0.7 to +0.3 ‰ (PDB)). Post-spill portions of these shells have $\delta^{18}O$ and $\delta^{13}C$ values from -6.9 to -5.8 ‰ and -1.3 to -0.6 ‰ (PDB), respectively. There is no overlap of the two populations. While some of this offset may be result from different salinities in each location, it is possible that these differences may be the result of oil-induced stress. A similar decrease in $\delta^{18}O$ values was observed in the shell of a fatally stressed brachiopod (Carpenter and Lohmann, in press). The near 1 ‰ decrease in $\delta^{13}C$ values in post-spill, oiled specimens may reflect the introduction of *Exxon Valdez* Oil. Further shell analyses and water data are needed.

Given the poor chance of incorporating metabolized oil carbon into Mussel shells, these differences are encouraging. The reduced growth rates in oiled shells, compared with both the control group and samples from Puget Sound, suggests that these mussels have undergone a chronic stress. Comparison of Sr and Cd contents of shells may help quantify extension rate differences between populations. Corrections for salinity differences and variable cation concentrations in fluids will need to be made following water and shell monitoring. Background variations due to normal metabolic activity and ontogeny will need to be described. Further examination of the isotopic composition of the aragonite portion of the Mytilus shell is needed. Annual banding is visible near the hinge in shell cross-sections, yet no data have been reported from this portion of

Mytilus shells.

Another area of research is the examination of thin sections for oil inclusions in the skeletal carbonate. Mussels from heavily oiled locations have been described as being fully immersed in oil (M. Babcock, pers. comm.). This intimate association with oil may have caused oil to be trapped during shell growth (as fluid inclusions). If so, fluorescence microscopy of shell thin sections would quickly determine the onset of oil contamination. Should oil be included during shell growth, it may be possible to extract it for isotopic analysis using thermal decrepitation techniques (e.g., Lecuyer and O'Neil, 1994) or by crushing in an on-line inlet system of a quadrapole or gas chromatograph. If oil is detected we will attempt extractions using a system like that of Lecuyer and O'Neil (1994).

Barnacles

A cursory examination of the Exxon Valdez Oil Spill Environmental Impact Statement finds little mention of barnacle contamination. While barnacles are often considered a nuisance organism and are clearly not an economic resource, they may play an important role in monitoring the effects of oil contamination. Bourget (1980) has shown that barnacles record an excellent record of incremental shell growth that permits identification of molting, feeding, tidal changes and temperature variations. In addition, Killingley (1980) and Killingley and Newman (1982) have shown that the barnacles $d^{18}O$ values can be used to monitor changes in ambient temperature and fluid composition. The consistent ^{18}O enrichment of barnacle shell calcite makes barnacles a useful environmental monitor (Killingley and Newman, 1982). Compared to other biogenic calcites, barnacles have elevated Sr contents, which are consistent with their extremely rapid calcification rates (Milliman, 1974; Lowenstam and Weiner, 1989; Carpenter and Lohmann, 1992). Rapid calcification rates will yield better time resolution for an equal amount of $CaCO_3$ sampled, and may tend to elevate metallic cation concentrations (exclusive of Cd). Their co-occurrence with mussels, high resolution growth record, low Mg-calcite mineralogy, unusual growth rates and a known isotopic fractionation make barnacles a excellent choice as a pollution monitor.

Killingley and Newman (1982) found that $\delta^{18}O$ values of mussels and barnacles were consistently offset by 1.3 ‰ over a wide range of temperatures. This offset could be used to monitor oil-related perturbations in the metabolic activity of these organisms. Time equivalent samples from co-occurring specimens could be measured to precisely determine the timing of departures from this phylogenetic difference. Such departures would likely be the result of environmental stressors. Virtually no carbon isotope data have been reported for barnacles (5 from Wefer, 1985). These values are approximately 1 ‰ lower than equilibrium compositions, yet there are too few data to draw meaningful conclusions. More work is clearly needed.

Crustaceans possess digestive enzymes and organs that are similar to vertebrates (i.e., a liver like hepatopancreas; Waterman, 1961; van Weel, 1970). Admittedly, my familiarity with the recent literature on Crustacean digestive systems is limited. However, it is clear that barnacle digestive systems are different than those of mussels. As a result, carbon from *Exxon Valdez* Oil is likely to be metabolized and used in the calcification process. Regardless of the utility in tracing oil contamination, barnacles are a relatively unusual calcareous organism that has received little attention by researchers.

Otoliths

Incremental growth in fish sagittae (otoliths) has been described by several workers (e.g., Panella 1980). More recently, otoliths are being used for stock identification and a variety of isotope and minor/trace element analyses (see Gunn et al., 1992). While several workers have measured the stable isotope composition of otolith carbonate (e.g., Mulcahy et al., 1979; Wefer, 1985; Kalish, 1991; Radtke et al., 1987), Patterson et al. (1993) were the first to collect high resolution stable isotope data from otoliths. They have shown that the

$\delta^{18}O$ values of micro-samples can be correlated with ambient temperatures on a sub-monthly time scale. The proposed study will utilize a method with comparable sampling resolution.

Carbon isotope ratios from fish otoliths are often not reported. Wefer (1985) and Kalish (1991) have shown that there are linear relations between otolith $\delta^{18}O$ and $\delta^{13}C$ values. These variations are attributed to kinetic fractionation during hydroxylation of CO_2 during calcification (McConnaughey, 1989 a;b; Carpenter and Lohmann, in press). These potential vital effects should not significantly complicate monitoring efforts. The ability of fish to metabolize hydrocarbons suggest that isotopically distinct carbon from the *Exxon Valdez* Oil may be fixed during otolith precipitation. Therefore, a substantial decrease in otolith $d^{13}C$ values across the spill interval is anticipated.

We have recently received 20 pairs of pacific herring (*Clupea harengus pallasi*) otoliths (and vertebrae) from the ADFG (E. Brown). These specimens come from 7 to 10 year old fish which should insure inclusion of the *Exxon Valdez* Oil Spill in the otolith record. The long axis of these otoliths measures approximately 5 mm. While small, these should yield annual resolution with coarse sampling. We anticipate higher temporal resolution in larger fish otoliths (e.g., salmon *(Oncorhynchus gorbuscha* and *Oncorhynchus nerka*) and Rockfish (*Sebastes* sp. and *Sebastolobes* sp.). Rockfish otoliths are of particular interest as they have life spans of greater than 100 years. This long temporal record is also recorded in their large otoliths. The potential for tracing regional climate variations, long term changes in variable such as atmospheric CO_2 and other less publicized pollution events is tremendous.

These isotopic techniques can be used to monitor temperatures and related spawning events, migrations, diet and potentially diseases (if metabolism disruptions can be detected) in different fish populations. The thermal tagging of otoliths in hatcheries can also be monitored by knowing the temperature and isotopic composition of hatchery waters.

B. Methods and Facilities

Facilities

The UTD Sable Isotope Laboratory and related facilities were designed for all aspects of small sample carbonate analyses. This facility houses a Finnigan-MAT delta-E gas ratio mass spectrometer equipped with an automated micro-volume (auto-freeze) for the analysis of small volumes of CO_2. This, in conjunction with an on-line, common acid bath extraction line (operating at 75°C) allows analysis of $CaCO_3$ samples on the order of 0.2 mg. The delta-E is controlled by a 486DX/33 computer using Finnigan's ISODAT software. The laboratory supporting the mass spectrometer is fully equipped and functional. The major features of this facility are:

Extraction Lines: A multi-use "extraction line" for the preparation of CO_2 and the extraction of CO_2 from both fluids and solids is available. Extraction of ΣCO_2 from waters (for $\delta^{13}C_{SCO2}$) and CO_2-water equilibrations (for $\delta^{18}O_{water}$) are currently being conducted. A workstation for the extraction (thermal decrepitation) of CO_2 and H_2O from minerals containing fluid inclusions is also available.

Sample Roasting: A tube furnace and vacuum system are used to roast carbonate samples *in vacuo*.

Wet Chemistry Area: An acid fume hood and a lab area adjacent to a Millipore deionized water supply is used for preparation of minor/trace element samples, glassware cleaning and storage of chemicals and labware.

Computer Workstations: In addition to the dedicated PC's of the mass spectrometer and micro-sampler, two Macintosh computers and a laser printer are available for student and laboratory use. All computers are equipped with full ethernet connections and are networked to the University computer systems, a departmental computer laboratory and faculty offices. Downloading of data from ISODAT to PC spreadsheets for manipulations is done with minimal effort.

Sample Preparation Facilities: As correct sample preparation is extremely important to our analytical process, a facility nearby the stable isotope laboratory was recently renovated and outfitted with non-contaminating water saws and polishing tables. A small, low speed diamond band saw was purchased for cutting sections from a variety of materials including delicate biogenic carbonates.

Micro-sampling Equipment: A fully automated, PC-based, micro-sampling device has been described in the Project Description. Carbonate micro-samples can also be manually milled from polished chips, slabs and thick sections using a stationary dental drill (w/specialized bits), a Nikon SMZU stereoscopic zoom microscope and a manually controlled stage for sample manipulation. Extracted powders are then separated and stored for minor element and carbon, oxygen and strontium isotope analyses.

Radiogenic Isotope Laboratory and Strontium Isotope Facilities

Strontium isotope analyses are conducted on a Finnigan-MAT 261 under the direction of Robert Stern and William Manton. This TIMS has multiple sample capabilities and 8 faraday cups (6 of which are independently adjustable). Sr analyses are conducted in the dynamic multi-collection or peak-hopping mode. Analyses of the E&A $SrCO_3$ standard over the past year yield a mean $^{87}Sr/^{86}Sr = 0.70803 \pm 3$ (total range). Over the next year, NBS-987 (loading standard) and EN-1 (USGS Giant Clam Standard; procedural standard) will be routinely analyzed. This will allow inter-laboratory calibrations to correct for machine bias.

Ion exchange chemistry, sample evaporation and acid preparation is conducted in a newly constructed class 10+ clean room facility in UTD's School of Engineering. This procedure uses small Teflon ion exchange columns and Sr Spec exchange resin (EIChroM Industries, Inc). Because of the extremely small volume of acid used for exchange column chemistry these methods provide extremely low Sr blanks (< 50 picograms, e.g., CARPENTER et al., 1991), which are necessary when relatively small amounts of Sr are loaded and analyzed (approximately 100-200 ng Sr).

ICP-AES, AA Laboratory

Renovation of this laboratory space was recently completed (October, 1994). This new facility houses a Perkin Elmer Plasma II Emission Spectrometer (ICP-AES with an ultrasonic nebulizer and autosampler) and a Perkin Elmer Atomic Absorbtion Spectrophotometer with graphite furnace. Sample preparation facilities (sample dilution and glass cleaning) are available in the stable isotope laboratory.

Electron Microbeam Facility

This facility houses a fully automated JEOL 8600 Microprobe with 5 wavelength dispersive spectrometers (WDS) and an energy dispersive detector (EDS). A complete spectrum of elements (light and heavy) can be analyzed.

Microsampling

Carbonate micro-samples are milled from polished slabs (impregnated with epoxy) and thick sections using a stationary dental drill (w/specialized bits). Extracted powders are then separated and stored for isotopic and minor element analyses.

The automated micro-sampling system in use at UTD is a departure from the micro-sampling devices currently in use at the University of Michigan Stable Isotope Laboratory and at other locations. This system has transmitted light capabilities and uses a live video image and image analysis software to determine sampling pathways. This technique is both faster and more accurate that manually digitizing photographs of shell or crystal growth increments (e.g., Patterson et al., 1993).

This micro-sampling device is a fully automated, PC-based, video-controlled system. Three Newport 850B servo-motor actuators drive a precision, Newport X-Y-Z stage on which a transmitted light rotation stage is mounted. Thick sections (100 mm) are clamped in place on the rotation stage (used for transmitted light petrography) and are moved into the rotating drill bit. An Hitachi high-resolution, RGB video camera mounted on a Nikon SMZU stereoscopic zoom microscope and linked to a frame grabber video card allows display of live sample images on the 21" NEC monitor. Images are captured and transferred to the Optimas image analysis software. The image is scaled and sampling pathways are determined using the mouse-driven software. Sample pathways are transformed to data files that are read by the Compumotor AT6450 driver board and software. This software-hardware combination automatically drives stage actuators through the desired pathways. Following the milling of each sample pathway, powders are collected for isotopic and chemical analyses using a surgical scalpel. Using faceted tungsten carbide drill bits, this device can mill ~ 20 mm increments from materials such as bivalves, otoliths, corals and zoned crystals. High resolution micro-sampling will result in the collection of approximately 100 to 150 samples per specimen. Not all of these powder samples will be analyzed initially. Approximately 1/2 will be archived for future use (analyze every other sample). Only time periods of particular interest (i.e., rapid change in conditions) will require analysis of all samples collected.

Chemical analyses will be conducted using a variety of techniques which are dependent on detection limits. The Electron Microprobe (EPMA) will be used for high resolution sampling of Mg and Sr in all carbonate samples. Where Sr concentrations are below ~ 600 ppm, Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES) will be used. This will reduce temporal resolution slightly. Cd concentrations will be measured using Atomic Absorbtion Spectrophotometry. To obtain the best detection limits, a graphite furnace will be used. All equipment is available in the UTD Gesosciences Program.

For truly coordinated analysis of stable isotope and minor element data, on-line individual reaction vessels are being constructed to extract CO_2 from stable isotope samples and then use the residual phosphoric acid (4-5 drops) for minor element analysis.

The large number of micro-sample analyses is necessary to provide high resolution data across the 1988 to 1995 time interval. Analysis of fewer or larger samples from a given specimen compromises the resolution of the data and diminish the amplitude of observed changes.

Sample collection

Samples will be collected at various locations in Prince William Sound. Many of the samples needed for this study have already been collected (i.e., fish and mussels). One year monitoring of waters and biota at specific sites will be needed. The location of these sites will be determined by consultation with investigators already working in this area. Because many of our analyses are done post-mortem, our study can easily dovetail with existing research programs (e.g., ADFG and Auke Bay Laboratories). Our preliminary sampling strategy is to monitor a non-oiled control group, a moderately contaminated group and a heavily oiled group for each type of organism. Where possible, variations in salinity and temperature will be kept constant between populations to allow better comparison of isotope data.

C. Contracts and Other Agency Assistance

A majority of the research will be conducted by UTD personnel (PI, Students). All analytical work will be done in Richardson, Texas. No contracts are foreseen.

A proposal on a similar subject matter has been submitted (5/1/95) to the NSF-EPA Partnership for

Environmental Research. This proposal seeks $230,000 for the same two year period. Items requested in the NSF/EPA proposal are not redundant with those requested here. The NSF-EPA proposal requests funding for summer salary for the PI and two additional graduate students. The funding requested here is for a minimal two year pilot study.

D. Location

Samples will be collected at various locations in Prince William Sound. Many of the samples needed for this study have already been collected (i.e., fish and mussels). One year monitoring of waters and biota at specific sites will be needed. The location of these sites will be determined by consultation with investigators already working in this area. Because many of our analyses are done post-mortem, our study can easily dovetail with existing research programs (e.g., ADFG and Auke Bay Laboratories). Our preliminary sampling strategy is to monitor a non-oiled control group, a moderately contaminated group and a heavily oiled group for each type of organism. Where possible, variations in salinity and temperature will be kept constant between populations to allow better comparison of isotope data.

SCHEDULE

A. Measurable Project Tasks for FY 96

Start-up to January 1:	Arrange Logistics, set up monitoring sites, data collection
January 1 - September 30:	Continued data collection and site monitoring,
September 30 - October 30:	Continued data collection and complete site monitoring,

B. Project Milestones and Endpoints

Year 1:	Site Monitoring, Chemical Analysis of Preliminary Samples
Year 2:	Finish site monitoring followed by analysis of biota from monitored locations. Writing of reports and publications.

C. Project Reports

Annual project reports will be submitted at the end of each fiscal year. The first report will encompass initiation of site monitoring, and collection of isotopic and chemical data from preliminary samples. Year 1 will involve monitoring, sample collection and chemical analyses. Year 2 will involve predominantly chemical analyses and the writing of reports and publications. Reports and publications will continue beyond the end of the second fiscal year.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This study will be coordinated with the ADFG and the NOAA Auke Bay Laboratory. To date I have contacted Evelyn Brown at the ADFG and Malin Babcock at the Auke Bay Laboratory. They have provided preliminary samples for analysis. Continued interaction with these agencies is anticipated.

We hope to work closely with scientists in the Pacific Herring, Nearshore Ecosystem and Pink Salmon restoration programs.

ENVIRONMENTAL COMPLIANCE

I am unfamiliar with these laws and regulations. I will seek the advice of the appropriate government agencies regarding sampling and monitoring.

PERSONNEL

Principal Investigator

I have approximately 10 years experience in both gas ratio and thermal ionization mass spectrometry, gas extraction techniques and sampling procedures (see attached Biographical Sketch). The majority of pervious research has involved the measurement of various isotopic and chemical tracers in micro-samples of $CaCO_3$. The UTD Stable Isotope Laboratory was constructed three years ago at the time of my appointment and is a fully functional laboratory being utilized by 5 students. Several pieces of equipment have been designed and constructed on-site. Therefore, I am fully capable of operating, maintaining and designing all aspects of a stable isotope laboratory.

Student Support

One student will be supported on this project. Ms. Carol Sylvestri, who has recently joined our research program is beginning a Master's degree in Environmental Geochemistry and is currently being trained in the use of our laboratory equipment (mass spectrometer, extraction lines, etc.). Her previous work experience as a chemist for the New York City Department of Environmental Protection makes her well qualified for the tasks at hand. Two of my Ph.D. candidates, Dongho Lee and Jinhui Wang, who are conducting research in the area of biomineralization will also be assisting Ms. Sylvestri in various aspects of this project.

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BIOGRAPHICAL SKETCH

SCOTT J. CARPENTER
Assistant Professor

PERSONAL INFORMATION

Birth - December 3, 1962
Family - Wife, Leslie. Children: Patrick, 1991
Residence - 701 Forest Oaks Drive, Fairview, Texas 75069

EDUCATION

Ph.D. Geology, The University of Michigan, Ann Arbor, MI (December, 1991)
M.S. Geology, The University of Michigan, Ann Arbor, MI (August, 1988)
B.S. Geology, St. Lawrence University, Canton, NY (May, 1985)

EMPLOYMENT

1992-Present Assistant Professor, The University of Texas at Dallas
1991-1992 Post-doctoral Fellow, The University of Michigan

HONORS AND AWARDS

B.S. with honors, Magna Cum Laude
Phi Beta Kappa

PROFESSIONAL AFFILIATIONS

Society of Economic Paleontologists and Mineralogists
Geological Society of America
The Geochemical Society
American Geophysical Union

EDITORIAL DUTIES

Associate Editor (Methods) - Journal of Sedimentary Petrology (1991-1993)
Associate Editor (Carbonate Geochemistry) - Journal of Sedimentary Petrology (1993-Present)

LABORATORY EXPERIENCE

- Director, Stable Isotope Laboratory - University of Texas at Dallas (August 1992-Present)
- Assistant - Radiogenic Isotope Laboratory, University of Michigan (Fall 1988 to 1991)
- Assistant - Stable Isotope Laboratory, University of Michigan (Fall 1985 to 1992)
- Experience with gas ratio and thermal ionization mass spectrometers, gas extraction lines, AAS, ICP-AES techniques.

PUBLICATIONS

CARPENTER S.J., ERICKSON J.M., LOHMANN K.C, and OWEN M.R. (1988) Diagenesis of fossiliferous concretions from the Upper Cretaceous Fox Hills Formation, North Dakota. *Jour. Sed. Petrology* **58**, 706-723.

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5 publications most closely related to proposed work

CARPENTER S.J., ERICKSON J.M., LOHMANN K.C, and OWEN M.R. (1988) Diagenesis of fossiliferous concretions from the Upper Cretaceous Fox Hills Formation, North Dakota. *Jour. Sed. Petrology* **58**, 706-723.

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Collaborators within the last 48 months, graduate and postdoctoral advisors
Kyger C Lohmann, James R. O'Neil, Luis A. Gonzalez, Lynn M. Walter, Alex N. Halliday, Peter Holden, Ted Huston

Graduate Students Supervised: Ph.D. : Linda Smith, Jin Hui Wang, Dongho Lee; M.S.: Cynthia Durbin, Carol Sylvestri

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Budget Category:		Authorized FFY 1995	Proposed FFY 1996						
				[redacted]					
Personnel			$29.2						
Travel			$8.0						
Contractual			$15.5						
Commodities			$5.0						
Equipment			$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$0.0	$57.7	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
Indirect	45.50%		$26.3						
Project Total		$0.0	$84.0	$84.9	$0.0	$0.0	$0.0	$0.0	$0.0
				[redacted]					
Full-time Equivalents (FTE)			13.0						
		Dollar amounts are shown in thousands of dollars.							
Other Resources									

Comments:

1996

Project Number:
Project Title: A new technique for monitoring the effects of the Exxon Valdez Oil Spill: micro-sampling and analysis of otoliths, and barnacle and mussel shells
Name: Scott J. Carpenter

FORM 4A
Non-Trustee
DETAIL

Prepared:

4/27/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Personnel Costs:			Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1996
Name	Position Description					
Sylvestri	Research Assistant		11.0	1,100		12.1
Morris	Technician		2.0	3,500		7.0
****	Fringe Benefits					10.1
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		13.0	4,600	0	
					Personnel Total	$29.2

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FFY 1996
Description					
DFW-Alaska	800	10			8.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$8.0

1996

Project Number:
Project Title: A new technique for monitoring the effects of the Exxon Valdez Oil Spill: micro-sampling and analysis of otoliths, and barnacle and mussel shells
Name: Scott J. Carpenter

FORM 4B
Personnel
& Travel
DETAIL

4/27/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Contractual Costs:	Proposed
Description	FFY 1996
500 Minor Element Analyses	5.0
500 Carbonate Analyses - Stable Isotopes	7.5
100 Water Analyses-Stable Isotopes	3.0
Contractual Total	$15.5

Commodities Costs:	Proposed
Description	FFY 1996
Laboratory Materials/Expendibles	5.0
Commodities Total	$5.0

1996

Project Number:
Project Title: A new technique for monitoring the effects of the Exxon Valdez Oil Spill: micro-sampling and analysis of otoliths, and barnacle and mussel shells
Name: Scott J. Carpenter

FORM 4B
Contractual &
Commodities
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	

1996	Project Number: Project Title: A new technique for monitoring the effects of the Exxon Valdez Oil Spill: micro-sampling and analysis of otoliths, and barnacle and mussel shells Name: Scott J. Carpenter

FORM 4B
Equipment
DETAIL

4/27/95

Project Title: Development and Validation of a Decontamination and Restoration Process for Oil-Impacted Mussel Beds - "Submitted Under the BAA"

Project Number:	96109-BAA
Restoration Category:	Research
Lead Trustee Agency:	
Cooperating Agencies:	NOAA/NMFS Auke Bay Laboratory
Duration:	3 years
Cost FY 96:	$ 551,800
Cost FY 97:	$ 325,600
Cost FY 98:	$ 132,700
Geographic Area:	Prince William Sound, Kenai and Alaska Peninsulas
Injured Resource/Service:	Mussels

ABSTRACT

The mussel, *Mytilus trossulus*, has not recovered from the *Exxon Valdez* oil spill. It is an important resource for Alaskan villagers and may also be a food source for nearshore vertebrate predators that have not recovered. This project's goal is to develop and validate for implementation a treatment process to decontaminate and restore oil-impacted mussel beds. The project includes toxicity tests of oil-removing agents and field evaluations of treatment processes.

INTRODUCTION

The *Exxon Valdez* oil spill still impacts the marine and nearshore ecosystems of Alaska. Numerous studies have shown that significant contamination persists. The project proposed in this Detailed Project Description (DPD) will specifically address the decontamination and restoration of mussels, one of the species designated as an Injured Resource by the Trustee Council (Trustee Council, 1995 - references appear at the end of the DPD). The Project Team will develop a treatment process and validate its effectiveness on oil-impacted mussel beds. The basic premise is that decontamination of sediment underlying the mussel beds will reduce or eliminate the continuing exposure of mussels to oil enabling this species to recover to prespill levels. Restoration of these beds will also enable the Trustee Council to determine if this accelerates recovery of other Injured Resources, e.g. the black oystercatcher, sea otters and harlequin ducks. Likewise, decontamination of these beds will increase the availability of this resource for villages along the oil-impacted shoreline.

The Project Team has extensive experience in the assigned tasks. PES-Alaska (PES) is proposed as the prime contractor responsible for project and fiscal management, participation in development and evaluation of treatment processes, and preparation of reports. The Chenega Corporation (Chenega) will participate in the design of treatment processes and have primary responsibility for their field application, and provide equipment and logistical support. The University of Alaska Fairbanks (UAF) will collect and analyze information on candidate oil-removing agents, will lead the team in analyzing findings throughout the project, and conduct cost analyses of the treatment processes. The University of California Santa Cruz (UCSC) will have primary responsibility for the laboratory-based toxicity testing of agents selected for evaluation. The NOAA/NMFS Auke Bay Laboratory (ABL) will be primarily responsible for proposing and designing field sites, as well as obtaining and analyzing chemical and biological samples.

The proposed project will build upon the experiences gained from projects funded by the Trustee Council and the Alaska Department of Environmental Conservation (ADEC). The ABL has a long and distinguished history of studying nearshore and marine environments, and is currently monitoring mussel beds in Prince William Sound. In 1992, the ABL found that 50 of 64 mussel beds had underlying sediments with total petroleum hydrocarbons (TPH) levels in excess of 1,000 μg/g wet weight. Of these beds, 25 had sediment TPH levels in excess of 10,000 μg/g wet weight. Limited analyses of mussel tissue revealed polynuclear aromatic hydrocarbons (PAHs) body burdens up to 6.97$\pm$ μg/g dry weight (Babcock et al, 1994). This study also found that stripping of mussels from a portion of the bed resulted in a decrease in the underlying sediments' TPH levels. Results suggest that the mussel beds have a protective effect on the underlying sediment insulating them from the flushing action of the tides.

The long term effects of oil is evident from the laboratory finding that the LC50 (lethal concentration that produces 50% incidence of fatalities) for mussels, *Mytilus edulis*, is inversely related to exposure duration, decreasing approximately 50% when the exposure duration is increased from 7 to 28 days (Stickle et al, 1985). Sublethal responses to long term oil exposure include decreased growth and reproduction, and reduction in byssal thread production rates (Rice et al, 1984; Stickle et al, 1985; Babcock et al, 1994).

Working in conjunction with ADEC and Chenega, ABL in 1994 removed 38 tons of oiled sediment and replaced it with clean sediment to determine whether this intervention will accelerate recovery of mussels in 12 beds. This reduced hydrocarbon concentrations in underlying sediments (Babcock et al, 1995). More long term data will be obtained during FY 95. Use of the sediment removal and replacement process is limited, however, to mussel beds that have underlying sediments that are amenable to manual manipulation, have suitable areas for disposal of excavated oiled sediment, have a nearby source of clean sediment, and are accessible by the heavy equipment required for this process. It is for these reasons that this process does not appear to be suitable for application on the remaining oil-impacted mussel beds (Loeffler, 1995). Therefore, alternative measures must be pursued.

Selection of any treatment process for use on oil-impacted mussel beds should include the effectiveness of oil removal; environmental impact; cost of the treatment process; feasibility of applying a process on other beds, as well as its for other oil-impacted shoreline applications. Effectiveness and environmental impact considerations should include the direct impact on the mussels themselves, accelerated restoration to prespill conditions, and consequences of the mussels' recovery on predator species. Considerations of the treatment process costs should include manpower, equipment, supplies (including the oil removing agents), logistical support, mobilization, demobilization, etc.

This DPD proposes to evaluate the effectiveness of surface washing agents, shoreline cleaners, etc. for displacing the *Exxon Valdez* oil from sediments underlying mussel beds. Data on candidate agents for inclusion in this project will be gathered from manufacturers, databases compiled by independent organizations (EPA and MSRC), and open literature publications on laboratory (e.g. Environment Canada) and field (e.g. Oil Spill Conference Proceedings) evaluations of these agents.

Delivery of these agents into the sediment will be via a modified airknife injection system developed for treatment of contaminated subsurfaces, building upon experience gained from a 1993 shoreline restoration project funded by ADEC (Rog et al, 1994). The team for this project included PES, UAF and Chenega. They used this system to deliver a biosurfactant into the cobble/gravel subsurface down to depths of 2 feet and displaced 90% of the remaining semivolatile hydrocarbons (Tumeo et al, 1994). Once displaced, the oil was flushed to the surface and recovered with absorbent pads or flushed to a boomed shoreline area and removed by pads or skimmers. In addition to demonstrating the effectiveness of this process, the project addressed, indirectly, the environmental impact issue because samples taken before and after revealed no introduction of oil into the water column. It can be inferred from this finding that there would be minimal, if any, effect on the intertidal flora and fauna. NOAA personnel "...observed no obvious changes" in a patch of mussels after the treatment of this beach (Peyton and Whitney, 1993).

The research objective of the proposed project is to develop, evaluate and validate an effective treatment process for decontamination and restoration of oil-impacted mussel beds. By design, this project also includes a restoration objective to develop expertise in Chenega because they will apply this process on oil-impacted mussel beds during this project. Experience gained by Chenega on this and earlier projects will establish within Alaska a group with a broad level of expertise that can complete the decontamination and restoration of the remaining oil-impacted mussel beds, and apply this treatment process, when appropriate, to other oil-impacted shorelines in Arctic and Sub-Arctic regions..

NEED FOR THE PROJECT

A. Statement of the Problem

Spills and leakage of crude oil and refined petroleum products continue as a major concern for Alaska from an economic and environmental perspective. Despite the massive efforts that were mounted in response to the *Exxon Valdez* oil spill, contamination persists along the shoreline of Prince William Sound. The 1993 Shoreline Assessment (Piper et al, 1993) report indicated that in the 59 surveyed sites, 109 distinct areas were found with visually observable subsurface oiling. Even though there was a substantial decrease from findings in earlier surveys, the authors concluded, "Because of the unlikelihood of further effective treatment and the natural entrenchment of the remaining oil there will probably not be a significant reduction in subsurface oil for several years."

Surveys conducted by ABL since 1991 indicate that more than 50 mussel beds remain impacted by the *Exxon Valdez* oil spill. The overlying mussels appear to provide a protective layer reducing the effectiveness of natural processes to remove residual oil from the underlying sediment. As a consequence, Babcock et al (1994) stated, "...restoration measures will have to be more intrusive to reduce present levels of contamination throughout a bed."

B. Rationale

Evidence cited in this DPD indicates that recovery of mussel beds is unlikely to occur in the near future unless a process is developed to remove the residual oil from subsurface sediments. The treatment process to be developed, evaluated and validated will enable the decontamination and restoration of oil-impacted mussel beds. Once implemented, this treatment process should be less intrusive and costly than the sediment removal and replacement process. If required, this treatment process will be able to operate from a floating platform thereby minimizing reliance on an accessible beach area. On a broader scale this process, with modifications as required, should be useful for decontaminating other subsurface sediments along the shoreline or even in-land.

C. Summary of Major Hypotheses and Objectives

1. To evaluate the toxicity of available surface washing/beach cleaning agents alone, and in combination with weathered oil on the mussel, *Mytilus trossulus*.

2. To develop, evaluate and validate a treatment process that will effectively remove subsurface oil from impacted mussel beds thereby accelerating their recovery to prespill conditions.

3. To transfer a cost-effective treatment process to an Alaskan village-based corporation for implementation on remaining oil-impacted mussel beds on Prince William Sound.

D. Completion Date

A laboratory evaluation of candidate agents' toxicities is to be completed in FY 96. Field evaluations of candidate treatment processes are to be completed in FY 97. Field evaluation of a prototype treatment process is to be completed in FY 98. The project will be completed in FY 98 after the submission of a final report and a treatment process recommended for implementation.

COMMUNITY INVOLVEMENT

As a consequence of the *Exxon Valdez* oil spill, a number of the Alaskan villages are still unable to utilize the shorelines and intertidal nearshore regions as a subsistence resource. A goal of this project is to develop and transfer a cost-effective treatment process for the decontamination and restoration of oil-impacted mussel beds to Chenega for implementation. Chenega is a key partner in this project and will be a primary resource for treatment of other oil impacted shorelines throughout Alaska, and other Arctic and sub-Arctic regions, in the event of future oil spills. Video and slide/transparency materials will be prepared for use by the Project Team and the Trustee Council during public meetings to ensure public understanding of the project.

FY 96 BUDGET

Personnel	34.9
Travel	2.8
Contractual	483.7
Commodities	3.0
Equipment	0.0
Subtotal	524.4
Gen. Admin.	0.0
Indirect Costs	27.4
Total	551.8

PROJECT DESIGN

A. Objectives

This project has the following objectives.

1. To evaluate the toxicity of available surface washing/beach cleaning agents alone and in combination with weathered oil on the mussel, *Mytilus trossulus*.

2. To develop, evaluate and validate a treatment process that will effectively remove subsurface oil from impacted mussel beds thereby accelerating their recovery to prespill conditions.

3. To transfer a cost-effective treatment process to an Alaska village-based corporation for implementation on remaining oil-impacted mussel beds on Prince William Sound.

B. Methods

The Project Team will perform the laboratory and field evaluations in this project and provide results to a Project Oversight Committee (POC) that will make recommendations to the Trustees Council on the findings at each major milestone. It is recommended that the following organizations be represented on the POC; the Trustee Council, ADEC, NOAA (Juneau and Seattle), US Coast Guard, the Oil Spill Research Institute, Chenega, Environment Canada, UAF and PES. It is proposed that the UAF representative serve as chairperson and the PES representative be an *ex officio* member and serve as recording secretary. By using this approach, the Project Team believes that this will be a cost-effective investment by the Trustees Council.

Members of the Project Team will participate in the two Trustee Council workshops annually. To ensure that participants obtain the maximum benefit from presentations/discussions of this project, videotape recordings will be obtained during the field evaluations, along with slides and transparencies of the results obtained in the laboratory and field evaluations.

A core group from the Project Team will visit up to 10 field sites that could be used for the field evaluations to be conducted in FY 96 and FY 97. During this trip planned for May, 1996, the team will identify the most appropriate sites, determine unique aspects that will need to be incorporated into the design of the experimental protocols, and obtain baseline sediment, water column and mussel samples. Priority for bed selection will include selection of beds with comparable chemical characteristics (hydrocarbon levels in subsurface sediment), biological characteristics (e.g. mussel density), and physical characteristics (e.g. sediment composition, bed size, etc.), and locations. The first two factors are important for making comparisons among the treatment processes whereas the third factor is important to enable the field teams to overlap treatment activities, thereby reducing field time.

THE FOLLOWING HYPOTHESIS WILL BE TESTED TO MEET THE FIRST OBJECTIVE.

1. One or more surface washing/beach cleaning agents do not elicit significant acute effects in *Mytilus trossulus* under treatment conditions that are likely to be required for their effective application on oil-impacted mussel beds on Prince William Sound.

The laboratory evaluations to test this hypothesis will be completed in FY 96.

Selection of Agents for Laboratory Toxicity Testing

UAF will have lead responsibility for assembling a database on surface washing and beach cleaning agents, as well as any other agents that may be suitable for application on oil-impacted mussel beds. Sources of information include manufacturers' materials, open literature publications, independent agency evaluations, etc. Primary sources of information include the EPA National Contingency Plan Product Schedule, the Marine Spill Response Corporation report on chemical oil spill treating agents (Walker et al, 1993), and technical reports and publications from Environment Canada (e.g. Fingas et al, 1991). The MSRC report describes 11 "shoreline cleaning agents" that could be considered for inclusion in the proposed project. Of these, 8 were considered as having passed an effectiveness screen established by the authors. Information on several key factors will be sought on candidate agents. These factors include the chemical nature and mechanisms of oil removal, recommended treatment methods (application procedures, concentrations, residence time, flushing procedures, etc.), and results of laboratory and field-based evaluations of the agent for toxicity and effectiveness. Another factor that will be considered in the selection of agents is the requirements of the ADEC Draft Protocols for Chemical Product Use in Spills in Marine Waters of Alaska (ADEC, 1993) which includes a stipulation that products be on the EPA National Contingency Plan Product Schedule. This information will be assembled and prioritized by UAF. Results of this data collection and analysis will be presented to the POC for review and recommendations as to which agents should proceed to the laboratory evaluation of toxicity. These results and recommendations will be compiled into the first Interim Report which will be submitted to the Trustee Council.

Laboratory Toxicity Testing

The laboratory evaluation of candidate agents will focus on the two primary ways in which these agents will be threats to mussels; exposure to the agents during the treatment process, and exposure to the displaced oil (and agents) during the flushing and recovery phases of the treatment process. Exposure of the mussels to the agents will depend on several factors including the chemical composition of the agents, recommended treatment concentrations, residence time (which will allow increasing amounts of the agent to float up into the beds), and flushing procedures. Four different toxicity tests are proposed; adult mussels exposed to the agents alone, adult mussels exposed to representative oil/agent mixtures, larvae exposed to agent alone, and larvae exposed to representative oil/agent mixtures.

At the earliest time possible after the contract is initiated, UAF will travel to Prince William Sound to collect non-oiled mussels, *Mytilus trossulus*, to ship to UCSC for laboratory evaluations of the toxicity of candidate agents. Shipments will be in accordance with state regulations in Alaska and California.

UCSC will conduct the laboratory evaluations of the toxicity of candidate agents on the mussel, *Mytilus trossulus*. Toxicity evaluations will use adult/subadult mussels which form the mussel beds to assess the effect of the agents, as well as the acute effects of reoiling the mussels that could occur during the flushing and recovery phases of treatment processes. Toxicity of the soluble fraction of the agents and the aqueous fraction of the displaced oil/agent mixture will be evaluated on the larval stage. A state-of-the-art, flow-through exposure system (Singer et al, 1990, 1991, 1993) will be modified to accommodate these tests. Diagrams of the toxicity testing system and an enlarged version of a single exposure chamber appear in Appendix A. This spiked-exposure toxicity testing system has already been accepted by California as a standardized test for evaluating dispersant toxicity. For purposes of this DPD, it will be assumed that five agents will be evaluated.

To assess the impact of the agents, mussels will be exposed to the agent in concentrations and exposure times that simulate conditions likely to be experienced in the field. Estimations of these concentrations will be made by the Project Team based on manufacturer's recommended application concentrations and residence times. The mussels will be maintained in, and flushed with, seawater at temperatures similar to those prevailing in Prince William Sound during the summer months when the field evaluations will be conducted. Aqueous concentrations of the agent will be monitored by the most appropriate means based on their chemical composition. The acute effects of oil/agent mixtures will be assessed by combining weathered Alaska North Slope (ANS) oil with agent in a manner similar to that described by Clayton and Renard (1993). The effluent from this process will be used as the test solution for the spiked-exposure test procedures on the larvae and adult mussels.

Evaluation of the potential water-column toxicity of the agents and oil/agent mixtures will involve testing larval mussels using the standard bivalve acute toxicity test as a procedural basis (ASTM, 1992). Toxicity of the agents will be assessed by exposing fertilized mussel embryos to various concentrations of the aqueous fraction of the agent under spike-exposure conditions (Singer et al, 1991). Potential water-column effects resulting from exposure of the fertilized mussel embryos to oil/agent mixtures will be assessed by using the aqueous effluent described previously. Concentrations of oil will be measured by gas chromatography (GC-FID).

Endpoint determinations for the toxicity tests will be accomplished by using standard statistical procedures. No-observed-effect concentration (NOEC) will be calculated using a one-way analysis of variance with Dunnett's comparison of treatments against a control, and median effect concentrations (MEC), i.e. the concentration at which 50% of the test population is effected, will be estimated using the trimmed Spearman-Karber method (Zar, 1974; Schimmel et al, 1989). Effects to be measured include fatalities in the adult mussel and abnormal development of prodissoconch I stage shells in the larval mussel tests. Additionally comparisons will be made using analysis of covariance to ensure comparability among treatments (Singer et al, 1991). Each type of test will be performed in duplicate to assess validity.

The laboratory evaluations will not include considerations of the agents' potential effectiveness because of the uncertainty as to which laboratory-based effectiveness test is most relevant to the intended application. This uncertainty is evidenced by the decision of the EPA which is updating their National Contingency Plan Product Schedule, but not designating an effectiveness test for a new category of oil-removing agents, surface washing agents (Federal Register, 1994). Further, NOAA personnel recommended that the focus be on, "...evaluating a variety of products to obtain the best available balance between maximum effectiveness and minimum environmental impact" (Hoff et al, 1994).

Analysis of Candidate Agents Suitability for Field Evaluation

Results of the laboratory evaluations will be integrated with the agent information collected by UAF and analyzed for potential toxicity of these agents under conditions which would be needed for effectively decontaminating the oil-impacted mussel beds. Results of this analysis will be presented to the POC for review. A prioritized list of field sites will also be included. The POC will make recommendations as to which agents should proceed to the field evaluations, and which sites should be used. These results and the POC recommendations will be submitted to the Trustee Council as the first Interim Report. For purposes of this DPD, it will be assumed that one or more of the agents will be approved for the first phase of field evaluations.

THE FOLLOWING HYPOTHESIS WILL BE TESTED TO MEET THE SECOND OBJECTIVE.

2. As a consequence of treating oil-impacted beds, the mussels have significantly different short term (less decrease in abundance) and long term (accelerated recovery - abundance and productivity) responses as compared to beds treated with the sediment removal and replacement process, and as compared to other untreated oil-impacted mussel beds.

The primary activities required to test this hypothesis will be completed in FY 97.

PES-Alaska will have lead responsibility for this phase. PES will obtain the necessary regulatory agency approvals for the field sites. PES, working in conjunction with UAF and Chenega, will use the manufacturer's information, to develop a Candidate Treatment Process for each agent approved for field evaluation. This process will include the application of agents via a modified airknife injection system, flushing of the oil/agent mixture, and removal of the displaced oil from the surface with absorbent pads and skimming. Data available from ABL and other sources will be reviewed to ensure that the treatment processes are optimized to the types of sediment found at these sites. Among the variables to be considered will be the density of injection sites and depth of subsurface penetration. In general, the finer the sediment the more dense will be the injection sites. Depth of penetration will depend on the availability of information on the depth of contamination.

Chenega will have lead responsibility for providing equipment for flushing and recovering the oil, as well as the logistical support for the field evaluations to be conducted throughout this project. Detailed description of the equipment and supplies required for all phases of this project are included with the Budget in Appendix D. PES and Chenega will be responsible for the application of the treatment processes, as well as flushing and recovery of the displaced oil. Application rates for the agents, residence time and flushing procedures will be in accordance with manufacturer's guidance as much as is feasible.

For purposes of this DPD, it is assumed that three agents will proceed to the first phase of field evaluations. Because of the size of these beds, it is recommended that each process be evaluated on a separate bed. This will require that four mussel beds be used in this phase of field evaluations. The fourth mussel bed will serve as a Positive Control in which the treatment will consist of applying the modified airknife injection system and flushing procedures without application of any agents. Data accumulated from these beds in previous years by ABL and pretreatment data will be used as baselines against which the impact of the treatment processes will be compared. Should there be a marked difference in any of the Candidate Treatment Processes, e.g. requirement for a prolonged residence time for the agent, the Positive Control site may have to be divided into sub-plots, if feasible. Otherwise a fifth site may be required. For purposes of this proposal, it is assumed that this phase of field evaluations can be conducted at a total of four sites. As was mentioned in the previous section, priority will be given to using mussel beds having comparable physical and biological characteristics to facilitate analyzing the difference among the treatment processes. It will also be a priority issue that the beds be located in close enough proximity, if feasible, to overlap the treatment activities thereby reducing total field time.

)econtamination of the Mussel Beds

This first phase of field evaluations is planned for July/August, 1996. Realistically, there will be some variations due to unique characteristics of individual oil-impacted mussel beds, and differences in the treatment processes dictated by manufacturers' recommendations for applications of the candidate agents. Analysis of the results of these field evaluations will include considerations of these variations in determining the effectiveness of the Candidate Treatment Processes. The following general procedures will be used at each of the field evaluation sites.

a. Based on available information on the mussel beds and previous experience with field projects, it is proposed that the time at each site could be up to seven days, barring inclement weather. The first day will be allocated for staking out the area to be treated, and obtaining sediment, water column and mussel samples. Treatment will be applied in one to two days depending on a number of factors including: bed size; requirements of the treatment processes (application rates, residence time, time required to flush and achieve a sheen-free condition, and time required to recover the displaced oil); time required to obtain samples; and weather. Two to three days will be allocated for obtaining post treatment samples. Demobilization from the site will require one day. It is assumed that the four sites will be located such that the treatment periods can overlap somewhat enabling this phase to be completed in 14 days. For example, it should be feasible to move and set up the majority of the treatment equipment and obtain pre-treatment samples at a site while an already treated site is undergoing the final stages of oil recovery and post treatment sampling. Should there be delays due to weather and other unforeseen problems, the total time for the first phase of field evaluations may have to be extended. For budgeting purposes, the 14 day time frame will be used.

b. In general, the modified airknife injection system will use intermittent bursts of high pressure air to open channels in the mussel footings and sediments down to a depth of one to two feet below the sediment surface (the system permits deeper penetrations, if needed). Once the tip of the injection system passes through the surface of the sediment, the air bursts will also include an aerosol of the oil removing agent. Experience obtained in the 1993 shoreline restoration project indicates that this technique is likely to have a sphere of influence around the tip of the injection system of two feet vertically and a lateral radius of four to five feet. At this time, it is projected that injections will be made in the center of two foot in diameter overlapping circles to ensure a thorough coverage of the underlying sediments. This may be modified depending on the physical characteristics of the sediment underlying the individual mussel beds.

c. Depending on the manufacturer's recommended residence time for the product, flushing will begin almost immediately using a large diameter hose coupled with a deluge header to force ambient temperature seawater down through the channel left by the injection system. Flow rate and pressure will be adjusted to minimize the potential for displacing the mussels from their footings. If needed, subsurface well-points may be used to administer seawater directly into the subsurface. This system would consist of stainless steel well-points driven into the subsurface in a grid pattern throughout the treatment area. These well points would be connected to hoses for flushing with seawater to maintain an "upswelling" condition throughout the treatment period. Flushing with hoses will also be used to herd the floating oil into the boomed area for recovery. Flushing will continue until the beds are covered by the tide and may be repeated during the next time they are exposed with the objective of achieving a sheen-free condition.

d. The treatment process will be administered during a rising tide, beginning across the lowermost transect of the mussel beds and proceeding shoreward. This procedure will minimize the time during which the mussels are exposed to the agents and displaced oil, and enable the oil to be floated away into the boomed region where it will be recovered.

e. The displaced oil will be recovered by using absorbent pads and skimmers from the boomed area that will surround each treated bed. Absorbent pads will be collected and bagged for later disposal. The recovered oil/agent mixtures will be pumped into a storage tank on board an Oil Spill Response Vessel; decanted to remove excess water, and the volume of the remaining oil/agent mixture will be recorded. The oil/agent mixtures and sorbents will be disposed of in accordance with applicable regulations.

f. The actual time for each phase of the treatment process, amounts of consumable supplies and estimates of the volume of oil recovered, will be recorded for each of the treatment processes. These data will be used in estimating the cost-effectiveness of the candidate treatment processes.

Chemical and Biological Sampling Protocols

ABL will design and implement the sampling of sediments, water-column, and mussels for evaluation of the treatment processes. Site sampling design for chemical analysis will be based on individual spot sampling of 0.25m. by 0.25m. quadrats and will encompass not only the bed itself, but also mussels and sediment lateral to the bed and sediments seaward of the treated bed. Sediment samples will be collected from the near surface (0-2cm) as in previous studies (Babcock et al, 1994) and from the deeper subsurface. The depth of the latter samples will be dictated by the data available on individual sites, and the results of the baseline analysis to determine the depth of residual oil. Samples of sediment and the water column will be taken before, during, two days and two months after, and annually thereafter through FY98. ABL will conduct the chemical analysis of the sediment, water column, and mussel tissues. Mussel samples will be obtained on the same schedule except for the deletion of the one to two days after sampling.

UAF will conduct a biological analysis of the mussels. Samples will be collected from randomly located $0.1m^2$ quadrats prior to, two days and two months after, and annually thereafter. Samples will be preserved and returned to UAF for analysis. In the laboratory, the size and age frequency distribution will be determined to analyze for growth rate and recruitment patterns. The matrix fauna will also be identified and counted.

All sediment and water samples will be analyzed for hydrocarbons by ultraviolet fluorescence (UVF), as adapted from Krahn et al (1991). For UVF screening, water or wet sediment samples will be extracted twice with methylene chloride, then concentrated or diluted to match a calibration curve based on an *Exxon Valdez* oil standard. These extracts will be analyzed with a high-performance liquid chromatograph equipped with a fluorescence detector. Excitation/emission spectra of the extracts will read at the phenanthrene wavelengths (260 nm/380 nm), and values will be calculated to estimate total petroleum hydrocarbons (TPH) based on the amount of phenanthrene in *Exxon Valdez* oil. This cedure allows for economical screening of many samples and produces semi-quantitative data which be used to select samples for further analyses by gas chromatography/mass spectrometry (GC/MS) for quantitative determination of individual hydrocarbon analytes. Selected sediment and mussel samples will be analyzed by GC/MS as described by Short et al (in press) for quantitative determination of individual polynuclear aromatic hydrocarbons (PAH) and alkanes. These results will allow comparisons with *Exxon Valdez* oil patterns to verify origin of the oil and state of weathering. Values produced by UVF can be used with reliability for estimating the oiling conditions of sediment. There is agreement ($R^2 = 0.74$) between UVF and total PAH values and even better correlation ($R^2 = 0.83$) between UVF data and total hydrocarbons (the sum of all aromatic and alkane hydrocarbon analytes, as determined by GC/MS) (Babcock, et al, in press).

Analysis of Results from the Field Evaluations of Candidate Treatment Processes

Data obtained from the chemical and biological analyses will be compared to determine:

1. the impact of a treatment process over time (within bed);

2. differences in the effectiveness of the candidate and prototype treatment processes (across beds) and;

3. differences in the effectiveness of these processes as compared to other treated and untreated beds using data collected under the Trustee Council's funded project that is monitoring mussel beds (#090).

These comparisons will include ANOVA and other statistical tests including paired t-tests, where appropriate.

UAF will lead the Project Team in the analysis of the results of the field evaluations. Effectiveness criteria will include the extent of decrease in sediment and mussel bed hydrocarbon levels over the first year post treatment. Focus of the chemical analyses will be decreases in TPH, diesel and semivolatile range hydrocarbons in the sediments and water-column, and PAH levels in the mussel tissues. Biological analysis of the mussels will focus on changes in abundance of mussels in the treated beds, and comparisons with other treated and untreated oil-impacted beds using data obtained previously (Trustee Council project #090).

Other criteria will be an estimate of the relative effectiveness of the treatment process, i.e. ratio of volumes of agent used to oil recovered, and an estimate of the time required for each of the treatment processes. This data will be integrated with costs for the candidate treatment processes. These costs include the requirements for equipment (airknives, skimmers, etc.), supplies (e.g. oil removing agents, absorbent pads, etc.), remote site logistical support (shipping requirements, landing crafts, berthing requirements), personnel (required expertise, man-hours for preparation, treatment and oil recovery, etc.). The cost-effectiveness of these treatment processes will be compared to alternative measures, e.g. the sediment removal and replacement process used by the NOAA/ADEC/Chenega team in 1994. Results of this analysis will be incorporated into a progress report that will include a prioritized list of the candidate treatment processes. This will be submitted to the POC for review. The second Interim Report incorporating the POC recommendations will then be submitted to the Trustee Council.

Based on the findings from this initial phase of field evaluations, the Trustee Council may determine that one of the processes is suitable for implementation without any further refinements (and an additional evaluation) or that none of these processes warrant further evaluation. If there is to be no further field evaluation, a final report will be submitted by the Project Team. For purposes of this DPD, it is assumed that the Trustee Council will approve the second phase of field evaluation.

THE FOLLOWING HYPOTHESES WILL BE TESTED TO MEET THE THIRD OBJECTIVE.

3. The validated treatment process is cost-effective as opposed to other available alternative measures for the decontamination and restoration of oil impacted mussel beds.

The activities required to test this hypothesis will be completed in FY 98.

PES and Chenega will develop a Prototype Treatment Process based on the results of the first phase of field evaluations and recommendations of the POC. Chenega will have sole responsibility for applying this process to oil-impacted mussel beds in this phase to ensure that this process is applied in a fashion most likely to be used once it is implemented on a broad scale. For purposes of this DPD, it is assumed that two mussel beds will be treated with the Prototype Treatment Process. If there is a substantial difference in this process from that used previously, there may be a need to use a third site as a Positive Control in which the process is used without application of any oil removing agent. Criteria for selecting these sites include their proximity so that this phase can be completed in seven days. Another criterion will be that the beds have distinctly different sediment characteristics, e.g. one fine grain site similar to the 12 sites treated with the sediment removal and replacement process, and one similar to the sites treated in the first phase of the field evaluations. By treating these two different site types, it will be possible to evaluate the effectiveness of the Prototype Treatment Process on a broader range of sediment types. This phase of the field evaluations is planned for August, 1997.

Design of the treatment sites, sampling protocols, chemical and biological analyses and statistical analyses will be similar those described in the previous section. A final round of sampling of the beds treated with the candidate and prototype treatment processes will be obtained in FY 98.

UAF will lead the Project Team in analyzing the results of the short and long term chemical and biological analyses and the costs of the Prototype Treatment Process to determine the cost-effectiveness and feasibility of using this process versus other alternatives, e.g. the sediment removal and replacement process. Additionally, these results will be incorporated with the field experiences of Chenega to refine the treatment process, as needed. Assuming there are no substantial changes, this process will be considered as a validated treatment process recommended for implementation. Comparisons will be made between the cost-effectiveness of this treatment process and other alternatives, e.g. the sediment removal and replacement process that was used on 12 mussel beds in 1994.

Results of these efforts will be incorporated into a draft final report that will be submitted to the POC for review. This report will also identify the mussel beds that would be most suitable for application of this process and the projected costs for implementing this treatment process. The draft final report and POC recommendations on the suitability of implementing this treatment process will be submitted to the Trustee Council. A final report will be submitted incorporating the decisions of the Trustee Council on whether the treatment process is to be approved for implementation.

C. Contracts and Other Agency Assistance

The roles and responsibilities of the Project Team members were described in the Methods Section, and are highlighted here.

1. PES is a small business that manufactures and distributes bioremediation, spill response and industrial cleaning products. PES personnel have extensive experience in spill response and bioremediation projects throughout Alaska. As was described previously, this system was used to decontaminate subsurface sediments in the 1993 shoreline restoration project funded by ADEC. The PES-Alaska office will have primary responsibility for coordinating the activities undertaken during this project. It is proposed that PES have overall lead responsibility for the contract including project management, fiscal management, collection and archiving of data from the other team members for integration into reports, obtaining permits for field sites, training and oversight of the modified airknife application process, development and revision of treatment processes, and coordination of the overall project with the Trustee Council.

2. UAF is a component of the University of Alaska system. For this project, the overall management of the institution's participation will be in the Environmental Technology Laboratory. UAF will have lead responsibility for collection and analysis of information on agents for potential inclusion in this project, for analyzing the results of the laboratory and field evaluations, and participation in the biological analysis of the mussels from the treated beds.

3. Chenega is an Alaska village-based corporation. Chenega will provide equipment, supplies and logistical support for the field evaluations, participate in the design and analysis of the treatment processes, and apply the treatment processes during the field evaluations.

4. UCSC is a component of the University of California system. UCSC will have lead responsibility for the laboratory toxicity studies. The group that will conduct these tests developed the spiked-exposure test procedure that is used by the state of California for evaluation of dispersants and, is conducting research for the Office of Oil Spill Prevention and Response of the California Department of Fish and Game.

5. ABL is a component of the NOAA National Marine Fisheries Service located in Juneau and is a Trustees Agency. ABL will assist in choosing the treatment sites, staking areas to be treated, will design and implement the sampling protocol for sediment, water-column and mussels, and analyze results for evaluation of the treatment processes.

D. Location

Details on the locations at which this project will be conducted are provided in the Methods Section, and are highlighted here.

1. Juneau will be the location for design of the sampling protocols, and chemical analysis of the sediment, water-column and mussel tissue samples obtained in the field evaluations.

2. Fairbanks will the location for the collection and analysis of information on agents that are

candidates for inclusion in this project, integration of the laboratory and field evaluation data, and will be the site of the biological analysis of the mussels obtained during the field evaluations.

3. Anchorage will be the location of the coordination of the field evaluations, design of the treatment processes, and meetings of the Project Team and Project Oversight Committee.

4. Prince William Sound, Kenai and Alaska Peninsulas are the sites for the field evaluations of the treatment processes.

5. Santa Cruz, California will be the site of the laboratory-based toxicity tests of the agents selected for evaluation.

6. San Antonio, Texas will be the site of the integration and archiving of the information and results obtained in this project, and the site of overall project and fiscal management.

SCHEDULE

The schedule summarized in Table 1 is based on the project beginning early in FY 96. This will allow sufficient time for completion of the laboratory toxicity tests so that the first phase of field evaluations can be conducted in July or August, 1996.

A. Measurable Project Tasks for FY 96

As described in the Methods Section and shown in Table 1, the laboratory evaluations of candidate agents will be completed in FY 96. In addition, the initial phase of field evaluations, and short term effectiveness of the Candidate Treatment Processes will be completed in this fiscal year.

B. Project Milestones and Endpoints

As described in the Methods Section and shown in Table 1, results of the activities to test each hypotheses will be presented to the POC for review and recommendations on the advisability of proceeding to the next phase. These will be submitted to the Trustee Council for approval . The POC will review the results of the field evaluations and determine if the final design of the treatment process is likely to achieve the Trustee Council's restoration objectives for mussels. Results of the overall project and the recommendations of the POC will be submitted to the Trustee Council. The final milestone will be the submission of a final report incorporating the decision of the Trustee Council as to whether the treatment process should be implemented to decontaminate and restore remaining oil-impacted beds.

C. Project Reports

Quarterly progress updates will be provided to ensure that the Trustee Council is kept current on the activities underway/completed as were described in the Methods Section and summarized in Table 1. Five formal reports will be submitted to the Trustee Council during this project.

1. The first Interim Report will be submitted after the initial evaluation of information on the agents

which could be included in the project.

2. The second Interim Report will be submitted after completion of the laboratory toxicity testing of the candidate agents.

3. The third Interim Report will be submitted after completion of the first phase of the field evaluations.

4. A Draft Final Report will be submitted after completion of the analyses of the effectiveness of the Prototype Treatment Process.

5. A Final Report will be submitted to the Trustee Council incorporating their decision as to the implementation of the treatment process.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project was designed to maximize coordination with agencies and organizations having responsibilities and interests in treatment of oil-impacted shorelines. The Project Oversight Committee will be the primary mechanism for coordinating this project with other state and federal agencies, and other organizations actively involved in overseeing, developing and/or implementing oil spill response processes.

The design of this project has been coordinated with Ms. Malin Babcock of the ABL. She is the leader of the ABL team that is conducting the mussel monitoring project and led the team that applied the sediment removal and replacement process on oil-impacted mussel beds (#090).

Planning for treatment of mussel beds will also be coordinated with other Trustees Council projects that are assessing the shorelines on Prince William Sound, e.g. the Shoreline Assessment/Oil Removal project (#266 by ADEC) and the planned PWS Shoreline Assessment project planned for FY 98 (#027). This will ensure that data and experiences obtained from earlier projects are incorporated into the planning of the field evaluations. Further, results of the field evaluations will provide data that should of value to future surveys along this shoreline.

The Trustee Council will make decisions at each major milestone as to whether the project should proceed to the next phase. As such, they will be able to incorporate the planned activities and results into the council's planning and budgeting for future investments. This includes the potential implementation of the treatment process to decontaminate and restore the remaining oil-impacted mussel beds on Prince William Sound. Additionally, the Trustee Council will be able to test the hypothesis of whether decontamination of the mussels accelerates the recovery of nearshore predator species injured by the *Exxon Valdez* oil spill. These species are being studied in Trustee Council projects that are monitoring black oystercatchers (#035), harlequin ducks (#427) and other nearshore vertebrate predators (#025).

The Project Team proposed for this project has the required experience to successfully complete this project. As described in the Personnel Section, the experience of the personnel to be involved in the laboratory and field evaluations is equivalent to or may exceed that which is present within the Trustee

Agencies. Both PES and Chenega have the unique experience of designing and conducting a shoreline restoration project using the modified airknife injection system to access subsurface oiled sediment in the 1993 shoreline restoration project. By using this system as proposed in this DPD, it will be possible to deliver oil-removing agents with minimal disruption of the mussels. Further, PES personnel have extensive experience in planning and participating in spill response and environmental restoration projects throughout Alaska. UAF personnel have extensive experience in research projects on the impact of oil spills on Arctic environments, e.g. Dr. Raymond Highsmith is the lead investigator on the Trustee Council's Herring Bay monitoring project (#086C). UCSC personnel have extensive background in designing and conducting toxicity studies on a variety of marine species. The NOAA/NMFS ABL is a Trustee Agency with significant experience in monitoring these mussel beds, as well as performing the sediment removal and replacement process (#090) and will be a member of the Project Team. Due to existing commitments of ABL, management and performance of the overall project would likely exceed their existing resources and require that a team be established with the expertise and experience already assembled for the proposed project.

ENVIRONMENTAL COMPLIANCE

This project will be conducted in accordance with all applicable federal, state and municipality regulations. Permits will be requested from appropriate organizations to enable the Project Team to treat the mussel bed sites selected for use in the field evaluations. Based on information available at this time, permits/approvals may need to be requested from the following organizations (others may be designated by the Trustee Council):

1. Alaska Department of Natural Resources - land use permit for mussel beds that are owned by the state;

2. State Historic Preservation Office - site review to determine presence of cultural resources or archeological sites and any potential impacts from the field evaluations;

3. Chenega - land entry permission for activities on corporation owned lands;

4. US Coast Guard - Captain of the Port, Valdez District;

5. Oily wastes collected in the field evaluations will be disposed of through Alaska Pollution Control, Inc. of Anchorage. Whenever possible, sorbent materials will be reused through on-site treatment; and

6. Mussels will be collected by UAF and shipped to UCSC in accordance with the Alaska Fish and Game regulations for transport of invertebrates. Prior to shipment, permission will also be obtained from the California Department of Fish and Game.

Following the initial trip to the potential field sites and review of the data by the POC, the required organizations will be informed of the specific sites selected. Approvals from the land owners, public notices and any other actions recommended by the Trustee Council will be obtained/completed by PES in time to enable the first phase of the field evaluations to be conducted in July or August, 1996. The second phase of the field evaluations are planned for August, 1997.

PERSONNEL

This section contains a brief summary of the experience of key personnel from each of the participating organizations. Additional information is contained in curriculum vitae which are included in Appendix B.

1. PES-Alaska

a. Mr. Stephen R. Rog is to be a Co-Project Manager responsible for coordinating the field evaluations and participating in the analysis of the laboratory and field evaluations, obtaining agency and land owners' approval for the field sites, participating as *ex officio* member and recorder on the Project Oversight Committee, and will be a point of contact for the Trustee Council and Project Team members. He manages PES-Alaska and is Vice President of the Oil Spill Response and Industrial Cleaning Division for PES. He holds a B.S. degree in Geology from Long Island University, is a professional geologist (AIPG-6743), and is a licensed geologist in Alaska (AA-132). Mr. Rog has received toxic and hazardous waste training, oil spill training, and is currently certified at the Hazardous Waste Supervisor level. He has over 20 years experience in geological, geotechnical, environmental, and hydrogeological projects. On these projects his responsibilities have included project management, technical management, data collection and evaluation, field logistics, subcontractor coordination, instrumentation installation and monitoring, construction inspection, and laboratory testing. Mr. Rog has been responsible for remote field investigation projects and is knowledgeable in the permit and regulatory aspects for conducting these projects within Alaska and other western states. Prior to joining PES, Mr. Rog was the Senior Environmental Coordinator for Tesoro Alaska Petroleum Company. Mr. Rog's oil pollution research experience includes serving as Project Manager on the previously described Prince William Sound shoreline restoration project in 1993 (Rog et al, 1994). During this project, his responsibilities included design of the field site; coordination of the project team that involved UAF and Chenega; coordination of data gathering; and development of reports and publications.

b. Dr. William Alter III is to be a Co-Project Manager responsible for overall management of the project, including fiscal matters, collection and integration of the team members' results into reports to be submitted to the POC and the Trustee Council, and will be the primary point of contact for the Trustee Council and Project Team members. Dr. Alter is an Environmental Physiologist and serves as the Director for Research and Technology Development at PES headquarters in San Antonio, and holds a doctorate from the University of New Mexico. Dr. Alter has extensive experience in development and coordination of R&D programs during his 22 years as an Aerospace Physiologist in the Air Force and during his 5 years as Research Coordinator at the University of Texas at San Antonio (UTSA). During his time at UTSA, he led multiorganizational teams in developing programs to identify, evaluate and transfer technologies for commercialization for the Air Force, NASA, and the city of San Antonio. He also led a multidisciplinary team in establishing the Environmental Biotechnology research program at UTSA which has received federal, state and industrial funding. He is the author/co-author of over 40 refereed publications and conference proceedings in the areas of physiology and technology transfer. Dr. Alter assembled the team members and coordinated the development of the proposal to decontaminate and restore oil-impacted tundra that has been recommended for funding by the Alaska Department of Environmental Conservation.

c. Dennis C. Owens will participate in the planning and analysis of the laboratory and field evaluations. He is a microbiologist and chemist for PES and has a Master of Science degree from Texas Tech University. Mr. Owens has extensive experience in the design and application of oil spill response products and served as the Technical Director for the 1993 shoreline restoration project. Mr. Owens founded PES in 1989 and is the holder of several patents and patent designs. Mr. Owens is currently serving on the Shoreline Countermeasures and Bioremediation Committees of the American Society of Testing and Materials (ASTM).

d. Mr. Swayne Walther will participate in the field evaluation efforts. He is the Senior Environmental Scientist for PES and holds a B.S. degree in Environmental Science from Sam Houston State University. He has over 11 years experience in the environmental area with extensive experience in oil spill response and bioremediation projects in Alaska while working for ENSR, Inc. Mr. Walther has experience in laboratory-based projects having headed the Bioremediation Laboratory for NuKem Development. He has completed Hazardous Waste Operations Training and is a member of the Alaska Association of Environmental Professionals.

2. University of Alaska Fairbanks

a. Dr. Mark Tumeo is to lead the UAF team and is proposed as the chairperson for the Project Oversight Committee. He is Director of the Environmental Technology Laboratory and Associate Professor of Civil Engineering at UAF. He holds a doctoral degree in Civil/Environmental Engineering from the University of California Davis. Dr. Tumeo has research experience in wast water treatment, modeling of fuel flows in ice in the Antarctic, ground water transport modeling, and the impact of petroleum hydrocarbons in Arctic and sub-Arctic environments. He led the UAF team in the shoreline restoration project in 1993, and was the primary author of the final report and journal publication on this project (Tumeo and Braddock, 1994; Tumeo et al, 1995).

b. Dr. Christina Behr-Andres will participate in the collection and analysis of information on agents that are candidates for inclusion in this project, and the analysis of laboratory and field evaluations during the project. She is an Assistant Professor of Civil Engineering at UAF and holds a doctoral degree from Michigan Technological University. Dr. Behr-Andres has research experience in evaluation and stabilization of hazardous wastes, and the characterization and recycling of industrial by-products and municipal solid wastes. Her research has been funded by state, federal (National Science Foundation, Environmental Protection Agency, U.S. Fish and Wildlife Service) and industrial sponsors.

c. Dr. Raymond Highsmith will conduct the biological analysis of the mussels at the field evaluation sites. Dr. Highsmith is a Professor of Marine Science at UAF and has a doctoral degree in Zoology from the University of Washington. Dr. Highsmith is one of the foremost authorities on mussels and other bivalves in Arctic waters. He is lead investigator on the Trustee Council Herring Bay monitoring project (#086C).

3. Chenega Corporation

Mr. Chuck Totemoff is President and Ms. Gail Evanoff is Vice President of the Chenega Corporation . Both have extensive experience in the planning, management and performance of oil spill response projects throughout Prince William Sound. They led the corporation's participation in the 1993 shoreline restoration project that was funded by ADEC.

4. University of California Santa Cruz

a. Dr. Ronald Tjeerdma will have lead responsibility and will participate in the design and performance of the laboratory evaluations of the candidate agents' toxicity. Dr. Tjeerdma is an Associate Professor of Chemistry and Biochemistry at UCSC and has a doctoral degree in Pharmacology and Toxicology from the University of California Davis. He has conducted toxicity tests on both invertebrate and vertebrate marine species. Dr. Tjeerdma has published extensively in journals, books and government reports. He was also one of the co-developers of the spiked-exposure test procedure which will be a key tool in the laboratory evaluation, and is accepted as a standard method by the state of California for dispersant toxicity testing. His laboratory is receiving funding from the Office of Oil Spill Prevention and Response of the California Department of Fish and Game, the Marine Spill Response Corporation and the US Coast Guard for research and toxicity testing of marine species.

b. Mr. Michael Singer will have primary responsibility for designing and performing the laboratory toxicity tests. Mr. Singer is a Research Associate with a master's degree in marine biology from San Jose State University. He has extensive experience in the performance of laboratory toxicity tests and has over 18 publications in journals, books and government reports. Mr. Singer led the group that designed the spiked-exposure test procedure which will be used in these laboratory toxicity tests.

3. NOAA/NMFS Auke Bay Laboratory

Ms. Malin Babcock will have lead responsibility for the ABL team participating in this project and will assist in choosing the field sites, design and implement the sampling protocols, and analyze results for evaluation of the treatment processes. She is a Researcher and Task Leader in ABL and has a master's degree from Oregon State University in Zoology. Ms. Babcock has extensive experience in laboratory and field-based studies on the short term and long term impacts of petroleum hydrocarbons on fish and shellfish. She has led ABL teams in the Trustee Council funded Coastal Habitat Study entitled "Pre-spill and post-spill hydrocarbon concentrations in mussels and sediments in Prince William Sound", and the NRDA study entitled "Injury to Oysters". Ms. Babcock also is leading ABL's activities on the Trustee Council's project that is monitoring mussels (#090). This project includes efforts to investigate the impact of exposing or replacing sediments to determine their impact on mussel bed recovery.

Table 1: Timelines and Milestones for Decontamination and Restoration of Mussel Beds

PROJECT MILESTONES	MONTHS AFTER PROJECT START															
	1	2	3	4	5	6	7	8	9	10	11	12	18→	24→	30→	36→
Contract Award	◆															
Establish Project Oversight Committee (POC)	◆															
Objective 1: Laboratory Analysis of Candidate Oil Removing Agents																
Literature Review and Analysis of Oil Removing Agents	◆	◆														
Review and Recommendations by POC		◆														
Interim Report 1 Submitted to Trustee Council		◆														
Obtain mussels for toxicity studies		◆														
Laboratory Toxicity Studies	◆	—	—	—	—	—	◆									
Examination of Potential Field Sites								◆								
Review and Recommendations by POC								◆								
Interim Report 2 Submitted to Trustee Council								◆								
Objective 2 - Field Evaluation of Candidate Treatment Processes																
Field Site Design						◆	—	◆								
Design of Candidate Treatment Processes							◆	—	◆							
First Phase of Field Evaluations										◆◆						
Analysis of Chemical and Biological Samples										◆	—	—	—	◆		
Analysis of Field and Laboratory Results														◆		

Table 1(Continued): Timelines and Milestones for Decontamination and Restoration of Oil-Impacted Mussel Beds

PROJECT MILESTONES	MONTHS AFTER PROJECT START															
	1	2	3	4	5	6	7	8	9	10	11	12	18→	24→	30→	36→
Cost Analysis of Candidate Treatment Processes											◆		◆			
Review and Recommendations by POC														◆		
Interim Report 3 Submitted to Trustee Council														◆		
Objective 3 - Field Evaluation of Prototype Treatment Process																
Design of Prototype Treatment Process													◆	◆		
Second Phase of Field Evaluations														◆		
Analysis of Chemical and Biological Samples														◆		◆
Cost Analysis of Prototype Treatment Process															◆	◆
Analysis of Field and Laboratory Results																
Review and Recommendations by POC																◆
Draft Final Report to Trustee Council																◆
Decision by Trustee Council on Implementation of the Validated Treatment Process																◆
Final Report to Trustee Council																◆
Quarterly Progress Updates			◆			◆			◆			◆	◆ ◆	◆ ◆	◆ ◆	◆

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PROJECT TEAM MEMBER'S COMMITMENTS

The team members have submitted budgets for inclusion in this proposal. Three of the organizations have submitted commitment letters which appear in Appendix C. The fourth, Chenega, is forwarding this letter by telefax to PES, and it will be forwarded to the Trustee Council as soon as it is received.

William A. Alter III

William A. Alter III, Ph.D. , Project Leader
PES
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Proposed Project Manager
Trustee Agency

April 28 1995

Date Prepared

APPENDIX A

DIAGRAMS OF THE SPIKED-EXPOSURE APPARATUS FOR TOXICITY TESTING

THE UNIVERSITY OF CALIFORNIA SANTA CRUZ

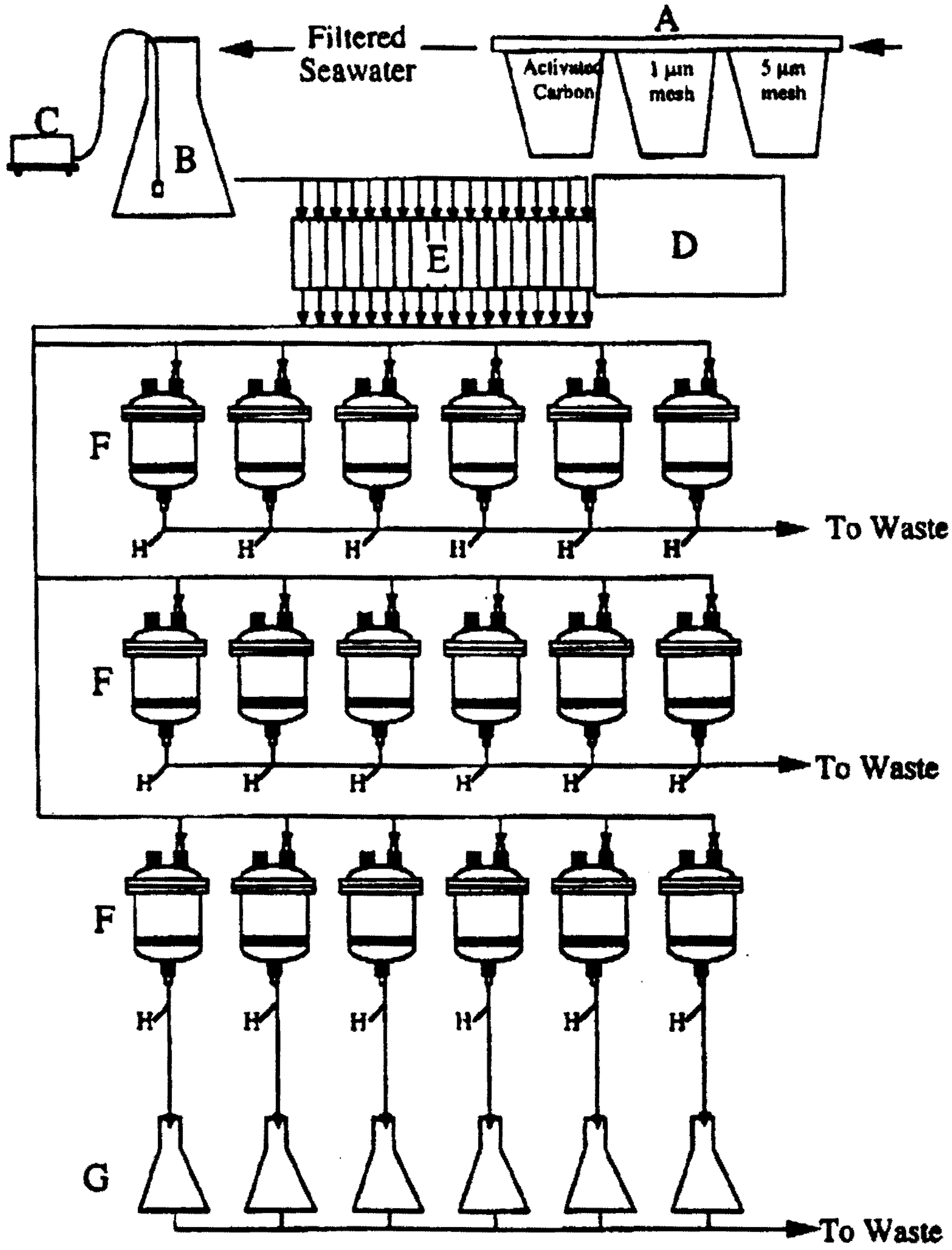

Figure . Schematic diagram of the exposure system showing flow patterns and main system components. A, cartridge filters; B, seawater head tank; C, aeration pump; D, peristaltic delivery pump; E, cartridge pump heads (18); F, exposure chambers; G, water quality sampling flasks, H, chemistry sampling ports.

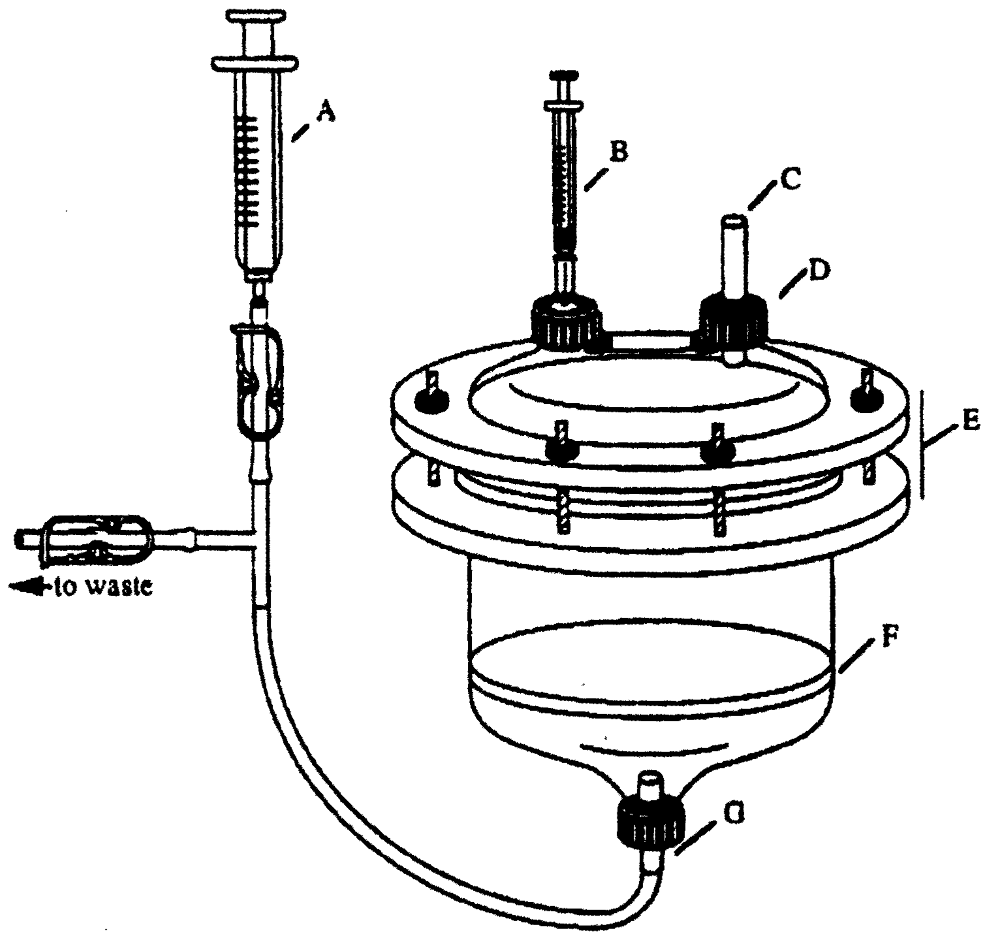

Figure . Schematic diagram of the toxicity test exposure chamber: A. Glass syringe for chemistry sampling; B, syringe for food introduction; C, Diluent inlet; D, threaded glass fittings with phenolic caps; E, silicone O-ring sealed glass flange with clamp; F, fritted glass disk; G, discharge outlet.

APPENDIX B

CURRICULUM VITAE

FOR KEY PROJECT TEAM MEMBERS

William A. Alter III, Ph.D.

Director, Research and Technology Development
Petroleum Environmental Services, Inc.

EDUCATION: 1964 B.A., Biology, St. Michael's College, VT
1966 M.S., Physiology, Purdue University, IN
1973 Ph.D., Physiology, University of New Mexico, NM

RECENT PROFESSIONAL EXPERIENCE:

1993-1994	NASA Space Grant Fellow, University of Texas - Austin, Located to NASA Johnson Space Center, Houston, TX
1993-Pres.	Faculty, U. S. Air Force School of Aerospace Medicine, Brooks AFB, TX
1990-1993	Adjunct Associate Professor, Department of Radiology, The University of Texas Health Science Center at San Antonio, TX
1989-1993	Research Coordinator, College of Sciences and Engineering, University of Texas at San Antonio, TX
1988-1993	Adjunct Associate Professor, Division of Life Sciences, University of Texas at San Antonio, TX
1987-1993	Lecturer, Aerospace Medicine Primary Course, USAF School of Aerospace Medicine, Brooks AFB, San Antonio, TX
1984-1988	Reviewer, Radiation Research Journal
1985-1987	Chief, Chemical Defense Division, Research and Technology Directorate, Human Systems Division, Brooks AFB, San Antonio, TX
1984-1985	Chief, Aeromedical Systems Function, Crew Technology Division, School of Aerospace Medicine, Brooks AFB, San Antonio, TX
1978-1984	Visiting Lecturer, Chemistry Department, United States Military Academy, West Point, NY
1980-1984	Assistant Professor of Military Medicine, Uniformed Services University of the Health Sciences, Bethesda, MD

PROFESSIONAL SOCIETIES:

Air and Waste Management Association
American Physiological Society
Associate Fellow of the Aerospace Medical Association
Technology Transfer Society

SELECTED REVIEWED PUBLICATIONS (from among 20):

1. Alter III, W.A., T.S. Mobley and R.L. Persing. Three to five day lethality in sheep following exposure to ^{60}CO-gamma radiation. Health Physics 20:343-345, 1971.

2. Alter III, W.A., G.K. Weiss, D.V. Priola and H.A. Spurgeon. The effects of 6-hydroxydopamine on the vagal cardioaccelerator system. Journal of. Pharmacol. Exp. Ther. 187:99-104, 1973

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7. Alter III, W.A., R.N. Hawkins, L.J. Parkhurst, S. Poulin and D. Padgett and D. Fink. Barbiturate depression of neurally mediated reflexes to coronary artery occlusion. Proc. Soc. Exptl. Biol. Med. 160:281-286, 1979.

8. Ashani, Y., G.N. Catravas and W.A. Alter III. An irreversible anticholinesterase probe for studying increased permeability of the rat blood brain barrier. Biochemical Pharmacol. 30:2585-2592,1981.

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12. Flannery, W.T. and Alter, W.A. III. Development, Implementation and Demonstration of a Technology Transfer Process. Final Report on a USAF Contract (W-7405-Eng-82) for the Human Systems Division, Brooks AFB, TX. 1991.

MALIM M. BABCOCK

EDUCATION:

Oregon State University, 1963, B.S., Zoology
University of Alaska Fairbanks, 1968, M.S., Zoology (Fisheries)

EXPERIENCE:

Researcher and Task Leader, Auke Bay Laboratory, National Marine Fisheries Service, Juneau, Alaska. Field, lab and analytical expertise, and data analyses and interpretation particularly with effects of petroleum hydrocarbons on aquatic fish and shellfish. Studies have included Prince William Sound chemical baseline, short term and long term water soluble fraction of crude oil and sediment toxicity tests assessing physiological and biochemical impacts, including growth and reproduction. I became Task Leader for the Coastal Habitat task within Habitat Investigations, ABL, in 1988 and directly supervise several staff scientists in varied research projects. I have strong participation in overall Habitat Investigations research planning, budget management and staffing.

After the Exxon Valdez oil spill, I was co-principal investigator for the EVOS Coastal Habitat Study "Pre-spill and post-spill hydrocarbon concentrations in mussels and sediments in Prince William Sound", becoming Principal Investigator for this project in 1991 and 1992; was also Principal Investigator for the NRDA study "Injury to Oysters" in 1989. In 1991, I participated in the interagency planning for investigating an evolving problem that of the effects of contaminated mussel beds on higher consumer organisms, and led the preliminary field effort for identifying these beds and sampling parameters to establish the extent and intensity of petroleum hydrocarbons contamination.

I have been project leader for NOAA for the PWS portion of Mussel Bed restoration and monitoring, coordinating and leading a staff to investigate extent and intensity of oiling; distribution of HCs within a mussel bed; effects of minimally intrusive manipulative techniques to reduce HCs by increasing exposure of oiled sediments; effects of chronic oiling on mussels (byssal thread production, condition and reproductive indices, glycogen stores, feeding rates, growth and histopathological abnormalities) and restoration of selected oil mussel beds in PWS.

Additionally, staff under my direct supervision are involved in many aspects of EVOS Restoration program for several studies, training all NRDA study personnel in sampling for hydrocarbons, the NRDA/Restoration database, sample custody and tracking, etc.

SELECTED PUBLICATIONS:

Rice, S.D., D.A. Moles, J.F. Kainen, S. Korn, M.G. Carls, C.C. Brodersen, J.A. Gharrett and M.M. Babcock. 1984. Effects of Petroleum Hydrocarbons on Alaskan Aquatic Organisms: A Comprehensive Review of All Oil-Effects Research on Alaskan Fish and Invertebrates Conducted by the Auke Bay Laboratory, 1970-81. NOAA Technical Memorandum NMFS F/NWC-67. pp. 128.

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CHRISTINA B. BEHR-ANDRES
Assistant Professor
Civil Engineering Department
University of Alaska
Fairbanks, Alaska 99712

EDUCATION:

1992 Ph.D. Environmental Engineering, Michigan Technological University
1988 M.S. Geochemistry, New Mexico Institute of Mining and Technology
1984 B.S. Geological Sciences, University of Michigan

PROFESSIONAL EXPERIENCE:

1994 - Present	Assistant Professor, Civil Engineering Department, Environmental Quality Science and Engineering Program, University of Alaska Fairbanks
1992 - 1994	Assistant Professor, Center for the Management, Utilization and Protection of Water Resources and the Civil and Environmental Engineering Department, Tennessee Technological University, Cookeville, Tennessee
1988 - 1992	Graduate Research Fellow, Civil and Environmental Engineering Department, Michigan Technological University, Houghton, Michigan
1987 - 1988	Engineering Scientist, Solid Waste and Geochemistry Group, Chemistry Division, Radian Corporation, Austin, Texas
1984 - 1987	Graduate Teaching and Research Assistant, Geoscience Department, New Mexico Institute of Mining and Technology, Socorro, New Mexico
1983 - 1984	Research Assistant, Geological Sciences Department, University of Michigan, Ann Arbor, Michigan

SELECTED HONORS, AWARDS AND FELLOWSHIPS:

1991 U.S. Department of Education, Doctoral Environmental Engineering Fellowship
1987 Radian Corporation, Corporate Achievement Award

PROFESSIONAL SOCIETY MEMBERSHIPS:

American Society of Civil Engineers
American Chemical Society, Environmental Chemistry Division
National Solid Waste Management Association
American Water Resources Association
Sigma Xi, The Research Society
Association of Environmental Engineering Professors

REVIEWED PUBLICATIONS:

Behr-Andres, C.B. and J.L. King, 1994. Evaluation of Alternative Materials for Solidification and Stabilization of Metal Sludge. *Hazardous Waste and Hazardous Materials*, in preparation.

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Raymond C. Highsmith

Curriculum Vitae

Professor of Marine Science
Institute of Marine Science
University of Alaska Fairbanks
Fairbanks, AK 99775-7220
Telephone: (907) 474-7836

Education:

Ph.D., 1979, Zoology, University of Washington (A.J. Kohn)
B.A., 1972, Zoology, Univ. of Iowa w/honors & distinction

Research Interests:

Intertidal and benthic community ecology, larval ecology, productivity, biodiversity

Professional Activities:

Chair, Kasitsna Bay Laboratory Comm., 1988-; President, Western Assoc. Marine Labs, 1995; Director, West Coast Nat'l Undersea Res. Center, 1990-; P.I. and Coordinator, Coastal Habitat Damage Assessment Study (EXXON Valdez oil spill), 1989-; P.I. & Coord. Herring Bay Experimental and Monitoring Studies, 1990-; Chief Scientist, 12 benthic community ecology & production cruises; Chief Scientist, 3 manned submersible cruises; NSF panel, NOAA panel

Related Publications:

Highsmith, R.C., T.L Rucker, M.S. Stekoll & others. Submitted. Impact of the EXXON Valdez oil spill on intertidal biota.
Coyle, K.O. and R.C. Highsmith. 1994. Benthic amphipod community in the northern Bering Sea: analysis of potential structuring mechanisms. Marine Ecology Progress Series 107:233-244.
Highsmith, R.C., K.O. Coyle and E. Stockmar. Submitted. Arctic food webs: fish and decapod predation on benthic amphipods.
Stekoll, M.S., L. Deysher, R.C. Highsmith & others. Submitted Coastal habitat Injury Assessment: Intertidal communities and the EXXON Valdez oil spill.
Highsmith, R.C. and K.O. Coyle. 1992. Productivity of Arctic amphipods relative to potential gray whale predation. Mar. Ecol. Prog. Ser. 83:141-150.
Highsmith, R. C. and K. O. Coyle. 1991. Amphipod life histories: community structure, impact of temperature on decoupled growth and maturation rates, productivity, and P:B ratios. American Zoologist 31:861-873.

Other Significant Publications:

Highsmith, R. C. and K. O. Coyle. 1990. High productivity of northern Bering Sea benthic amphipods. Nature 344:862- 864.

Highsmith, R. C. and R. B. Emlet. 1986. Delayed metamorphosis: effect on growth and survival of juvenile sand dollars (Echinoidea: Clypeasteroida). Bull. Mar. Sci. 39:347-361.

Highsmith, R. C. 1985. Floating and algal rafting as potential dispersal mechanisms in brooding invertebrates. Mar. Ecol. Prog. Ser. 25:169-179.

Highsmith, R. C. 1983. Sex reversal and fighting behavior: co-evolved phenomena in a tanaid crustacean. Ecology 64:719-726.

Highsmith, R. C. 1982. Induced settlement and metamorphosis of sand dollar (*Dendraster excentricus*) larvae in predator-free sites: adult sand dollar beds. Ecology 63:329-337.

DENNIS C. OWENS

PROFESSIONAL EXPERIENCE

Mr. Owens is founder and Chief Executive Officer of Petroleum Environmental Services, Inc. (PES®) having developed the original formulations of PES® biotreatment products.

He has over 20 years experience in leading teams of scientific, engineering and business professionals in the development, production and distribution of products in the petrochemical and food industries. Mr. Owens has also conducted research and directed analytical laboratories. Results of the research appear in over 20 publications in scientific and technical journals, and conference proceedings.

Prior to founding PES, Mr. Owens founded Biogenesis Labs, Inc. in 1984. This company manufactured biological products for the food service industry. Merk Laboratories, Inc. acquired Biogenesis in 1986, and thereafter, Mr. Owens served as Director of Research and Development for their Biological Products Division until establishing PES® in 1989. Earlier in his career, he founded Micro-Environmental Labs, Inc., a consulting company, that provided world-wide services to petrochemical industries specializing in corrosion engineering and wet chemistry analysis for secondary and tertiary oil recovery projects.

Mr. Owens established Petroleum Environmental Services, Inc. (PES®) as a manufacturer of bioremediation products. For the first four years, PES® products were sold by Tesoro Petroleum Corporation under an exclusive distributorship arrangement. Beginning in April of 1994, PES bought back these distribution rights, acquired the exclusive license to a bioremediation technology developed by the University of Texas at San Antonio (UTSA), and is now providing bioremediation products and technical services.

He is the holder of several patents and product designs that are currently marketed by various national firms. Most recently, Mr. Owens has filed a patent for a air-knife application process that will significantly enhance the method of releasing petrochemicals from subsurfaces after oil spills.

Over the past five years, Mr. Owens has directed PES®'s investment in university-based research programs that includes projects at UTSA, the University of Alaska Fairbanks, and the University of California at Santa Cruz. Based on the success of these investments, he conceived of the idea that a consortium of companies with similar interests could be far more effective in developing and commercializing technologies. This has led to the development of the Environmental Biotechnology Consortium which is to be a for-profit joint venture of companies with interests in developing and using remediation technologies and processes to permanently resolve problems with contaminated soils and groundwater.

EDUCATION/TRAINING

- **Bachelor of Science in Microbiology and Chemistry** - Texas Tech University, 1974
- **Master of Science in Industrial Microbiology and Inorganic Chemistry** - Texas Tech University, 1976

PROFESSIONAL ASSOCIATIONS

- American Society for Microbiology
- National Water Well Association
- Chemical Manufacturers Association
- American Society for Industrial Microbiology
- American Society for Testing and Materials.

PROJECT EXPERIENCE

- **PES-51® - Shoreline Restoration of Weathered Subsurface Oil in Prince William Sound, Alaska.** Leader for this project in which PES-51® was applied via an air-knife injection system to a rocky shoreline section on LaTouche Island. Results demonstrated that this process achieved dramatic reductions in petroleum contaminants, that had still adhered to subsurface rocks as a consequence of the 1989 *Exxon Valdez* oil spill. Mr. Owens assembled a team of scientists and engineers and technical personnel from universities, industries, government agencies and the Chenega Indian corporation to conduct this project. He secured funding from the Exxon Valdez Oil Spill Trustees Council to underwrite the majority of expenses for this project. A brief description of the project was published in the Almanac Section of the August 1994 issue of National Geographic.

- **Off-shore Corrosion Engineering.** Perform services for various major oil companies. Mr. Owens was responsible for developing secondary and tertiary corrosion and biocide programs for producing oil fields. Working locations for these services were provided at North Slope of Alaska, North Shore oil production, Central and South America, and various Pacific Basin production sites.

STEPHEN R. ROG, P.G.

PROFESSIONAL EXPERIENCE

Mr. Rog joined Petroleum Environmental Services, Inc. (PES®) in April, 1994 and is the head of the Alaska Sales Office. He has over 20 years of diverse geologic, geotechnical, environmental, and hydrogeologic experience on various engineering, construction, and exploration projects throughout Alaska and the Western United States. Project experience includes technical management, data collection and evaluation, field logistics and subcontractor coordination, instrumentation installation and monitoring, construction inspection, and laboratory testing.

Mr. Rog has worked on a variety of projects including oil spill response, hazardous waste and groundwater contamination investigations; underground storage tank (UST) and petroleum remediation (soil & groundwater) studies; arctic offshore site investigations; arctic and sub-arctic foundation studies; remote site explorations; pipeline route studies; design and installation of geotechnical monitoring equipment; dam site investigations; mineral resource evaluations; geologic hazard assessments; geotechnical engineering and environmental studies on tunnels, railroads, and military facilities; and multi-disciplinary environmental assessment projects. Mr. Rog has been responsible for remote field investigation projects and is knowledgeable in the permit and regulatory aspects for conducting these projects within Alaska and other western states.

Mr. Rog has worked as an exploration geologist for several mining companies in Alaska and the western United States and as an engineering geologist on the Trans Alaska and Northwest Alaska Pipeline Projects. He was also a geotechnical/environmental consultant for Hart Crowser, Inc., Earth Technology Corporation and Chen and Associates. Most recently, Mr. Rog was the Senior Environmental Coordinator for Tesoro Alaska Petroleum Corporation. Mr. Rog currently serves as Vice President of Petroleum Environmental Services, Inc., and is responsible for the Oil Spill Response and Industrial Cleaning Division.

EDUCATION/TRAINING

- **Bachelor of Science - Geology** - Long Island University, 1972
- Graduate Studies - University of Utah, 1972-1975
- Ground Water Quality Investigation, Monitoring and Sampling - Univ. of Alaska - Anchorage, 1987
- Ground Water and Unsaturated Zone Monitoring and Sampling (NWWA), 1987
- Toxic and Hazardous Waste Training (OSHA) - Univ. of Alaska - Anchorage, Mining and Petroleum Training Services (MPTS), 1987, 1988, 1989, 1990, 1991, 1992, 1993
- Hazardous Waste Supervisor Training - Univ. of Alaska - Anchorage (MPTS), 1987, 1991, 1992, 1993
- Cook Inlet Spill Response Organization - Oil Spill Training (Incident Command System) and spill drills, 1990, 1991, 1992, 1993

PROFESSIONAL REGISTRATIONS/ASSOCIATIONS

- **Professional Geologist (AIPG 6743)**
- **Licensed Geologist of Alaska (AA-132)**
- **Registered Environmental Professional (REP) (Pending)**
- American Institute of Professional Geologists (Vice President, Alaska Section 1987-88)
- Association of Engineering Geologists (Secretary/Treasurer 1989-90, Vice Chairman 1990-91)
- Geological Society of America
- National Ground Water Association
- Alaska Pipeline Builders Association
- Alaska Mining Association
- Alaska Ground Water Association

PROJECT EXPERIENCE

- **PES-51® - Prince William Sound Shoreline Restoration Project,** Alaska. Project Manager for PES-51® subsurface injection project at Sleepy Bay, LaTouche Island, Alaska. Coordinated contracts, logistics and scientific evaluations.

- **PES Bioremediation Projects,** Alaska. Project Manager for various *ex-situ* and *in-situ* soil and groundwater remediation projects utilizing PES-31® bioremediation products.

- **PES-51® Oil Spill Response Team** (various locations). Project Manager for PES-51® oil spill response team. Coordinated PES-51® orientation, testing and usage as well as health and safety monitoring at the following spills:

    - Morris J. Berman No. 6 fuel oil spill - San Juan, Puerto Rico (Jan-Feb 1994)
    - Brouchard Barge spill - Tampa, Florida (Aug-Sep 1993)
    - Barry Oil Company pipeline spill - McGrath Beach, California (Dec 1993)
    - UNOCAL Baker platform spill, Cook Inlet, Alaska (March 1994)
    - British Petroleum - Tanker/Vessel Eastern Lion Spill Valdez, Alaska, (May, 1994)

- **Tesoro Alaska, Anchorage Terminal, Port of Anchorage, Alaska.** Site assessment/characterization, secondary containment upgrade at Tanker/Truck Loading Rack (TTLR), pipeline leak investigation/remediation, soil remediation by DCR™ (Bolsing Process), soil bioremediation/re-vegetation, Oil Spill Contingency Plan (OSCP), hazardous waste disposal/coordination. Technical Committee member for Petroleum Users Group (PUG) area wide assessment.

- **Tesoro Alaska - Fairbanks Terminal, Fairbanks International Airport, Alaska.** Site assessment/characterization, ground water monitoring, free product recovery, OSCP, hazardous waste disposal/coordination.

- **Tesoro Alaska - Valdez Terminal, Valdez, Alaska.** Technical monitoring of on-going groundwater bioremediation project, OSCP, hazardous waste disposal/coordination.

- **Tesoro Alaska - Nikiski Terminal, Nikiski, Alaska.** Site assessment/characterization.

- **Tesoro Refining, Marketing and Supply Company - Sacramento Terminal, California.** Site assessment/characterization, soil/ground water remediation, agency negotiations, area wide assessment.

- **Tesoro Refining, Marketing, and Supply Company - Stockton Terminal, California.** Site assessment/characterization, soil/ground water remediation, Port of Stockton Technical Committee.

- **Tesoro Alaska and Tesoro Petroleum Corporation - Underground Storage Tank Projects.** (Alaska, California, New Jersey, South Dakota, Virginia, Maryland). Manager/coordinator for UST project site assessments, characterization, remediation efforts for current and prior operated retail gas stations.

- **MAPCO/UNOCAL Terminal, Port of Anchorage, Alaska.** Project Manager for multi-phase investigation including historical, regulatory compliance, hydrogeologic, and environmental investigation/assessment of the level and extent of petroleum hydrocarbons in soils and groundwater. A 19-monitoring well network was installed for ongoing testing. Remediation alternatives were developed and are pending negotiations with the Alaska Department of Environmental Conservation.

- **Chevron Terminal, Port of Anchorage, Alaska.** Project Manager for hydrogeologic/environmental site assessment for petroleum hydrocarbons in soils and groundwater. Scope of work included installation of a 10-monitoring well network, groundwater sampling/testing, and negotiations with the Alaska Department of Environmental Conservation for scoping of level of effort for the assessment and monitoring program.

- **Chevron Bulk Plant, Valdez, Alaska.** Project Manager for pre-acquisition site assessment and subsurface investigation for petroleum contamination assessment. This work was initiated by Tesoro and continued by Chevron USA, Inc.

- **Petro Star, Inc., Fairbanks, North Pole, and Delta Junction, Alaska.** Project Manager for environmental audit of refinery, bulk plant, retail fuel and maintenance operations. Work included regulatory compliance audit, site reconnaissance/inspections and development of recommendations for facility management consideration to upgrade compliance status.

- **Alaska Department of Environmental Conservation, North Kenai and Anchor Point, Alaska.** Project Manager for hazardous waste/petroleum investigations for Anchor Point and Arness disposal site assessments, monitoring well drilling, and soil vapor extraction feasibility testing for remediation of soil and groundwater. Preliminary cost estimates were developed for the various alternatives.

- **Underground Storage Tank Assessment-Groundwater Investigation, Site Remediation, Anchorage, Alaska.** Project Manager for multi-phase investigation of 12 gas stations to determine the source and extent of petroleum product subsoil and groundwater contamination beneath the sites. The project involved installation of monitoring wells, wellhead elevation surveys, well development, soil and groundwater sampling, and geochemical testing for hydrogeologic assessments. Site remediation (vapor extraction) and product recovery systems were developed for four stations under scrutiny of the Alaska Department of Environmental Conservation. Project Manager for numerous UST removal/upgrade projects for site closure and station reconstruction/remediation.

- **Alaska Railroad PCB Cleanup, Whittier, Alaska.** Project Manager for development of the Remedial Action Plan (RAP) and on-site technical coordinator for major PCB cleanup project. Responsibilities included development of soil/wipe sampling plans and data assessment, and daily coordination of soil excavation, PCB waste handling and cleanup operations of two 35-gallon PCB transformer spills in a railroad freight transit shed recess track area, and decommissioning and cleanup of PCB transformer vaults. Project responsibilities included development of controlled soil excavation methods using a backhoe and an assessment of potential PCB groundwater contamination in 2 deep excavations.

- **Ground Water Investigation/Soil Vapor Extraction System (SVX), Soldotna, Alaska.** Project Manager/Geologist responsible for subsurface exploration, monitoring well installation, and groundwater sampling for a remedial investigation of a petroleum product contaminated aquifer. Design and installation of an SVX system for remediation. Conducted negotiations with the Alaska Department of Environmental Conservation for compliance order.

PUBLICATIONS

- Rog, S.R. and K.L. Marcus. 1982. Middle Cretaceous Coal Bearing Stratigraphy from Wainwright, North Slope, Alaska. Geological Society of America. Abs.

- Rog, S.R., and D. Brailey. 1989. Rate Limited Vapor Extraction of Dissolved/Absorbed Gasoline Constituents: Soldotna, Alaska. Environmental Hazards Conference and Exposition, Seattle, WA, Abs.

- Rog, S.R., K.L. Marcus, R. Donovan, and S. Kent. 1994. Assessment and Remediation of a Mixed Waste Site, Kenai, Alaska. Air and Waste Management Association Proceedings, Abs.

- Rog, S.R., S. State, and E. Opstad. 1994. Remediation of a Remote Site in Alaska Contaminated with Naturally Occurring Radioactive Material (NORM). Waste Management Proceedings. Abs.

- Rog, S., D. Owens, L. Pearson, M. Tumeo, J. Braddock, and T. Venator. 1994. PES-51® Shoreline Restoration of Weathered Subsurface Oil in Prince William Sound, Alaska. Proceedings of the 17th Arctic and Marine Oil Spill Program (AMOP) Technical Program. Vancouver, British Columbia. June, 1994. pp. 607-620

- Tumeo, M., J.F. Braddock, T. Venator, S. Rog, and D. Owens. 1994. Effectiveness of a Biosurfactant in Removing Weathered Crude Oil from Subsurface Beach Material. Spill Science and Technology Bulletin 1(1): 53-59, 1994.

MICHAEL M. SINGER

EDUCATION

A.B. Occidental College (Marine Biology)
M.A. Moss Landing Marine Laboratories, San Jose State University (Marine Biology)

POSITIONS

Research Assistant, Department of Biology, Occidental College,1975 – 1979; Biological Aide, National Marine Fisheries Service, 1980; Graduate Research Assistant, Moss Landing Marine Laboratories, 1980 – 1981; Research Assistant, Kelco Division of Merck & Co., Inc., 1981; Graduate Teaching Assistant, Moss Landing Marine Laboratories 1981; Environmemtal Specialist, Vantuna Research Group, Occidental College, 1982 – 1987; Research Assistant, Moss Landing Marine Laboratories., 1987; Staff Research Associate II, UC Santa Cruz, 1988 – 1990; Operations Manager, Bioassay Division, ToxScan, Inc. Watsonville, CA, 1990 – 1991; Assistant Research Specialist III, UC Santa Cruz, 1991–1993;Associate Research Specialist II, UC Santa Cruz, 1993–present.

SELECTED PUBLICATIONS

Singer, M. M., 1985. Food habits of juvenile rockfishes (*Sebastes*) in a central California kelp forest. *Fish. Bull.* 83(4):531–541.

Stephens, J S., Jr., G. A. Jordan, P. A. Morris, M. M. Singer, and G.E. McGowan, 1986. Is there a relationship between planktonic larvae, recruitment and population stability on a temperate reef? CalCOFI Rep., Vol. 27:65–83.

Love, M. S., J. S. Stephens, Jr., P. A. Morris, M. M. Singer, M. Sandhu, and T. Sciarrotta, 1986. Inshore soft substrate fishes in the Southern California Bight, an overview. CalCOFI Rep., 27:84–106.

Stephens, J. S., Jr., M. M. Singer, and L. Targgart, 1989. Notes on the first record of the orangethroat pikeblenny, *Chaenopsis alepidota* (Gilbert), in mainland California. *Cal. Fish Game* 75: 181–184.

Tjeerdema, R. S., M. M. Singer, G. M. Scelfo, D. L. Smalheer, L. M. Swall, G. E. Croston, D. M. Fry, and M. Martin, 1990. *Environmental Toxicology of Oil Spill Cleanup Agents*. National Technical Information Service, PB 90-250267-AS, US Departmnent od Commerce, Springfield, VA, 175 pp.

Singer, M. M., D. L. Smalheer, and R. S. Tjeerdema, 1990. A simple continuous-flow toxicity test system for microscopic life stages of aquatic organisms. *Wat. Res.* 7:899–903.

Singer, M. M., D. L. Smalheer, R. S. Tjeerdema, and M. Martin, 1990. Toxicity of an oil dispersant to the early life stages of four California marine species. *Environ. Toxicol. Chem.* 9:1387–1395.

Singer, M. M., D. L. Smalheer, R. S. Tjeerdema, and M. Martin, 1991. Effects of spiked exposure to an oil dispersant on the early life stages of four California marine species. *Environ. Toxicol. Chem.* 10:1367–1374.

Tjeerdema, R. S., M. M. Singer, and D. L. Smalheer, 1991. Continuous-flow toxicity tests using the microscopic life stages of various marine organisms. *Can. Tech. Rep. Fish. Aquat. Sci.* 1774:348–354.

Tjeerdema, R. S., and M. M. Singer, 1991. Closed flow-through toxicity testing with microscopic organisms: Not necessarily incompatible. *Mar. Pollut. Bull.* 22:59–61.

Singer, M. M., R. S. Tjeerdema, and D. L. Smalheer, 1992. Evaluation of the toxicological effects of oil dispersants by modeled-exposure toxicity testing. *Can. Tech. Rep. Fish. Aquat. Sci.* 1863:175–182.

Singer, M. M., S. George, D. Benner, S. Jacobson, R. S. Tjeerdema, and M. L. Sowby, 1993. Comparative toxicity of two oil dispersants to the early life stages of two marine species. *Environ. Toxicol. Chem.* 12:1855–1863.

Singer, M. M., and R. S. Tjeerdema, 1993. Fate and effects of the surfactant sodium dodecyl sulfate. *Rev. Env. Contam. Toxicol.* 133:95–149.

McNulty, H. R., B. S. Anderson, J. W. Hunt, and M. M. Singer, 1994. Relationship between respiratory surface area and age-specific copper toxicity to topsmelt, *Atherinops affinis*. *Environ. Toxicol. Chem.* 13:487-492.

Singer, M. M., S. George, S. Jacobson, I. Lee, R. S. Tjeerdema, and M. L. Sowby, 1994. Comparative effects of oil dispersants to the early life stages of topsmelt (*Atherinops affinis*) and kelp (*Macrocystis pyrifera*). *Environ. Toxicol. Chem.* 13:649 655.

Singer, M.M., S. George, S. Jacobson, I. Lee, R.S. Tjeerdema, M.L. Sowby, 1994. Comparative toxicity of Corexit® 7664 to the early life stages of four marine species. *Arch. Environ. Contam. Toxicol.* 27:130-136.

Singer, M.M., S. George, R.S. Tjeerdema, 1995. Relationship of some physical properties of oil dispersants and their toxicity to marine organisms. *Arch. Environ. Contam. Toxicol.* (in press).

Singer, M. M., S. George, S. Jacobson, I. Lee, R. S. Tjeerdema and M. L. Sowby, 1995. Acute toxicity of the oil dispersant Corexit 9554 to marine organisms. *Ecotoxicol. Environ. Saf.* (in press).

MARK A. TUMEO
Associate Professor
Department of Civil Engineering
Director, Environmental Technology Laboratory
University of Alaska Fairbanks
Fairbanks, Alaska 99775

EDUCATION:

1988	Ph.D. Civil/Environmental Engineering, University of California Davis
1986	Environmental Law, Water Law, Martin Luther King Law School, University of California Davis
1982	M.S. Civil/Environmental Engineering, University of California Davis
1981	B.S. Civil Engineering, University of Notre Dame
1981	B.S. Biology, University of Notre Dame

PROFESSIONAL REGISTRATION:

Registered Professional Engineer in the State of Alaska, License Number CE 7767
Certified Underground Storage Tank Worker, State of Alaska (Pending)

PROFESSIONAL EXPERIENCE:

1993 - Present	Associate Professor, Department of Civil Engineering, University of Alaska Fairbanks
1988 - 1993	Assistant Professor, Department of Civil Engineering, University of Alaska Fairbanks
1990 - Present	Director, Environmental Technology Laboratory, University of Alaska Fairbanks
1984 - Present	Principal, Tumeo Engineering, Fairbanks, Alaska
1986 - 1988	Associate Instructor and Post-Graduate Research Engineer, University of California Davis
1985 - 1986	Chief Project Engineering, Cunningham Engineering, Davis, California
1983 - 1985	Consulting Engineer, G.T. Orlob & Associates, Green Valley, California
1983	Invited Researcher, Young Scientists' Summer Program, International Institute of Applied Systems Analysis, Vienna, Austria.
1982 - 1983	Design Engineer-I, Moldenhauer Engineering, Davis, California

SELECTED HONORS, AWARDS AND FELLOWSHIPS:

1993 - 1994	AAAS Congressional Fellow, Office of Senator Barbara Mikulski
1991	Fulbright Teaching Award to Peru
1990	Recipient of a UAF Mellon Grant Travel Award
1986 & 1987	Participant in two NATO Advanced Study Institutes
1986	Best Paper Award, 19th Annual Simulation Symposium, Tampa, Florida
1986	American Chemical Society Graduate Student Award in Environmental Chemistry
1977 - 1981	Recipient of the Glenna R. Joyce Scholarship to the University of Notre Dame

PROFESSIONAL SOCIETY MEMBERSHIPS:

American Society of Civil Engineers
National Water Well Association
Society for Judgement and Decision-Making
Water Pollution Control Federation
Association of Environmental Engineering Professors
Hazardous Materials Control Research Institute

SELECTED REVIEWED PUBLICATIONS:

Tumeo, M.A., J.F. Braddock, T. Venator and S. Rog. Effectiveness of a biosurfactant weathbered crude oil from sub-surface beach material. In Spill Sci. Technol. Bull., 1(1):53-59, 1994.

Tumeo, M.A. and T. Stephens (Pending). Evaluation of small diffusers for on-site waste water treatment. Submitted to J. of Environ. Engineering (Sept., 1994).

Church, A., M.A. Tumeo and L. Raad (Pending). An experimental study on the leaching of fly ash. Submitted to Transportation Research Board (Aug., 1994).

Stephens, T. and M.A. Tumeo (Pending). An alternative to septic tanks for on-site wastewater treatment. Submitted to J. of Environ. Engineering (Apr., 1994).

Tumeo, M.A. and A.E. Wolk (Pending). Assessment of the presence of oil-degrading microbes at McMurdo Station. Submitted to U.S. Antarctic Journal (May, 1994).

Tumeo, M.A. and M.K. Larson (Pending). Movement of fuel spills in the Ross ice shelf. Submitted to U.S. Antarctic Journal (May, 1994).

Tumeo, M.A., J.F. Braddock, T. Venator, S. Rog and D. Owens, 1994. Effectiveness of a biosurfactant in removing weathered crude oil from subsurface beach material. In Spill Sci. Technol.Bull., 1(1), pp. xxx-xxx.

Jaffe, D.A., E. Leighton and M.A. Tumeo, 1994. Environmental impact on the polar regions. In Forum for Applied Research and Public Policy, Vol. 9, No. 1, pp. 65-70.

Tumeo, M.A. and Bret Davidson, 1993. Hydrocarbon exclusion from ground water during freezing. In ASCE J. of Environ. Engineering, Vol. 119(4), pp. 715-724.

Stephens, T. and M.A. Tumeo, 1993. Pulsation errors in compressible flow measurement. In ASCE J. of Environ. Engineering, Vol. 119(2), pp. 384-389.

Tumeo, M.A., 1992. Effects of lime-sludge discharge on an arctic river. In Water Resources Bulletin, Vol. 28, No. 6, pp. 1083-1094.

Kirts, C.A. and M.A. Tumeo, 1991. Teaching the dilemmas of commons property management using the commons game. J. of Environ. Ed., Vol. 22(3), pp. 22-27.

Gosink, T.A., J.J. Kelly, B.R. Koci, T.W. Burton and M.A. Tumeo, 1991. Butyl acetate, an alterative drilling fluid for deep ice coring projects. Journal of Glaciology, Vol. 37(25), pp. 170-176.

Zukowski, M. and M.A. Tumeo, 1991. Modeling solute transport in groundwater at or near freezing. In Groundwater, Vol. 29(1), pp. 21-25.

Kirts, C.A., M.A. Tumeo and J.M. Sinz, 1991. The commons game: Its instructional value when used in a natural resouces management context. In Simulation and Gaming, Vol. 22(1), pp. 5-18.

Tumeo, M.A. and C.T. Orlob, 1990. A technique for the assessment of uncertainty in water quality models used for public health risk analysis. Contribution 201, ISSN 0575-4941, California Water Resources Center, University of California, Publishers, December, 1990.

Tumeo, M.A. and G.T. Orlob, 1989. An analytic technique for Stochastic analysis in environmental models. In Water Resources Research, Vol. 25(12), pp. 2417-2422.

RONALD S. TJEERDEMA

EDUCATION

B.S. Humboldt State University, 1980 (Wildlife Management)
B.S. Humboldt State University, 1980 (Natural Resource Planning and Interpretation)
M.A. UC Santa Barbara, 1983 (Marine Pharmacology)
Ph.D. UC Davis, 1987 (Pharmacology and Toxicology)

POSITIONS

Teaching Assistant, Department of Biology, UC Santa Barbara, 1981–83; Research Assistant, Department of Biology, UC Santa Barbara, 1982; NIEHS Predoctoral Fellow, Department of Environmental Toxicology, UC Davis, 1983–87; Assistant Research Toxicologist, Institute of Marine Sciences, UC Santa Cruz, 1987–92; Assistant Professor of Chemistry and Biochemistry, UC Santa Cruz, 1992–94; Associate Professor of Chemistry and Biochemistry, UC Santa Cruz, 1994–present.

SELECTED PUBLICATIONS

Tjeerdema, R. S., Croston, G. E., Swall, L. M. and Martin, M. 1989. *Petroleum Fate and Cleanup Agent Toxicology: An Annotated Bibliography [1967–1988]*. National Technical Information Service PB89-134589-AS, US Department of Commerce, Springfield, VA, 120 pp.

Croston, G. E., and Tjeerdema, R. S. 1990. Hydrolysis of a model surfactant as measured using acyl coenzyme A synthetase. *Toxicol. Environ. Chem.* 28:245–256.

Singer, M. M., Smalheer, D. L. and Tjeerdema, R. S. 1990. A simple, continuous-flow toxicity test system for the microscopic life stages of aquatic organisms. *Water. Res.* 7:899–903.

Singer, M. M., Smalheer, D. L., Tjeerdema, R. S., and Martin, M. 1990. Comparative toxicity of Corexit 9527 to early life stages of four California marine species. *Environ. Toxicol. Chem.* 9:1387–1395.

Tjeerdema, R. S., and Jacobs, R. S. 1990. Partitioning of 2,4,5,2',4',5'-hexachlorobiphenyl between seawater and air. *Bull. Environ. Contam. Toxicol.* 44:572–578.

Tjeerdema, R. S., Singer, M. M., Scelfo, G. M., Smalheer, D. L., Swall, L. M., Croston, G. E., Fry, D. M. and Martin, M. 1990. *The Toxicology of Oil Spill Cleanup Agents*. National Technical Information Service PB90- 250267-AS, US Department of Commerce, Springfield, VA, 175 pp.

Scelfo, G. M., and Tjeerdema, R. S. 1991. Simple method for determination of Corexit 9527 in natural waters. *Mar. Environ. Res.* 31:69–78.

Singer, M. M., Smalheer, D. L., Tjeerdema, R. S., and Martin, M. 1991. Comparative toxicity of declining Corexit 9527 exposures to early life stages of four marine species. *Environ. Toxicol. Chem.* 10:1367–1374.

Swall, L. M., and Tjeerdema, R. S. 1991. Tissue disposition and temperature dependence of xenobiotic hydrolysis in the dungeness crab (*Cancer magister*). *Aquat. Toxicol.* 20:1–12.

Tjeerdema, R. S., Fan, T. W.-M., Higashi, R. M., and Crosby, D. G. 1991. Sublethal effects of pentachlorophenol in the abalone (*Haliotis rufescens*) as measured by in vivo ^{31}P NMR spectroscopy. *J. Biochem. Toxicol.* 6:45–56.

Tjeerdema, R. S., Kauten, R. J., and Crosby, D. G. 1991. Interactive effects of pentachlorophenol and hypoxia in the abalone (*Haliotis rufescens*) as measured by in vivo ^{31}P NMR spectroscopy. *Aquat. Toxicol.* 21, 279–294.

Tjeerdema, R. S., Kauten, R. J. and Crosby, D. G. 1991. Sublethal effects of hypoxia in the abalone (*Haliotis rufescens*) as measured by in vivo ^{31}P NMR spectroscopy. *Comp. Biochem. Physiol.* 100B, 653–659.

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SWAYNE A. WALTHER

PROFESSIONAL EXPERIENCE

Mr. Walther joined Petroleum Environmental Services, Inc.(PES®) in April, 1994 as the Senior Environmental Scientist. He is responsible for the design and coordination of bioremediation projects and provides technical assistance to clients in products' applications. Mr. Walther has eleven years advancing experience in the environmental industry. His specialization entails the design, implementation, operation and management of *in situ* and above-grade, solid and liquid phase bioremediation treatment processes with extensive experience in remediation projects in Alaska. Mr. Walther also has considerable experience in screening, developing, directing, and operating bench and pilot-scale biological and physical treatment processes.

Mr. Walther began his professional career as a Laboratory Supervisor for East Texas Environmental, Inc. He was a Remediation Specialist for ENSR Consulting and Engineering, Inc. and held several positions while at NuKem Development including Head of the Bioremediation Laboratory, Research Chemist and Project Manager.

EDUCATION/TRAINING

- **Bachelor of Science - Environmental Science** - Sam Houston State University in 1985
- BioVenting Principal & Practices - Robert Hinchee/International Network for Environmental Training, Inc.
- Bioremediation of Contaminated Soils and Sludges - University of Texas
- 40-hour Hazardous Waste Operations Training.

PROFESSIONAL REGISTRATIONS & AFFILIATIONS

- National Association of Environmental Professionals
- Alaska Association of Environmental Professionals
- Texas Association of Environmental Professionals

EXPERIENCE ON REPRESENTATIVE PROJECTS

- **Cook Inlet Pipe Line Company - Bioremediation Project.** Remediation specialist for the *in situ* and above-grade treatment of hydrocarbon-impacted soils and groundwater resulting from crude oil and aviation fuel spills in Drift River, Alaska. Responsible for designing and conducting microbiological and physicochemical monitoring programs for air sparging, engineered landfarm, and biocell treatment projects.
- **Alyeska Pipeline Service Company - Bioremediation Project.** Remediation specialist for the bioremediation of diesel-contaminated soils in an above-grade treatment cell in Delta, Alaska. Project included design and installation of vapor monitoring points, thermistors, and soil moisture sensors for monitoring of the treatment system operation.
- **Tesoro Alaska Petroleum Company - Bioremediation Test Plot Study.** Project manager for a bioremediation study on hydrocarbon-impacted soils at the Tesoro Refinery in Nikiski, Alaska. Designed soil test plots and evaluated the performance of land-treated soils receiving microbial inoculation versus those relying upon indigenous microorganisms.

- **Wood River Lodge - Bioremediation Project.** Bioremediation specialist for the biological treatment of soils and groundwater impacted from various fuel oil, diesel, and gasoline spills in Aleknagik, Alaska. The on-site remediation consisted of a biocell treatment system aerated by a blower and *in situ* treatment consisting of several aeration vents aerated by low-energy blowers.

- **Suburban Propane - Bioremediation Project.** Bioremediation specialist for the design and implementation of a bioremediation project used to treat 500 cubic yards of diesel-contaminated soil in Anchorage, Alaska. Included evaluation of nutrient requirements, performance monitoring, and development of site closure strategies.

- **French Limited Superfund Site - Field Laboratory Manager.** Managed the on-site inorganic laboratory during the French Limited *in situ* bioremediation demonstration. Coordinated and supervised sampling and analysis; guided daily amendments; and interpreted data relating to the fate of CERCLA target compounds in regards to microbial metabolism.

- **Nite/Denite™ Process.** Directed ENSR's proprietary process for the biological treatment of high strength nitrogenous industrial wastewaters. Responsibilities included data interpretation, supervision of bench-scale pilot plant operation, and chemical analysis.

- **Geneva Steel.** Supervised the start-up and operation of a 15 gallons per hour activated sludge pilot plant in Orem, Utah utilizing ENSR's Nite/Denite™ technology.

- **Alyeska Pipeline Service Company - Feasibility Study.** Lead a feasibility study of treatment alternatives for an oily sludge produced at a terminal in Valdez, Alaska. Included performing and supervising treatability studies at a research laboratory, and engineering feasibility evaluations, resulting in significant cost savings for sludge management.

- **Biotreatability Screenings.** Supervised in-house biotreatability laboratory. Responsible for biotreatability screening studies for various clients at numerous sites throughout Alaska. Studies included evaluation of site and soil characteristics, nutrient availability, oxygen uptake, toxicity, and microbial enumeration. These studies provided recommendations to clients on the potential of bioremediation processes.

- **Refinery Sludge Treatment Process.** Participated in the development of ENSR's Proprietary Solvent Extraction Process for selective removal of oils and EPA-regulated organic contaminants from refinery sludges. Responsibilities included supervision of bench-scale parametric studies; GC/FID analytical method development and data acquisition, interpretation, and reduction to design and construction of a 3-5 gallons per hour pilot plant. Patent application filed.

- **Enterprise Products - Mt. Pleasant, Texas.** Directed the start-up of a 0.13 million gallons per day oxidation pond. Responsibilities included monitoring operational parameters prior to permitted discharge; implementing a sampling program to meet regulatory and operational requirements and conducting seminars to train personnel with sampling and treatment pond maintenance.

APPENDIX A

DIAGRAMS OF THE SPIKED-EXPOSURE APPARATUS FOR TOXICITY TESTING

THE UNIVERSITY OF CALIFORNIA SANTA CRUZ

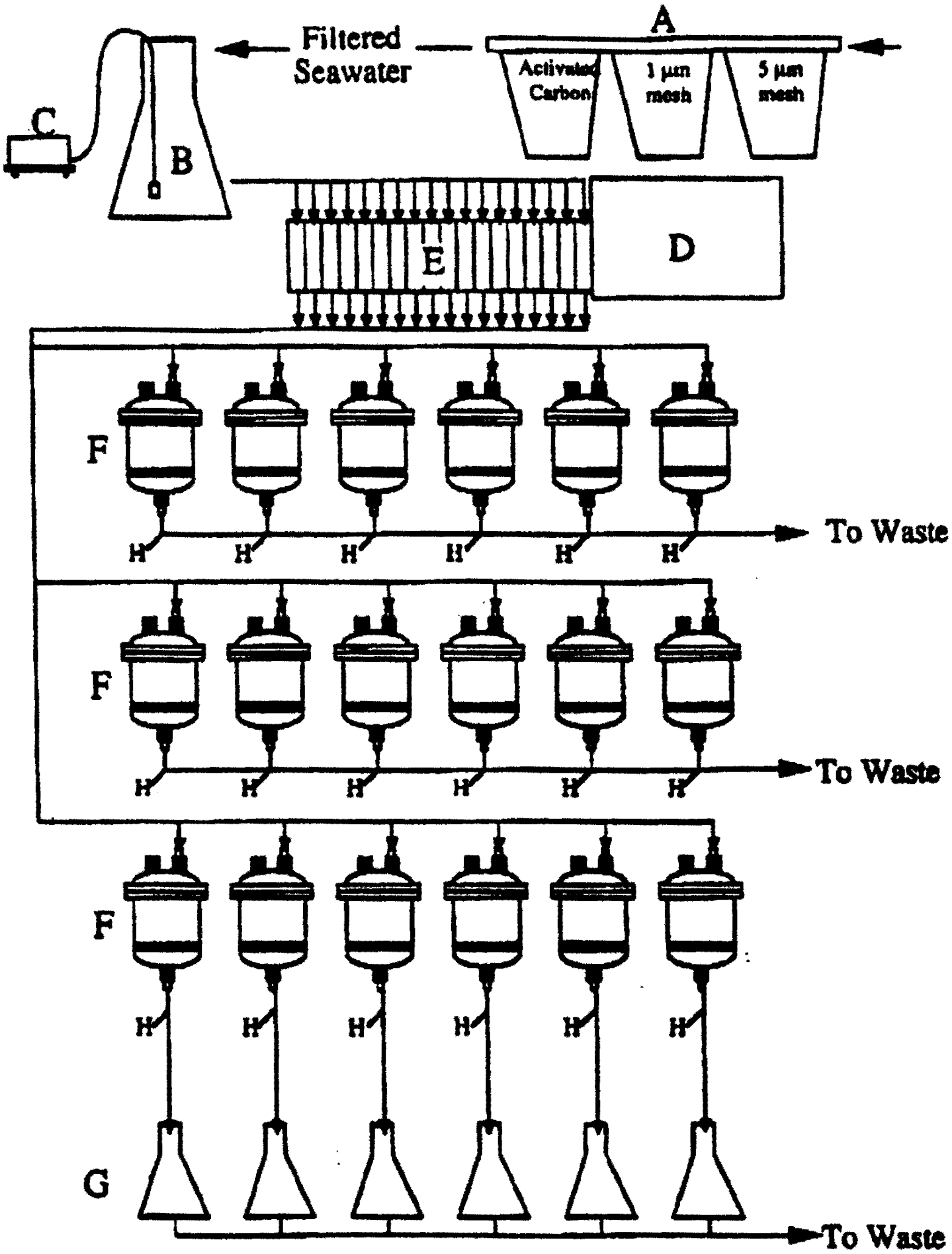

Figure . Schematic diagram of the exposure system showing flow patterns and main system components. A, cartridge filters; B, seawater head tank; C, aeration pump: D, peristaltic delivery pump; E, cartridge pump heads (18); F, exposure chambers; G, water quality sampling flasks, H, chemistry sampling ports.

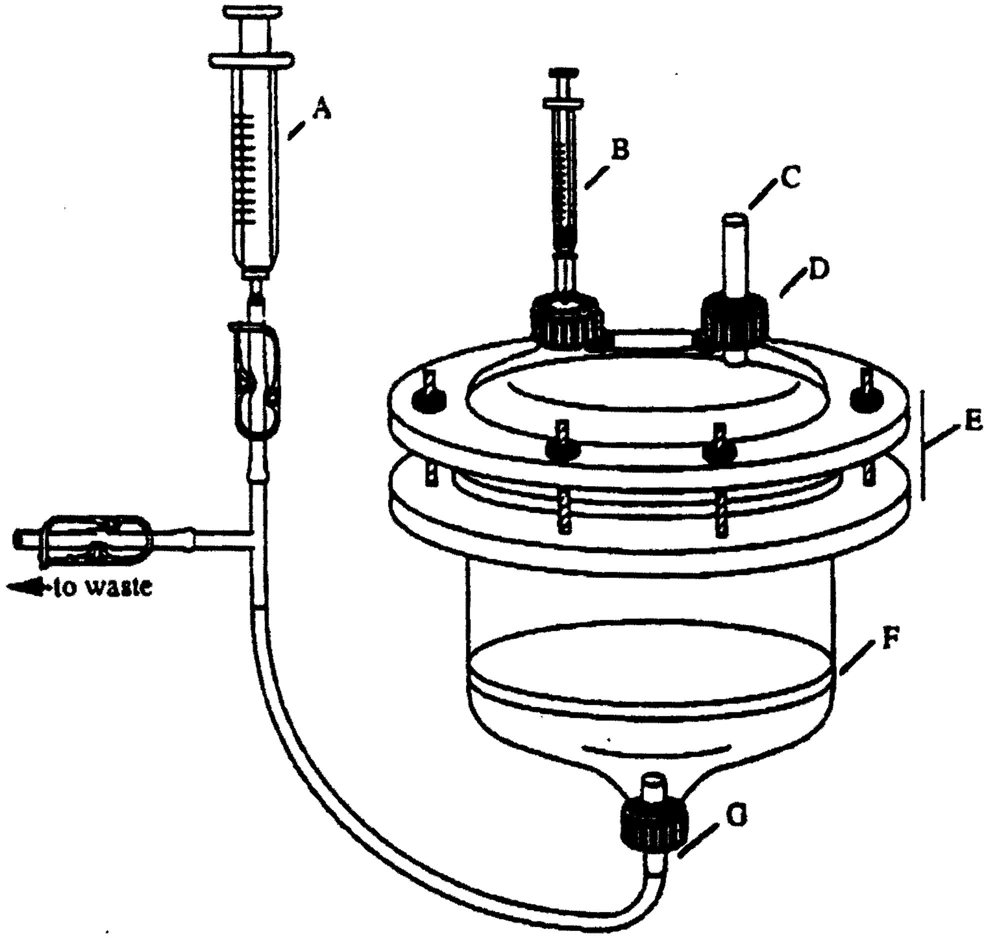

Figure . Schematic diagram of the toxicity test exposure chamber: A. Glass syringe for chemistry sampling; B, syringe for food introduction; C, Diluent inlet; D, threaded glass fittings with phenolic caps; E, silicone O-ring sealed glass flange with clamp; F, fritted glass disk; G, discharge outlet.

APPENDIX C

DEVELOPMENT AND VALIDATION OF A DECONTAMINATION AND RESTORATION TREATMENT PROCESS FOR OIL-IMPACTED MUSSEL BEDS

PROJECT TEAM MEMBER COMMITMENTS

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
ALASKA FISHERIES SCIENCE CENTER
AUKE BAY LABORATORY
11305 Glacier Hwy, Juneau, AK 99801-8626
(907) 789-6000

24 hour RAPICOM (907) 789-6094

26 April 1995

Exxon Valdez Oil Spill Trustee Council
645 G Street, Suite 401
Anchorage, Alaska 99501-3451

RE: FY 96 Proposal: Development and Validation of a Decontamination and Restoration Process for Oil Impacted Mussel Beds. Submitted under the BAA as a multi-agency effort.

The Auke Bay Laboratory has participated in the development of this proposal because of previous experience (under Studies R103, 93036, 94090, 95090, and proposed 96090) leading projects dealing with persistence of oiling in mussel beds in Prince William Sound. If this study is funded, we will be willing to further participate in the implementation of the entire study as indicated in this proposal.

Malin M. Babcock

Malin M. Babcock
Task Leader

cc: Dr. Stanley D. Rice
Bruce Wright, NOAA Program Manager

Environmental Quality Engineering

UNIVERSITY OF ALASKA FAIRBANKS

School of Engineering
PO Box 755900 • Fairbanks, Alaska 99775-5900

25 April, 1995

William Sims, President
Petroleum Environmental Services, Inc.
P.O. Box 680488
San Antonio, Texas 78268-0488

Dear Mr. Sims:

As Director of the Environmental Technology Laboratory of the University of Alaska Fairbanks, I am excited and pleased to participate on the team you have assembled on your proposed project entitled "Decontamination and Restoration of Oil-Impacted Mussel Beds." Our participation will be conducted under the Sponsored Research Agreement that the ETL already has developed with Petroleum Environmental Services (PES). Final details on our participation can be worked out for the detailed proposal under the terms of this agreement.

As you are aware, the Environmental Technology Laboratory operates as an umbrella organization that promotes interdisciplinary approaches to today's difficult environmental problems. Our research scientists and engineers are of the highest quality and have extensive experience in the unique conditions of the Arctic. For the particular project at hand, we have assembled three researchers who will work with you to address research, analyses and data interpretation needs. The team I have assembled includes:

<u>Dr. Tina B. Behr-Andres</u>: Dr. Behr-Andres has specialized in the characterization of industrial by-products. Her in-depth knowledge of the physio-chemical reactions within the soil and sediments under the mussel beds will assist us to provide the best possible chemical analyses and interpretation of data.

<u>Dr. Raymond Highsmith</u>: Dr. Highsmith has specialized in marine invertebrates and is one of the nation's foremost authorities on mussels and other bivalves in Arctic waters. He will be the lead scientist for the project team in data collection and analyses.

<u>Dr. Mark A. Tumeo</u>: As Director of the ETL, Dr. Tumeo will oversee all aspects of the teams participation. In addition, he has extensive experience in the use of surfactants in the Arctic and Antarctic for oil spill remediation. Dr. Tumeo will also serve as chair of the Project Oversight Committee and coordinate all meetings of that committee.

As you can see, this research team has the experience and expertise to address all aspects of the biosurfactant project you are proposing. You will find attached a Table delineating the three year budget of approximately \$203,600 for the proposed project. The Environmental Technology Laboratory will provide an additional \$81,600 by way of in-kind match support for Dr. Tumeo and Dr. Behr-Andres.

This budget includes the activities associated with the oversight and coordination of the Project Oversight Committee. The budget also includes the involvement of both graduate and undergraduate students, a dimension of the project that I feel, strengthens the overall proposal by providing for the training of the next generation of oil remediation specialists.

I look forward to our cooperation and participation in your project. If you have additional questions, please do not hesitate to contact me.

Sincerely,

Mark A. Tumeo

Mark A. Tumeo, Ph.D., P.E.
Director, Environmental Technology Laboratory

UNIVERSITY OF CALIFORNIA, SANTA CRUZ

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY SANTA CRUZ, CALIFORNIA 95064

April 26, 1995

Dr. William Alter
PES
P.O. Box 680488
San Antonio, TX 78268-0488

Dear Dr. Alter:

I have read your project description of the study "Decontamination and Restoration of Oil Impacted Mussel Beds." I believe we can make a significant contribution to this work and am interested in our research group's participating.

Please accept this letter as confirmation of our intent to participate in this project at the funding level described in the attached documents.

Sincerely yours,

Ronald S. Tjeerdema, Ph.D., D.A.B.T.
Associate Professor of Toxicology
Phone: 408-459-2917
FAX: 408-429-0146
Internet: tjeerdem@chemistry.ucsc.edu

Enclosures

96109

CHENEGA CORPORATION

3333 Denali Street, Suite 220-E
Anchorage, AK 99503
(907) 277-5706

Post Office Box 8060
Chenega Bay, AK 99574-0060
(907) 573-5118

April 27, 1995

PES-Alaska
Attn: Mr. Stephan R. Rog
552 West 58th Avenue, Unit #E
Anchorage, AK 99518

Dear Mr. Rog:

We have reviewed the proposal entitled, "Development and Validation of a Treatment Process for the Decontamination and Restoration of Oil-Impacted Mussel Beds". The focus of this project is a high priority issue for the State of Alaska. We strongly endorse the goals of this project, especially the implementation of a process for the treatment of the remaining oil-impacted mussel beds in Prince William Sound.

We understand that this proposal will be submitted to the Exxon Valdez Oil Spill Trustee Council for funding.

Please keep us informed of the status on this proposal. We agree to participate in this important project and look forward to participating in the Project Oversight Committee.

Please contact Ms. Gail Evanoff who will have lead responsibility for our participation in this project.

Sincerely,

CHENEGA CORPORATION

Charles W. Totemoff
President/CEO

CWT/caw/c:rog/a:210

APPENDIX D

DEVELOPMENT AND VALIDATION OF A DECONTAMINATION AND RESTORATION TREATMENT PROCESS FOR OIL-IMPACTED MUSSEL BEDS

PROJECT BUDGET

Submitted by PES-Alaska
on behalf of the
Project Team

PES-Alaska
Auke Bay Laboratory of NOAA
Chenega Corporation
University of Alaska Fairbanks
University of California Santa Cruz

APPENDIX D

DEVELOPMENT AND VALIDATION OF A DECONTAMINATION AND RESTORATION TREATMENT PROCESS FOR OIL-IMPACTED MUSSEL BEDS

PROJECT BUDGET

Submitted by PES-Alaska
on behalf of the
Project Team

PES-Alaska
Auke Bay Laboratory of NOAA
Chenega Corporation
University of Alaska Fairbanks
University of California Santa Cruz

BUDGET SUMMARY

The total proposed budget for this three year project is $ 1,010,100. The subtotals for the three fiscal years are:

1. FY 1996 = $ 551,800

2. FY 1997 = $ 325,600

3. FY 1998 = $ 132,700

BUDGET FORMS

In accordance with the instructions provided in the Invitation to Submit Restoration Projects from the *Exxon Valdez* Oil Spill Trustee Council, the following forms are submitted. As needed, additional comments and

1. Forms 4A and 4B for PES, which is proposed as the prime contractor, combines all of the funds requested by the other Project Team members including the NOAANMFS Auke Bay Laboratory.

2. Forms 4A and 4B for the University of Alaska Fairbanks - Projected budget for FY 1996 is $89,000. Total projected budget for the three year project is $203,700.

3. Forms 4A and 4B for the University of California Santa Cruz - Projected budget for FY 1996 is $94,400 which represents their total budget.

4. Forms 4A and 4B for the Chenega Corporation - Projected budget for FY 1996 is $204,200. Total projected budget for the three year project is $309,000.

5. Forms 3A and 3B for the Auke Bay Laboratory of NOAA - Projected budget for FY 1996 is $ 63,000. Total projected budget for the three year project is $ 199,000.

BUDGET COMMENTS

This budget was developed on the basis of minimizing the costs required to achieve the project objectives. This section will describe specific ways in which the projected expenses were reduced or can be reduced based on decisions that will be made after the project is undertaken.

1. Project Oversight Committee (POC). Since UAF was proposed as the chairperson, funding for the costs of all meetings is included in the UAF budget. Considering that a number of the organizations proposed for the POC are federal or state agencies, it is possible that their agencies will contribute the funds for them to attend these meetings. In addition, a number of these agencies have offices in Anchorage, and as a result could utilize personnel that will not have to expend travel funds to attend these meetings. As a consequence, the projected costs for the POC

meetings could be reduced significantly from that which currently appears in the UAF budget.

2. Field Evaluation Expenses: As was described in the Methods Section, the Project Team will make every effort to keep these times to a minimum while still adhering to the protocols for the field evaluations.

3. Equipment: Only one piece of equipment is proposed for purchase in this project. The autosampler unit required by UCSC will be used to process the chemical samples in a far more efficient manner than would be possible if this were done manually. The latter would significantly increase personnel costs and significantly prolong the time required to complete this portion of the project. No other equipment purchases are required for this project. Project Team members already have all the other equipment required for the laboratory-based activities. Equipment required for the field evaluations will be leased.

4. Vessels for the Field Evaluations: The budget stipulates the leasing of three vessels.

a. Berthing Vessel - Requirement for this vessel is based on the likelihood that the field site will be located in remote locations (greater than 1 hour from a village-based support location). The use of this vessel will permit crew and equipment deployment in a timely fashion to take advantage of the tidal cycles. It also provides lodging and feeding facilities, and shelter during inclement weather.

b. Oil Spill Response Vessel - Requirement for this vessel is based on the need for its capability to cost-effectively skim and store the recoverable oil, as well as to deploy the containment boom and to provide deluge flushing to supplement shorebased pump systems, if needed.

c. Landing Craft - Requirement for a shallow draft, nearshore work boat is based on the need to haul heavy equipment and supplies to/from the field sites. If required, this vessel would enable the work crews to decontaminate the mussel beds without relying on shore-based support.

5. Other Resources: As an indication of the the Project Team's commitment to achieving the objectives of this project, the team members have committed a significant amount of other resources in the form of man-hours. Additionally, PES has reduced its indirect rate from that which was charged in previous submissions to the Trustee Council.

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel		$34.9						
Travel		$2.8						
Contractual		$483.7						
Commodities		$3.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$524.4	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
Indirect		$27.4						
Project Total		$551.8	$325.6	$132.7				
Full-time Equivalents (FTE)		5.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources		$25.0	$8.4	$2.0				

Comments:

Personnel cost includes fringe benefits

Indirect costs calculated on the basis of percentages provided in the Trustees Council's solicitation, i.e. 15% of personnel costs + 7% of Project's contractual costs up to $250,000, and 2% of the Project's contractual costs > $250,000.

Other resources: PES is contributing the amounts shown in "Other Resources" as in-kind services.

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: PES

FORM 4A
Non-Trustee
DETAIL

Prepared:

Personnel Costs:

Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1996
S. Rog	Co Project Manager		3.3	6,345		20.9
						0.0
W. Alter	Co Project Manager		1.3	6,345		8.2
						0.0
D. Owens	Microbiologist/Chemist		0.2	6,345		1.3
						0.0
S. Walther	Environmental Scientist		1.0	4,442		4.4
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		5.8	23,477	0	
					Personnel Total	$34.9

Travel Costs:

Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FFY 1996
					0.0
S. Walther - to/from Anchorage	1,600	1	2	150	1.9
					0.0
S. Rog - Site Selection Trip (Depart Valdez)	100	1	4	150	0.7
Helo transport in contractual					0.0
Rental Car - Valdez - $200					0.2
					0.0
Other trips covered in Chenega budget for field evaluations					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$2.8

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: PES

FORM 4B
Personnel
& Travel
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

Contractual Costs: Description	Proposed FFY 1996
Videographer - 14 days @ $750 per day	10.5
Mobilization/demobilization transportation - 7 people, 2 trips @ $650	1.3
UAF - see accompanying budget forms 4A and 4B	89.1
UCSC - see accompanying budget forms 4A and 4B	94.4
Chenega Corp. - see accompanying budget forms 4A and 4B	204.2
NOAA/ABL - see accompanying budget forms 4A and 4B	63.0
Environmental consultant/Technician to support field evaluations	9.7
Helicopter for site selection trip	9.0
Float Plane charter - 5 days @ $500 (sample collection)	2.5
Contractual Total	$483.7

Commodities Costs: Description	Proposed FFY 1996
Miscellaneous Office Supplies, Telecommunications; and mailings of reports.	3.0
Commodities Total	$3.0

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: PES

FORM 4B
Contractual &
Commodities
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

New Equipment Purchases: Description		Number of Units	Unit Price	Proposed FFY 1996
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
				0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.			New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel		$38.2						
Travel		$18.2						
Contractual		$0.6						
Commodities		$2.2						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$59.3	Estimated	Estimated	Estimated	Estimated	Estimated	Estimated
Indirect		$29.7	FFY 1997	FFY 1998	FFY 1999	FFY 2000	FFY 2001	FFY 2002
Project Total		$89.0	$75.4	$39.3				
Full-time Equivalents (FTE)		7.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources		$27.5	$27.5	$26.7				

Comments:

Personnel cost includes fringe benefits

Indirect costs - use federally approved rate

Other resources - Dr. Tumeo and Dr. Behr-Andres in-kind services

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: University of Alaska - Fairbanks

FORM 4A
Non-Trustee
DETAIL

Prepared:

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

Personnel Costs:						
Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1996
M.A. Tumeo	Associate Professor of Engineering		2.0	6,747		13.5
C.B. Behr-Andres	Assistant Professor of Engineering		1.0	4,325		4.3
R.C. Highsmith	Professor of Marine Science		1.5	9,667		14.5
1 Graduate Student	Research Assistant		2.0	2,055		4.1
1 Undergraduate Student	Research Assistant		1.0	1,730		1.7
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		7.5	24,524	0	
					Personnel Total	$38.2

Travel Costs:					
Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FFY 1996
Site Selection Trip	700	1	3	150	1.2
First Phase Field Evaluation (2 persons)	700	2	4	150	2.0
First Phase Field Evaluation (2 persons)					0.0
2 POC Meetings (10 persons each)	600	20	20	150	15.0
(See attached sheet for further information)					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$18.2

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: University of Alaska - Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

Contractual Costs: Description	Proposed FFY 1996
POC Meeting Room - 2 meetings	0.8
Contractual Total	$0.8

Commodities Costs: Description	Proposed FFY 1996
Miscellaneous Analytical Supplies for use during field and laboratory activities Office Supplies for use in data collection and analysis Telecommunications; and copying of materials.	2.2
Commodities Total	$2.2

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: University of Alaska - Fairbanks

FORM 4B
Contractual &
Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	

PROJECT OVERSIGHT COMMITTEE (POC) MEETINGS EXPENSES - to be provided by UAF.

1. POC Membership (10) - The committee is projected to consist of representatives from the Trustee Council, NOAA (Juneau and Seattle), ADEC, Oil Spill Research Institute, US Coast Guard, Environment Canada, Chenega, UAF, and PES.

2. POC Meetings - Four one-day meetings are projected to be held in Anchorage during this project. The following are projected expenses for these meetings:

a.	Transportation: 10 persons for 4 meetings @ $600/trip	24,000
b.	Hotels/Per Diem: 10 persons for 4 meetings @ $150/one overnight stay	6,000
c.	Meeting Room Rental and Miscellaneous A/V Equip. & Supplies 4 meetings @ $400/meeting	1,600
	Subtotal for POC Meetings	31,600

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel		$43.7						
Travel		$0.3						
Contractual		$0.0						
Commodities		$22.2						
Equipment		$12.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$78.2	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
Indirect		$16.2						
Project Total	$0.0	$94.4						
Full-time Equivalents (FTE)		13.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources		$5.0						

Comments:

Personnel cost includes fringe benefits

Indirect costs - use federally approved rate

Other resources - Dr. Tjeerdma will provide $5,000 of in-kind services.

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: University of California at Santa Cruz

FORM 4A
Non-Trustee
DETAIL

Prepared:

04/28/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

Personnel Costs:

Name	Position Description	Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1996
M. Singer	Associate Research Specialist IV	3.5	4,659	0	16.3
					0.0
Various	Staff Research Assistant III	0.8	3,564	0	2.7
	Staff Research Assistant II	3.5	3,094	0	10.8
	Laboratory Assistant II	6.0	2,318	0	13.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
	Subtotal	13.8	13,635	0	
				Personnel Total	$43.7

Travel Costs:

Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FFY 1996
					0.0
Transportation of samples between Marine Pollution Studies Lab and					0.0
University of California at Santa Cruz. Distance = 120 mi. / RT plus parking	250	1	0	0	0.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.3

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: University of California at Santa Cruz

FORM 4B
Personnel
& Travel
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

Contractual Costs:	Proposed
Description	FFY 1996
none	
Contractual Total	$0.0

Commodities Costs:	Proposed
Description	FFY 1996
Miscellaneous glassware solvents and other chemicals lab supplies utilities (at Marine Pollution Studies Lab) equipment maintenance	22.2
Commodities Total	$22.2

1996	Project Number: Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds. Name: University of California at Santa Cruz	FORM 4B Contractual & Commodities DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
Autosampler unit for existing Hewlett-Packard 9850 Gas Chromatograph for			0.0
routine processing of samples in support of toxicity testing.	1	12,000	12.0
			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	$12.0

Existing Equipment Usage: Description		Number of Units	
Hewlett-Packard HP9850Gas Chromatograph with Flame Ionization Detector			
Hewlett-Packard Gas Chromatograph/Mass spectrometer			
	in place cost = 0		
Rosemount/Dohrmann DC-190 Carbon analyzer			
Misc. infrastructure: Computers, printer, copier, etc.			

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: University of California at Santa Cruz

FORM 4B
Equipment
DETAIL

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel		$59.5						
Travel		$0.0						
Contractual		$132.1						
Commodities		$12.6						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$204.2	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
Indirect		*						
Project Total	$0.0	$204.2	$104.8					
Full-time Equivalents (FTE)		9.8						
	Dollar amounts are shown in thousands of dollars.							
Other Resources		$0.0						

Comments:

* Indirect Costs are included in personnel and contractual costs.

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: Chenega Corporation

FORM 4A
Non-Trustee
DETAIL

Prepared:

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FFY 1996
Gail Evanoff	Vice President		2.0	6,067	0	12.1
						0.0
8 persons	Workcrew (0.97 man-months X 8 persons)		7.8	6,067	0	47.3
					0	0.0
					0	0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		9.8	12,133	0	
					Personnel Total	$59.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1996
					0.0
Travel costs incorporated into use of Berthing vessels.					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

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: Chenega Corporation

FORM 4B
Personnel
& Travel
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

Contractual Costs: Description	Proposed FFY 1996
Berthing Vessel See attached sheet for details	49.0
Landing Craft	28.0
Oil Spill Response Vessel	42.0
Skiff	2.8
2-6" pumps	2.4
2-2" pumps	0.4
Miscellaneous fire hoses	0.4
Modified AirKnife Injection System	1.5
250 CFM Compressor	1.2
Motor Freight (Mobilization/Demobilization)	0.8
Alaska Pollution control (Oily Wastes)	3.6
Contractual Total	$132.1

Commodities Costs: Description	Proposed FFY 1996
Surface Washing Agents See attached sheet for details	4.0
1,000 Linear feet of containment booms	3.6
Sorbents (Pads, Booms, Sweeps, etc.)	2.4
Miscellaneous Supplies	0.8
Fuel	0.8
Miscellaneous Office Supplies, Telecommunications, copying	1.0
Commodities Total	$12.6

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: Chenega Corporation

FORM 4B
Contractual & Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units

1996	Project Number: Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds. Name: Chenega Corporation	FORM 4B Equipment DETAIL

VESSELS, EQUIPMENT, SUPPLIES FOR FIELD EVALUATIONS - To be provided by Chenega Corporation

		TOTAL	FY 96	FY 97
1.	VESSELS			
a.	Berthing Vessel - 21 days @ $3,500/day	73,500	49,000	24,500
b.	Landing Craft - 21 days @ $2,000/day	42,000	28,000	14,000
c.	Oil Spill Response Vessel - 21 days @ $3,000/day	63,000	42,000	21,000
d.	Skiff - 21 days @ $200/day	4,200	2,800	1,400
2.	EQUIPMENT			
a.	Two 6" Pump - 3 weeks @ $600/week	3,600	2,400	1,200
b.	Two 2" Pump - 3 weeks @ $200/week	600	400	200
c.	Miscellaneous Fire Hoses	600	400	200
d.	Modified Airknife Injection System - 3 weeks @ $750/week	2,300	1,500	800
e.	250 cfm Compressor - 3 weeks @ $600/week	1,800	1,200	600
3.	SUPPLIES			
a.	Surface Washing Agents (Estimated at $1,000/site)	6,000	4,000	2,000
b.	1,000 linear feet of Containment Booms (Estimated)	5,400	3,600	1,800
c.	Sorbents (Pads, Booms, Sweeps, etc.)	3,600	2,400	1,200
d.	Miscellaneous Supplies (Estimated)	1,200	800	400
e.	Fuel (Estimated)	1,200	800	400
4.	MOBILIZATON/DEMOBILIZATION			
	Motor Freight (Estimated)	1,200	800	400
5.	DISPOSAL OF WASTE OIL			
	Alaska Pollution Control, Inc. (Estimated)	5,400	3,600	1,800
		-----------	---------	--------
	Subtotal for Field Evaluations	217,800	143,700	74,100

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel		$38.0						
Travel		$12.1						
Contractual		$0.0						
Commodities		$7.2						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$57.3	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration		$5.7						
Project Total	$0.0	$63.0	$75.5	$60.5				
Full-time Equivalents (FTE)		0.4						
	Dollar amounts are shown in thousands of dollars.							
Other Resources		$9.3	$9.5	$9.7				

Comments:
Other resources include donated time for Dr. Stan Rice (ABL's Habitat Program Manager), and Jeffrey Short (Sr. Chemist):
0.5 mo. for Dr. Rice @ $5.5; and 0.5 mo for Short @ $3.9 = $9.3K

Most chemical analyses costs are shifted to the succeeding FY because some UVF and all GC/MS processing will not occur until after 1 October.

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: NOAA/NMFS Auke Bay Laboratory

FORM 3A
AGENCY
PROJECT
DETAIL

Prepared:

04/28/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
	M. Babcock	Fishery Biologist	12/9	2.0	8	0	16.0
	P. Harris	Zoologist	9/5	1.0	5	0	5.0
	L. Holland	Chemist	11/6	2.0	6	0	12.0
							0.0
							0.0
							0.0
							0.0
							0.0
*	B. Wright	NOAA Program Manager	12/5				5.0
							0.0
							0.0
							0.0
		Subtotal		5.0	19	0	
Those costs associated with program management should be indicated by placement of an *.						Personnel Total	$38.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
						0.0
*	Anchorage, EV Workshop, planning & oversight mtgs.	444	4	15	225	5.2
	Car Rental/Miscellaneous					1.0
						0.0
						0.0
						0.0
	Valdez/PrinceWilliam Sound/field trip/2 staff	612	2	8	225	3.0
	Car Rental/Miscellaneous					1.0
	Prince William Sound/field work/2staff/2 trips	444	4	28	2	1.8
	Miscellaneous					0.1
	Charters accounted for elsewhere					0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					Travel Total	$12.1

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: NOAA/NMFS Auke Bay Laboratory

FORM 3B
Personnel
& Travel
DETAIL

Those costs associated with program management should be indicated by placement of an *.

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

Contractual Costs: Description	Proposed FFY 1996
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
Contractual Total	$0.0

Commodities Costs: Description	Proposed FFY 1996
Chemistry Lab supplies, solvents	4.2
Field Sampling equipment (hydrocarbon-free jars, Markingpens, waterproof notebooks, paper towels, film,	2.5
labeling tape, write-in-the-rain paper, etc.)	0.0
	0.0
Field Protective Clothing	0.5
	0.0
	0.0
	0.0
Commodities Total	$7.2

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: NOAA/NMFS Auke Bay Laboratory

FORM 3B
Contractual &
Commodities
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET• October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	
Hand-held radios	2	NOAA
GPS Units	1	NOAA

1996

Project Number:
Project Title: Development and Validation of a Decontamination and Restoration Process for Mussel Beds.
Name: NOAA/NMFS Auke Bay Laboratory

FORM 4B
Equipment

DETAIL

96115

Sound Waste Management Plan

Project Number:	96115
Restoration Category:	General Restoration (continued)
Proposed By:	Prince William Sound Economic Development Council
Lead Trustee Agency:	ADEC
Duration:	One (additional years will be required for subsequent phases of the project, see below for explanation.)
Cost FY 96:	$29,600
Cost FY 97 and Future Years:	None currently identified. (Additional funds may be requested for subsequent phases, see below for explanation.)
Geographic Area:	Prince William Sound
Injured Resource/Service:	Intertidal and subtidal organisms, harlequin ducks, black oystercatchers, sea otters, harbor seals, and other seabirds, shorebirds and marine mammals. The services most likely to benefit are subsistence and recreation, both of which are affected by the visual recognition of pollution.

ABSTRACT

The Sound Waste Management Plan is a comprehensive plan to identify and remove the major sources of marine pollution and solid waste in Prince William Sound that may be affecting recovery of resources and services injured by the *Exxon Valdez* Oil Spill. This request completes the first phase — planning begun in FY 95. The following phases of the plan will be to implement these solutions using funds from a variety of sources, possibly including the Trustee Council.

INTRODUCTION

In FY 95, the Trustee Council began the first phase of the Sound Waste Management Plan (SWMP), a comprehensive plan to identify and remove the major sources of marine pollution and solid waste in Prince William Sound that may be affecting recovery of resources and services injured by the *Exxon Valdez* Oil Spill. In the first phase, a contractor was selected in March 1995 to work with community representatives and agency personnel, identify problems, and recommend solutions that cam be implemented by federal, state, or municipal governments, or by private industry. In subsequent phases governments and industry will implement the solutions using funds from a variety of sources.

The contractor is overseen and works for the with representatives from each of the Sound's five communities. The report of the Council, prepared by the contractor, is due in January 1996.

FY 95 funding by the Trustee Council funds the contractor through completion of a report recommending solutions to the solid waste and marine pollution problems. This FY 96 request is to continue management of the contractor and to fund travel decisions concerning solutions by the Prince William Sound Economic Development Council.

NEED FOR THE PROJECT

A. Statement of the Problem

Despite the panoply of state and federal laws that govern the discharge of pollutants into the marine environment, there remain a number of important waste streams that still foul the environment of Prince William Sound. Complete restoration from the oil spill requires permanent protection from on-going chronic pollution sources that may be degrading the quality of marine habitat for injured resource and services, or may be stressing populations or sub-populations of resources and services.

In many cases, there is currently no easy or no feasible method of meeting state and federal laws designed to protect the Sound's environment. The communities of Prince William Sound, the Coast Guard, EPA, and ADEC are working on parts of these problems, but there is no regional approach. Currently, the lack of a coordinated, comprehensive approach may preclude effective, regional solutions, and may result in some important, regional problems not being addressed. The lack of a region approach may also preclude cost-effective solutions that are beyond the capacity of individual agencies or communities. As a result, there may be increased stress on the resources and services injured by the spill, especially on local populations important for communities, recreation, and subsistence use.

B. Rationale

In total, the plan will use funds from a variety of sources to effect a unified regional effort to permanently reduce the incremental damage being done to the environment of Prince William Sound from marine pollution. In this way, it will reduce stresses on recovering resources and services and protect their habitat.

C. Summary of Objectives.

A three phase approach is proposed. This project, however, includes funding for only the first phase. The project will be managed by the Prince William Sound Economic Development Council in conjunction with the Alaska Department of Environmental Conservation.

In continuing the efforts of the Prince William Sound Economic Development Council costs for the project are defrayed by shared transportation, teleconference and meeting costs from each participating community and organization. The regional approach resulted in the development of this project, and is the overall approach of each phase of the project.

With each community independently combating some of the problems of marine pollution, by coming together as a region, ideas are shared and discussed in a manner that leads to more efficient and cost-effective solutions which is the theme of the proposal. The success of this regional approach by the regional committee is the impetus for this project and will be maintained.

- Phase I will use a request for proposals to solicit a contractor to undertake a comprehensive review of pollution sources, their significance, and provide alternative cost-effective solutions.

- Phase II is the implementation of the Sound Waste Management Plan — implementing permanent solutions to the existing chronic problems. These solutions may take the form of a construction, such as a regional solid waste facility or facilities to accommodate bilge water, or they may take the form of programs to prevent pollution such as increased recycling.

D. Completion Date

The contractor's report is due in January 1996. Phase II will be planned at that time. Future requests for funds from a variety of sources — possibly including the Trustee Council — may be made for FY 97.

COMMUNITY INVOLVEMENT

This project is being implemented by representatives of Prince William Sound communities: Valdez, Cordova, Whittier, Chenega Bay, and Tatitlek. The Alaska Department of Environmental Conservation provides technical assistance and limited oversight. That is, this project was proposed, and is being implemented by the communities of Prince William Sound.

FY 96 BUDGET

Personnel	$3,300
Travel	4,200
Contractual	19,800
Commodities	400
Equipment	0
Subtotal	27,700
Gen. Admin.	1,900
Total	29,600

Of the amount in contractual, $19,000 is for a contract with the Prince William Sound Economic Development Council to administer the project to its conclusion. That amount includes approximately $10,000 for staff time for somewhat over 200 hours of staff time, and $8,000 in travel for the Council members to come together from Prince William Sound communities. The remaining thousand is for miscellaneous office supplies and teleconference fees.

PROJECT DESIGN

A. **Objectives.** The development of the Sound Waste Management Plan originated with Prince William Sound Economic Development Council's regional Solid Waste Management Committee.

The following outlines the objectives to be accomplished as part of Phase I:

1. *Identifying options.*
   a. Use existing information and where necessary gather new information to identify the major sources of marine pollution and solid waste, and evaluate which waste streams are priority for reduction.

   b. Analyze waste management reduction, processing, transportation, and disposal alternatives appropriate for Prince William Sound. Information for some or all alternatives should include regulatory requirements, site information, cost estimates, transportation methods, and funding sources.

   c. Recommend solutions to reduce the effects that can be implemented by municipalities, state and federal governments, private industry, or trustee agencies. Many of these may involve regional coalitions of groups.

2. *Community choice.* This project is not solely technical; rather, communities and agencies must implement the technical solutions. For that reason, the project objectives include establishing a public participation program to understand and address community concerns and needs. The public participation needs not involve public meeting or other mass participation mechanisms. However, it should ensure that communities are involved, and understand the problems and possible solutions in order to build consensus for actions to reduce marine pollution and solid waste that will restore Prince William Sound. Accomplishing this objective requires communities and agencies to choose which options to implement.

B. **Methods**

1. *Community Participation Component.* As a regional project, local input and coordination is crucial to the long-term success of the SWMP project by creating local ownership. Agreeing on and implementing effective solutions to waste management problems requires the participation of the communities that will implement them. A comprehensive, coordinated, regional approach requires participation by all communities in Prince William Sound. This proposal was developed and intended to be coordinated by Prince William Sound Economic Development Council's Solid Waste Management Committee with representation from all of the Sound's communities. The project will be completed in cooperation with ADEC.

   a. DEC will do the financial administration of the contract that is the major part of Phase I.
   b. Prince William Sound Economic Development Council's Solid Waste Management

Committee with participation from each of the Prince William Sound communities, DEC. This participation is important for the results of the project — that the recommended solutions will be agreed to and implemented by the appropriate communities and regulatory agencies.

2. *Technical Component for Phase I.* Through a competitive RFP, Ross and Associates was awarded the contract to prepare the information and facilitate the community choices to achieve accomplish the objectives of Phase I.

C. Contracts and Other Agency Assistance

The major part of this project is two contracts: the first to PWSEDC to complete the project; the second to a contractor (Ross and Associates) to complete the technical and community facilitation tasks. ADEC provides technical assistance and limited oversight.

D. Location

Prince William Sound communities.

SCHEDULE

A. Measurable Project Tasks for FY 96

January 10, 1996:	PWSEDC report to the Prince William Sound communities recommending solutions for solid waste and marine pollution.

B. Project Milestones and Endpoints

FY 95:

June 1, 1995:	Draft Inventory of Pollution Sources
September 1, 1995:	Draft Report on Alternative Solutions and Funding Sources

FY 96:

January 10, 1996:	Final Report. PWSEDC report to the Prince William Sound communities recommending solutions for solid waste and marine pollution.

Also, the final endpoints for the project — when the solutions to Prince William Sound solid waste and marine pollution will be implemented — are not yet known. In fact, determining them is part of the point of Phase I of the project.

C. Project Reports

See part B of this section for interim reports. The final report will be prepared by Prince William Sound Economic Development Council to the Trustee Council and communities of Prince William Sound January 1996. In approving the FY 95 work for this project, the Chief Scientist and Executive Director indicated that peer-review by the Chief Scientist's reviewers is not appropriate. However, the Executive Director will be asked to review the draft report, and appropriate copies of the final report will be submitted to the Executive Director.

D. Coordination and Integration of Restoration Effort

Not Applicable.

E. Environmental Compliance

A categorical exclusion under the National Policy Act was granted for this project in December 1994. Thus, NEPA compliance is complete for Phase I of the plan. Other permits and further NEPA compliance will likely be required for the implementation phase of the project. They are not needed for the FY 96 work .

F. Personnel

Not applicable for FY 96 (personnel for the project was selected in FY 95). Qualifications for technical personnel are available from the Prince William Sound Economic Development Council, or from ADEC.

Trustee Council Project Leader:

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Exxon Valdez Oil Spill Trustee Council
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Project Manager:

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1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel	$12.8	$3.3						
Travel	$6.0	$4.2						
Contractual	$245.6	$19.0						
Commodities	$1.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$265.4	$26.5	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration	$19.1	$1.8						
Project Total	$284.5	$28.3	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)	0.2	0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: Included is funding to provide for the Prince William Sound Economic Development Council to provide contract oversight to the Ross and Associates, Environmental Consulting contract in FFY 1996. The personnel funding is to provide backup support to the oversight conntractor, process payments, ajudicate problems, and represent the interests of the Department and Trustees. There is funding for the liasion to attend public meetings and brief the Environmental Conservation Trustee. This project was initiated in FFY 1995 as project number 96115.

1996

Prepared: 4/26/95

Project Number: 96115
Project Title: Sound Waste Management Plan
Agency: AK Dept. of Environmental Conservation

FORM 3A
AGENCY
PROJECT
DETAIL

8/18/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
*	David Bruce (18X012)	Restoration Specialist	23B	0.5	6,670		3.3
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		0.5	6,670	0	
Those costs associated with program management should be indicated by placement of an *.						Personnel Total	$3.3

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
*	Anchorage--Valdez	200	4	6	150	1.7
*	Anchorage--Cordova	224	2	2	150	1.2
*	Anchorage--Juneau	444	2	3	150	1.3
	Note: Not all of these trips are for project leader. Some include					0.0
	technical assistance by other DEC personnel, notably the DEC Valdez					0.0
	representative, and head of the Pollution Prevention Section in Anchorage.					0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					Travel Total	$4.2

1996

Project Number: 96115
Project Title: Sound Waste Management Plan
Agency: AK Dept. of Environmental Conservation

FORM 3B
Personnel
& Travel
DETAIL

9/18/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Contractual Costs:	Proposed
Description	FFY 1996
Contract PWS Economic Development Council for oversight of Ross an Associates Environmental Consultants contract (# 18-8011-95)	19.0
For detail concerning the $19,000 contract; see attached form 4.	
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$19.0

Commodities Costs:	Proposed
Description	FFY 1996
Commodities Total	$0.0

1996	Project Number: 96115 Project Title: Sound Waste Management Plan Agency: AK Dept of Environmental Conservation	FORM 3B Contractual & Commodities DETAIL

8/18/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1996

Project Number: 96115
Project Title: Sound Waste Management Plan
Agency: AK Dept. of Environmental Conservation

FORM 3B
Equipment
DETAIL

8/18/95

96120-BAA

Proximate Composition and Energetic Content of Selected Forage Fish Species in Prince William Sound, AK. Submitted Under the BAA

Project Number:	96120 -BAA
Restoration Category:	Research
Proposer:	Physiological Ecology Research Laboratory, Texas A&M University
Lead Trustee Agency:	NOAA
Cooperating Agencies:	none
Duration:	FY96 and FY97
Cost FY96:	$40.9K
Cost FY97:	$40.9K
Geographic Area:	Prince William Sound, AK
Injured Resource:	harbor seals/killer whales/various seabirds

ABSTRACT

This study will provide the data necessary for interpreting food web dynamics and ecology of the apex predators of Prince William Sound. In any long term study of foraging ecology, especially those investigating the recovery of impacted species, knowledge of prey species composition and energetic value is critical in the interpretation of consumption rates and therefore the impact of consumer species upon prey species stocks. Compositional analysis will also yield important information on the general quality of the environment by assessing the condition of important prey species.

INTRODUCTION

As a result of damage assessment studies initiated after the T/V *Exxon Valdez* struck Bligh Reef in March, 1989, it was noted that several pelagic-feeding marine mammal and seabird species found in Prince William Sound, AK were apparently not recovering back to predisturbance population levels. This lack of recovery may be due to a number of factors, including possible food limitations. Food quality has been suggested to be a potential problem for a variety of species which are found throughout the Bering Sea and Gulf of Alaska (Wooster 1993). While cause-effect relationships are difficult to demonstrate, changes in the energetic value of prey species can be quantified and these values used in the interpretation of energy availability to the impacted species. It is the purpose of this proposed project to evaluate and determine the variability in energetic value of the major prey species found in Prince Wiliam Sound on both a seasonal and annual basis.

NEED FOR PROJECT

A. Statement of Problem

Data on the composition and energetic value of prey species for marine mammals and sea birds are very limited. Most data which are available are for commercial species which are consumed by humans. These data are further limited, in their ecological application, because they usually only analyze the edible fillets which people consume. Another major limitation in the database relates to the lack of an appreciation for the magnitude of seasonal variability which occurs. For example, herring (*Clupea harengus*) can vary from as little as 3% lipid to as much as 22% lipid seasonally (Worthy 1985). Knowing the energy content and composition of these species will allow us to further enhance our understanding of the energetics and physiological ecology of the major consumer species in the Sound.

B. Rationale

In Prince William Sound, two marine mammal species [harbor seals (*Phoca vitulina*), and sea otters (*Enhydra lutris*)] and several seabird species [common murre (*Uria aalge*), harlequin duck (*Histrionicus histrionicus*), marbled murrelet (*Brachyramphus marmoratus*), and pigeon guillemot (*Cepphus columba*)] have been impacted and are not recovering (Anonymous 1993). Others, such as killer whales (*Orcinus orca*) are recovering but may be indirectly inhibiting the recovery of other species if food competition is a problem. There is increasing interest in the use of energetic models to study interactions between marine mammals or seabirds and their prey species (*e.g.* Jones and DeGange 1988). Often these models are based upon energy transfer between predator and prey (*e.g.* Wooster 1993). Although these models require information on the energy content or proximate composition of these species, few data are available. Those data which have been published have limited application due to the inherent seasonal and annual variability in the value of the prey (Stansby 1976, Hislop *et al.* 1991, Perez 1994). The goal of this proposed research is to assess on a seasonal and annual basis, the value of the major prey species which would be of significance to the mammalian and avian predators listed above. These data will allow for the development of models which may yield reasons for the lack of recovery of these species.

C. Summary of Major Hypotheses and Objectives

The major objective of this study is to analyze the proximate composition and energy value of a variety of major prey species on both a seasonal and annual basis to elucidate their value to the major predators of Prince William Sound.

D. Completion Date

This work will be completed during FY97.

COMMUNITY INVOLVEMENT

This work will require the assistance of local fishermen and boat operators to be completed.

FY96 BUDGET

Personnel:	$16.2K
Travel:	$ 1.6K
Contractual	$ 0.0K
Commodities	$ 8.0K
Equipment	$ 0.0K
Subtotal	$25.8K
General Administration	$ 3.5K
Indirect Costs (45%)	$11.6K
Total Project Costs	$40.9K

PROJECT DESIGN

A. Objectives

1. Assess the seasonal and annual changes in the proximate composition of the major forage fish species in Prince William Sound, AK.

B. Methods

Species which should be collected are listed in Table 1. Samples should be frozen immediately after collection and be representative of the size classes which are known to be consumed by the consumer species in question.

All analytical techniques are described in detail in Worthy and Lavigne (1983) and Hislop *et al.* (1991). Analysis will be performed on freeze-dried, ground fish and will include determinations of water content, total lipid content, total protein content, ash content and energy density. Initially, wet mass, sex and length of each individual specimen will be recorded. Specimens would then be combined, ground and homogenized prior to freeze-drying. Water content will be determined gravimetrically by lyophilization of ground homogenized prey until constant mass has been obtained. This will be accomplished using a LabConco Lyophilizer over a period of 4-5 days. Once the samples are dried, they are finely ground using a Spex 8000 Mixer/Mill. This ground material will be used in all subsequent analyses and will be available for other investigators to use for future studies.

Lipid content will be measure gravimetrically by Soxhlet extraction using petroleum ether as the solvent. Protein content will be assessed using a modified Kjeldahl analysis and ash content will be determined by ashing at 550°C for 24 h in an ashing oven. Ground lyophilized samples will be analyzed for energy content by means of a Parr adiabatic bomb calorimeter.

Collections will be done during APEX, SEA, NMFS, ADF&G cruises, charter cruises, and through the purchase of fish from local fishermen. All of the required equipment and expertise for this project are on-site at Texas A&M University - Galveston. This includes all of the specialized equipment required for the composition and energetics analysis, as well as archival capabilities for samples and the computer related software for full statistical analysis of the data.

C. Contracts and Other Agency Assistance

This project is being proposed by a non-Trustee agency, namely Texas A&M University.

SCHEDULE

A. Measurable Project Tasks for FY96

Startup to October 15:	Arrange with other projects to assist in fish collections.
October 15 to September 31:	Fish collections and sample analysis ongoing.
October 1 to October 31:	Preparation of annual report.

B. Project Milestones and Endpoints

The milestones for this project will be partially complete by the end of FY96, however to appreciate annual variability the final endpoint will not occur until the end of FY97.

C. Project Reports

An annual report will be completed at the end of FY96 and a final report at the end of FY97. All results from this study will be incorporated into a series of peer reviewed journal publications by interfacing with the participants in the APEx, Nearshore Predators, harbor seal, and killer whale projects.

COORDINATION AND INTEGRATION OF RESTORATION PROJECT

This project is coordinated with the APEX Project, SEA Project, as well as the seabird, killer whales and harbor seal monitoring projects. Fish samples collected as part of SEA or APEX trawls will be supplied to this project as well as fish collected during sampling operations for both the harbor seal and killer whale projects. No specific platform has been requested for the proposed project and therefore all samples will be collected in conjunction with other EVOS/NMFS/ADF&G operations.

ENVIRONMENTAL COMPLIANCE

This project will involve no field effort, besides collection of fish as part of either commercial operations of scientific research trawls. There should be no need for any permits to comply with federal, state or local regulations.

PERSONNEL

Dr. Graham Worthy's research interests relate to the understanding of the physiological ecology of marine mammals through the study of their energetics, growth and nutrition. His research program integrates laboratory and field based investigations utilizing stable and radioisotopes, calorimetry, compositional analyses, and radio/satellite tracking techniques in an attempt to elucidate the capabilities of different species to withstand normal seasonal variation in their environment. Worthy's program includes on-going investigations into the life history parameters and the physiological ecology of manatees, cetaceans, and pinnipeds. The overall program centers around the energy requirements of marine mammals and how the availability and quantity of food impacts their survival and growth. To that end Worthy is involved in studies investigating the thermoregulatory capabilities, water balance, feeding ecology and free-ranging energetics of several important species of marine mammals.

Tamara Miculka's research experience is in the analysis of prey species for proximate composition. Miculka has been involved in studies relating to the seasonal changes in prey species composition of the 13 major prey species of the bottlenose dolphin in the Banana River region of Florida, analysis of diet of captive marine mammals at Sea World parks, annual variability in the composition of herring in three California bay systems, and the assessment of assimilation efficiency in captive marine mammals. Miculka has also been involved in studies of the composition and insulative quality of cetacean and manatee blubber, and metabolism and thermoregulatory capabilities of manatees.

Graham Worthy

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Date Prepared

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Hislop, J.R.G., M.P. Harris and J.G.M. Smith. 1991, Variation in the calorific value and total energy content of the lesser sandeel (*Ammodytes marinus*) and other fish preyed upon by seabirds. J. Zool., Lond. 224: 501-517.

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Wooster, W.S. 1993. Is it food? An Overview. Pages 1-3 in Is it food? Addressing marine mammal and seabird declines. Alaska Sea Grant Report 93-01.

Worthy, G.A.J. 1985. Thermoregulation of young phocid seals. Ph.D. thesis, University of Guelph, Guelph, Ontario, Canada. 254 pp.

Worthy, G.A.J. and D.M. Lavigne. 1983. Changes in energy stores during postnatal development of the harp seal, *Phoca groenlandica*. J. Mammal. 64: 89-96.

Table 1: Forage fish species, of significance in the Prince William Sound System, which are proposed to be studied for composition and energetic value in the present study. Suggested species were determined by assessing their importance to the various seabirds and marine mammals which are found in Prince William Sound. Some species are of importance only to the larger species such as killer whales (*Orcinus orca*).

Common Name	Scientific Name
Pacific herring	*Clupea harengus pallasi*
Rockfish	*Sebastes sp.*
Cutthroat trout	*Salmo clarkii*
Capelin	*Mallotus villosus*
Rainbow smelt	*Osmerus mordax*
Sand lance	*Ammodytes hexapterus*
Eulachon	*Thaleichthys pacificus*
Pacific cod	*Gadus macrocephalus*
Walleye pollock	*Theragra chalcogramma*
Sablefish	*Anopoploma fimbria*
Pacific sandfish	*Trichodon trichodon*
Pink salmon	*Onchorhynchus gorbuscha*
Sockeye salmon	*O. nerka*
King salmon	*O. tshawytscha*
Silver salmon	*O. kisutch*
Chum salmon	*O. iceta*

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Budget Category:		Authorized FFY 1995	Proposed FFY 1996						
Personnel			$19.7						
Travel			$1.6						
Contractual			$0.0						
Commodities			$8.0						
Equipment			$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$0.0	$29.3	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
Indirect	45%		$11.6						
Project Total		$0.0	$40.9	$40.9	$0.0	$0.0	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)			8.0						
		Dollar amounts are shown in thousands of dollars.							
Other Resources									

Comments:
Texas A&M University charges 45% as their indirect costs rate. Fringe benefits on salary are calculated at a rate of 30% of salary.

1996

Prepared:

Project Number: 96120
Project Title: Proximate Composition and Energetic Content of Selected Forage Fish Species in Prince William Sound, AK.
Name: Texas A&M University

FORM 4A
Non-Trustee
DETAIL

4/27/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FFY 1996
Graham Worthy	PI		1.0	6,000		6.0
Tamara Miculka	Research Assistant		6.0	1,700		10.2
General Administration			1.0	3,500		3.5
monthly costs include 30% fringe benefits						0.0
except General Administration						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		8.0	11,200	0	
					Personnel Total	$19.7

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1996
Galveston, TX to Anchorage, AK for Trustee Council Meeting	1,000	1	6	94	1.6
for Tamara Miculka					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.6

1996

Project Number: 96120
Project Title: Proximate Composition and Energetic Content of Selected Forage Fish Species in Prince William Sound, AK
Name: Texas A&M University

FORM 4B
Personnel
& Travel
DETAIL

4/27/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Contractual Costs: Description	Proposed FFY 1996
Contractual Total	$0.0

Commodities Costs: Description	Proposed FFY 1996
solvents and expendibles	4.5
phone/mail/shipping	3.5
Commodities Total	$8.0

1996

Project Number: 96120
Project Title: Proximate Composition and Energetic Content of Selected Forage Fish Species in Prince William Sound, AK
Name: Texas A&M University

FORM 4B
Contractual & Commodities
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	

1996

Project Number: 96120
Project Title: Proximate Composition and Energetic Content of Selected Forage Fish Species in Prince William Sound, AK
Name: Texas A&M University

FORM 4B
Equipment
DETAIL

4/27/95

Stable Isotope Ratios And Fatty Acid Signatures Of Selected Forage Fish Species In Prince William Sound, AK. Submitted Under the BAA

Project Number:	96121 -BAA
Restoration Category:	Research
Proposer:	Physiological Ecology Research Laboratory, Texas A&M University at Galveston
Lead Trustee Agency:	NOAA
Cooperating Agencies:	none
Duration:	FY96 and FY97
Cost FY 96:	$51K
Cost FY 97:	$35K
Geographic Area:	Prince William Sound, AK
Injured Resource:	harbor seals/killer whales

ABSTRACT

This study will examine the feeding ecology of killer whales and their possible impact on harbor seals within Prince William Sound. Evidence suggests that the non-recovering status of harbor seals may be due to predation by killer whales. Traditional methods of food web analysis cannot determine whether this is true, but the combination of stable isotope tracer techniques and fatty acid signature analysis will allow us to estimate the degree of interaction between these two injured species.

INTRODUCTION

This project is designed to answer the question of whether excessive predation by killer whales (*Orcinus orca*) is preventing the recovery of the injured and non-recovering harbor seal (*Phoca vitulina*) population in Prince William Sound. There have been anecdotal reports of killer whales eating harbor seals in the vicinity of the Sound. Indeed, the consumption of other marine mammal species by killer whales has been documented on many occasions worldwide and the possibility is not in doubt. The question is do they consume a large enough number of seals to prevent the recovery of the injured population in Prince William Sound? To address this question we need to know what the preferred prey species are for killer whales. This is not an easy question to answer. The direct sampling of killer whales for this assessment is being undertaken in a separate, but integrated, project (95012), the role of the present proposal is to provide those investigators with the background data required to tease apart the complex feeding web of the killer whale. The use of stable isotope tracers or fatty acid signatures to understand feeding ecology requires two samples. The first sample is from the animal in question, *i.e.*, the killer whale. Specifically this is a biopsy sample of the blubber. The second set of samples you need consists of all the possible prey species that the whales may be consuming. These two sets of samples are then analyzed and compared to identify which ones are present in the whale's diet. The analyses of both whales and forage fish species will commence in FY95, but yet no samples have been collected pending final approval of support.

NEED FOR THE PROJECT

A. Statement of Problem

This project will provide invaluable data which are required to understand the degree of predation pressure being exerted by killer whales in Prince William Sound on the local population of harbor seals. Killer whales are currently listed as an injured biological resource which is recovering, whereas harbor seals are listed as injured but not recovering. There has been some discussion recently about whether the list status of killer whales should be changed to non-recovering due to the possible loss of several whales in 1994. This will be reevaluated after the 1995 summer season. The local killer whale population is subdivided into several pods of whales, some of which are resident year-round, while others are transient and only visit the area occasionally. These different pods may also consume harbor seals differentially. To answer the problem will require tissue samples collected from the whales themselves in addition to a comprehensive analysis of all potential prey species. It is the latter aspect that this proposal aims to assess.

B. Rationale

The study of food web dynamics is a central topic of ecology and fisheries and wildlife management. Evaluating the flow of energy between predator and prey is an important process in marine ecosystem dynamics (Platt *et al.* 1981). Until recently, stomach content analysis of dead animals and scat analysis provided the only sources of information on the diet of marine mammals. Although widely used, these techniques have several limitations in both their methodology and results. Such limitations provide the initiative to explore alternative methods of determining diets. Although its origins are in geology and geochemistry (Craig 1953; McMullen and Thode 1963; Bowen 1966), the use of naturally occurring carbon and nitrogen stable isotopes have recently come forth as a powerful tool to trace ecosystem dynamics and predator prey relationships.

Previous studies on marine mammals, birds, and fish (Fry 1988; Schell *et al.* 1989; Hobson 1990; Ostrom *et al.* 1993; Abend 1993), using carbon and nitrogen stable isotope tracers, have shown that the isotopic composition of a prey is reflected in the tissues of the predator. The trophic level of the predator is also reflected based on its diet (Rau 1983; Hobson 1990; Wada 1991; Ostrom *et al.* 1993). Trophic level refers to the number of successive transfers of energy from resource to consumer. This technique uses differences in the ratios of carbon ($^{13}C/^{12}C$) and nitrogen ($^{15}N/^{14}N$) to trace diet through carbon and nitrogen pathways. The carbon isotope ratio $^{13}C/^{12}C$ indicates the source of the diet, whereas the nitrogen isotope ratio $^{15}N/^{14}N$ reflects the trophic level of the animal (DeNiro and Epstein 1978, 1981; Minagawa and Wada 1984).

An advantage over traditional stomach content analysis is that the ratios of the stable carbon and nitrogen isotopes reflect the actual prey items that assimilate into the predator's tissues over time, providing a more accurate indication of their dietary history. The time course of the dietary history of an animal determined using stable isotope tracers and various tissues will depend upon the turnover rates of the tissue examined. Since individual tissue turnover rates vary based on their metabolism (Thompson 1953), analyses of stable isotopes of different tissues from the predator can provide information on the relative time frame of prey consumption (Tieszen *et al.* 1983). This approach with various fish tissues will depend upon the growth rate of the fish species. Slow growing fish may take years for a change in the isotopic ratio to occur in a tissue, whereas the isotope ratio in a fast growing fish may show up sooner (Hesslein *et al.* 1993). If the predator consumes multiple foods, isotope values can indicate, but not prove, that a certain type of food was ingested. However, isotope tracers can sometimes prove when a food item was not consumed and assimilated (Gearing 1991).

Recently, an innovative method has been proposed for understanding marine food webs and determining prey items and diets of marine mammals, the use of fatty acid signatures (Iverson 1993). Fatty acids are essentially the building blocks of lipids. Organisms are able to biosynthesize and modify fatty acids, but are subject to biochemical limitations, and differences in these processes, depending on the phylogenetic group or even species. Specific fatty acids cannot be synthesized by animals, refered to as essential fatty acids, and therefore can only originate from the diet. Lipids from marine organisms are characterized by an exceptionally complex array of fatty acids and substantial differences in fatty acid composition exist among species and prey types, as well as within species by geographical regions (Cook 1985; Iverson 1993). In carnivores, including marine mammals, dietary fatty acids are often deposited in body tissue without modification (*e.g.*, Iverson *et al.* submitted) and therefore it is possible to trace fatty acids obtained from the diet and then compare arrays in the tissues of the predator to those in the prey consumed.

In addition to fatty acid patterns, fatty acids may sometimes be used as individual tracers. For instance, a study by Hooper *et al.* (1973) indicated that jellyfish were a component of the diet of sunfish (*Mola mola*) on the basis of a single unusual fatty acid that was initially found in leatherback turtles (*Dermochelys coriacea coriacea*) (Ackman *et al.* 1972) whose diet is exclusively jellyfish. The combination of using stable isotope tracers and fatty acid signatures will allow the description of food webs beyond what is presently possible with existing methods.

However biological markers can also have multiple sources resulting in ambiguous results. The combined use of stable isotopes and fatty acids may not fully decipher the diet of an animal on their own. The use of a third approach could interpret such data whose resolution is not well defined for successful analysis. This new approach in food web analysis will be the analysis of the isotopic ratio of the fatty acids themselves. This will provide a higher resolution that may differentiate isotopic ratios and fatty acid signatures that are similar. Investigations suggest that the stable isotope compositions of discrete molecular structures more accurately reflect their origin and history than either isotopic composition or structure alone. The higher costs of this analysis preclude the use on a routine basis and will be used to interpret in situations where the results of tracers and signatures are similar.

The strength of the combination of these three methodologies will be the ability to define and identify individual stocks of prey that are being consumed by killer whales. This would provide the data needed to assess the degree of impact, if any, of killer whales on harbor seal recovery.

C. Summary of Major Hypotheses and Objectives

The major objectives of this proposal are to analyze the stable isotope ratios and fatty acid signatures of the potential prey species of killer whales both on a geographic scale throughout the Sound and also on a temporal scale over the course of the year. This latter objective is significant because the ratios and signatures of the prey will change seasonally.

D. Completion Date

This work will be completed during FY97.

COMMUNITY INVOLVEMENT

This work will require the assistance of local fishermen and boat operators to be completed successfully.

FY96 BUDGET

Personnel	$16.7K
Travel	$ 3.2K
Contractual	$10.8K
Commodities	$ 4.5K
Equipment	$ 0.0K
Subtotal	$35.2K
Indirect costs (45%)	$15.8K
Total	$51.0K

PROJECT DESIGN

A. Objectives

1. Determine the carbon and nitrogen stable isotopic ratios of the potential prey species of killer whales in Prince William Sound.

2. Determine the fatty acid signatures of potential prey species of killer whales in Prince William Sound.

3. Determine the stable isotope ratios of selected key fatty acids to increase the resolution of the two previous approaches.

B. Methods

The objectives of this study are to provide baseline diet, energy, and trophic level data of prey species that are prey of killer whales in Prince William Sound. Knowing the stable isotope ratios, and fatty acid signatures of prey will enhance our understanding of the food web structure of Prince William Sound and provide comparative results with stomach analysis.

It is suggested that sampling be conducted a minimum of two seasons when maximum productivity is occurring, but preferably over the course of the entire year. Species to be sampled would include those that are known to be prey of killer whales. These would include capelin (*Mallotus villosus*), herring (*Clupea harengus pallasi*), sand lance (*Ammodytes hexapterus*), pollock (*Pollachius virens*), surf smelt (*Hypomesus pretiosus*), squid (*Gonatopsis makka, Berryteuthis magister*), and salmon (*Oncorhynchus sp.*), and since the question is whether killer whales are feeding on harbor seals (*Phoca vitulina*) or even on Steller's sea lions (*Eumetopias jubatus*) - samples of these potential prey species will also need to be analyzed.

Twelve samples from each species (except for opportunistically collected marine mammals) per sampling area would be collected. Samples will be stored frozen and shipped to Texas A&M University for processing and analysis. A synopsis of the analytical techniques follows.

Isotope Analysis:
At present all analyses incorporating the use of stable isotopes, done under the auspices of the EVOS Trustee Council, are being undertaken in the lab of Dr. Don Schell, University of Alaska-Fairbanks. We would like to propose doing some of these analyses in our lab because it will allow us to do the stable isotope ratios of the fatty acids themselves (see below) - an approach which we are currently developing. We need to do some of the basic isotopic analyses to compare our results with those of Dr. Schell. We have been in discussion with him and he has offered the use of his calibration standards for this comparison.

Carbon and nitrogen occur naturally in two stable forms. Lighter forms ^{12}C and ^{14}N are more abundant than the heavier isotopes ^{13}C and ^{15}N. The common vernacular is to refer to the heavier isotope concentrations as a ratio in *d* notation in part per thousand noted (ppt) as determined from:

$$dX = [(R_{sample}/R_{standard}) - 1] \times 1{,}000$$

where X is ^{13}C or ^{15}N and R is the corresponding ratio $^{13}C/^{12}C$ or $^{15}N/^{14}N$. For this study, stable isotope values will be measured using a carbon-nitrogen isotope ratio gas mass spectrometer. The stable isotope value of a predator is directly related to its diet as follows:

$$d_{tissue} = d_{diet} + \Delta d_t$$

where Δd_t represents the isotopic fractionation factor between dietary and consumer tissue (Hobson 1990). Carbon isotope ratios are similar for marine systems typically differing between prey protein and consumer protein by +1ppt (DeNiro and Epstein 1978; Tieszen *et al.* 1983), while nitrogen isotope ratios differ between dietary protein and consumer tissue by 3-4ppt (Minagawa and Wada 1984; Dickson 1986; Fry 1988).

Fatty acid Analysis:
Tissue samples will be extracted in 2:1 chloroform/methanol (volume/volume) with 0.01% BHT (weight/volume) by the Folch method (Folch *et al.* 1957) as modified by Iverson (1988). Fatty acid methyl esters will be prepared directly from aliquots of the chloroform extract by the addition of borontriflouride in methanol, sealing under nitrogen, and heating at 100°C for one hour. Following transesterification, methyl esters will be extracted and purified in hexane.

Analyses of fatty acid methyl esters will be performed according to Iverson *et al.* (1992) using temperature programmed capillary gas liquid chromatography on a Perkin Elmer Autosystem II Capillary FID Chromatograph fitted with a 30m x 0.25 mm i.d. column (J&W DB-23) and linked to a computerized integration system (Turbochrom 4 software). Identifications of fatty acids and isomers will be determined from known standard mixtures (Nu Check Prep., Elysian, MN) and silver-nitrate chromatography (Iverson 1988; Iverson *et al.* 1992). Fatty acids will be designated by shorthand IUPAC nomenclature of carbon chain length:number of double bonds and location (n-x) of the double bond nearest the terminal methyl group.

Fatty acid data will be analyzed using a multivariate statistic method (tree-based regression models) which has been successfully applied to the analysis of these types of data (Iverson, Smith and Bowen, unpublished data).

Stable isotope-fatty acid analysis:
A gas chromatograph-isotope mass spectrometer will be used to analyze the stable isotope ratios of individual fatty acid molecules. This instrument performs stable carbon isotope analyses of individual compounds separated by gas-chromatography. This technique of using a gas chromatograph-isotope ratio mass spectrometer combines the separatory power of capillary gas chromatography with the precision of a mass spectrometer.

C. Contracts and Other Agency Assistance

This project is being proposed by a non-Trustee agency, namely Texas A&M University.

SCHEDULE

A. Measurable Project Tasks for FY96

Startup to October 15:	Arrange with other projects to coordinate fish collections.
October 15 to September 31:	Fish collections and sample analysis ongoing.
October 1 to October 31:	Preparation of annual report.

B. Project Milestones and Endpoints

Objectives 1, 2, and 3 will be complete enough to assess stable isotope ratios and fatty acid signatures of the various species by October of FY96. This data will allow a preliminary assessment of killer whale feeding through project 95012. We feel strongly that a second year of data collection is critical to assess whether these parameters change on an annual basis and therefore the objectives will not truly be achieved until October of FY97.

C. Project Reports

An annual report will be completed at the end of FY96 and a final report at the end of FY97. All results from this study will be integrated into series of peer reviewed journal publications that are anticipated by the end of FY97. This proposed project also links into other non-EVOS funded projects examining and calibrating the tissue turnover rates of stable isotopes and fatty acids in captive marine mammals.

COORDINATION AND INTEGRATION OF RESTORATION PROJECT

This project is coordinated with the APEX Project, the SEA Project, as well as the Killer Whale Monitoring and the Harbor Seal Monitoring Projects. Fish samples collected as part of SEA or APEX trawls will be supplied to this proposed project as well as fish collected during sampling operations for either the killer whale or harbor seal projects. A large proportion of the collection of prey species will be undertaken by NMFS. No specific platform has been requested for the proposed project and therefore all samples will be collected in conjunction with other EVOS/NMFS/ADF&G researchers. This coordination will allow full integration of the data obtained from our analysis into a full ecosystem approach to the study of feeding ecology in Prince William Sound. Sample analysis will also be multifaceted within Texas A&M University (Depts. of Marine Biology, Oceanography, and Rangeland Ecology and Management) and Dalhousie University, Halifax, Nova Scotia (Dept. of Biology).

ENVIRONMENTAL COMPLIANCE

This project will involve no field effort besides routine collection of fish as part of either commercial operations or NMFS trawls and therefore there should not be any federal, state or local environmental laws or regulations that will need to be complied with. No permits are anticipated to be needed.

PERSONNEL

Dr. Graham Worthy's research interests relate to the understanding of the physiological ecology of marine mammals through the study of their energetics, growth and nutrition. His research program integrates laboratory and field based investigations utilizing stable and radioisotopes, calorimetry, compositional analyses and radio/satellite tracking techniques in an attempt to elucidate the capabilities of different species to withstand normal seasonal variation in their environment. Worthy's program includes ongoing investigations into the life history parameters and the physiological ecology of manatees, cetaceans, and pinnipeds. The overall program centers around the energy requirements of marine mammals and how the availability and quality of food impacts their survival and growth. To that end Worthy is involved in studies investigating the thermoregulatory capabilities, milk production, water balance, feeding ecology and free-ranging energetics of several important species of marine mammals.

Dr. Luis Cifuentes research involves the understanding of oceanographic and estuarine processes using stable isotope tracers. Recently his ecological research with stable isotope tracers has involved the assessment of the stock structure of the king mackerel (*Scomberomorus cavalla*) in the Gulf of Mexico, determination of the source of DDT found in bottle nose dolphins (*Tursiops truncatus*) stranded along the Texas coastline, and the tracing of carbon through the microbial loop. Geochemical and organic chemistry research includes using lipids as tracers of carbon flow in non-photosynthetic ecosystems, application of gas chromatograph isotope ratio mass spectrometer (GC/IRMS) to tracing carbon sources in colloidal organic matter, distribution of stable carbon isotope ratios as an indicator of the source of atmospheric particulate organic carbon, and defining intrinsic tracers of pollutants in the marine environment Cifuentes has over 8 years of experience running mass spectrometers and recently obtained a GC/IRMS through NSF funding, which will be used in this project.

Dr. Thomas Boutton is a specialist in the application of stable isotopes to the study of nutrient cycling, ecophysiology and biological change in the terrestrial environment. Last May, Dr. Boutton sponsored a workshop at Texas A&M University entitled: "Stable Isotopes: Recent Advances in Plant Biochemistry, Physiology, and Ecology". Among the more than 180 participants were well-known scientists from the US and Canada. Dr. Boutton has been involved in the management and direction of stable isotope laboratories continuously since 1979, and established new laboratories at Augustana College and Texas A&M University.

Dr. Sara Iverson has worked extensively on marine mammal fatty acid metabolism. Her early studies led to the development of the use of fatty acid signatures in determining marine food webs. Currently, Iverson has assembled a collaborative group of scientists to work on fatty acids as indicators of diet and to develop statistical models for analysis of such data. This research program is looking at marine mammal/fisheries interactions in eastern Canada, specifically that of harp seals and grey seals in relation to cod and other commercial fish stocks. This program is describing the fatty acid patterns of seals and their prey species as part of a broad ecological survey and is related to the current proposal in that it provides some of the underlying framework and financial support for sample collection and captive studies.

Alan Abend has a broad background in marine and terrestrial wildlife research and husbandry. For his masters degree, he studied the distribution and diet of long-finned pilot whales (*Globicephala melas*) using carbon and nitrogen stable isotopes. This research was, in part, initiated by and reported to the International Council for the Exploration of the Seas Pilot Whale Study Group.

Graham Worthy

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April 28/95
Date Prepared

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1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Budget Category:		Authorized FFY 1995	Proposed FFY 1996
Personnel			$16.7
Travel			$3.2
Contractual			$10.8
Commodities			$4.5
Equipment			$0.0
Subtotal		$0.0	$35.2
Indirect	45%		$15.8
Project Total		$0.0	$51.0
Full-time Equivalents (FTE)			7.5

LONG RANGE FUNDING REQUIREMENTS

Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
$35.0	$0.0	$0.0	$0.0	$0.0	$0.0

Dollar amounts are shown in thousands of dollars.

Other Resources

Comments:
Texas A&M University charges 45% as their indirect costs rate. Fringe benefits on salary are calculated at a rate of 30% of salary.

1996

Prepared:

Project Number: 96121
Project Title: Stable Isotope Ratios and Fatty Acid Signatures of Selected Forage Fish in Prince William Sound
Name: Texas A&M University

FORM 4A
Non-Trustee
DETAIL

7/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Personnel Costs:						
Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1996
Graham Worthy	PI		1.0	6,000		6.0
Luis Cifuentes	PI		0.5	5,700		2.9
Alan Abend	graduate student		4.0	1,100		4.4
Tamara Miculka	Research Assistant		2.0	1,700		3.4
						0.0
	monthly costs include fringe benefits					0.0
	(30% of salary)					0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		7.5	14,500	0	
					Personnel Total	$16.7

Travel Costs:					
Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FFY 1996
Galveston, TX to Anchorage, AK for Trustee Council Meeting	1,000	2	12	94	3.1
for Alan Abend					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$3.1

1996

Project Number: 96121
Project Title: Stable Isotope Ratios and Fatty Acid Signatures of Selected Forage Fish Species in Prince William Sound, AK
Name: Texas A&M University

FORM 4B
Personnel
& Travel
DETAIL

4/27/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Contractual Costs:	Proposed
Description	FFY 1996
Texas A&M GC Mass spectrophotometer supplies	2,000.0
Fatty acid analysis supplies	800.0
Consulting fees to Sara Iverson (Dalhousie University)	8,000.0
Contractual Total	$10,800.0

Commodities Costs:	Proposed
Description	FFY 1996
Chemicals/solvvents	1,000.0
sampling bags	1,000.0
phone/mail/shipping	2,500.0
Commodities Total	$4,500.0

1996

Project Number: 96121
Project Title: Stable Isotope Ratios and Fatty Acid Signatures of Selected Forag Fish in Prince William Sound, AK
Name: Texas A&M University

FORM 4B
Contractual &
Commodities
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	

1996	Project Number: 96121 Project Title: Stable Isotope Ratios and Fatty Acid Signatures of Selected Forage Fish in Prince William Sound, AK Name: Texas A&M University	FORM 4B Equipment DETAIL

4/27/95

8/25/95 version

Project Title: **MAPPING POTENTIAL NESTING HABITAT OF THE MARBLED MURRELET IN PRINCE WILLIAM SOUND USING HABITAT MODELS LINKED TO GEOGRAPHIC DATABASES**

Project Number:	96122
Restoration Category:	Research
Proposer:	Robert L. DeVelice, Ph.D.
Lead Trustee Agency:	USFS
Cost FY 96:	$123,200
Cost FY 97:	$ 20,000
Geographic Area:	Prince William Sound
Injured Resource/Service:	marbled murrelet

ABSTRACT

This project would identify potential habitat of the marbled murrelet in Prince William Sound by linking habitat models to geographic databases of vegetation and physical site characteristics. Areas identified as having a high probability of containing nesting habitat could become focal areas for adjusting management prescriptions to favor habitat maintenance.

INTRODUCTION

Marbled murrelets (*Brachyramphus marmoratus*) were injured by oil contamination from the *Exxon Valdez* oil spill of March, 1989. Between 9,500 and 14,000 marbled murrelets died from the direct effects of oiling (Ford et al. 1991). This estimated mortality represents approximately 10% of the present total population size within the spill area (Klosiewski and Laing, MS). Presently, there is no known evidence of population recovery within the spill area (Klosiewski and Laing, MS; Kuletz, MS).

Habitat modifications (such as logging) both within and outside the spill area may pose additional threats to the area's marbled murrelet populations. Protection of nesting habitat areas through compatible management of public lands may reduce the extent of future disturbance so that population recovery may proceed.

This study represents an extension and culmination of previous work conducted by the DOI-FWS and the USFS dating back to the summer of 1990 (DeVelice et al. 1995; Kuletz et al. 1994). These studies characterized the nesting habitat of marbled murrelets throughout the spill area. The currently proposed work would be an operational application of the conceptual and quantitative models described in DeVelice et al. (1995) and Kuletz et al. (1994). The models would be linked to geographic databases of vegetation and physical site characteristics in the identification of potential nesting habitat of the marbled murrelet in Prince William Sound. The map outputs from this project will provide a state-of-science means for evaluating habitat protection options in reference to marbled murrelets (or other species whose potential habitat can be specified based on vegetation and landscape features). Areas identified as having a high probability of containing nesting habitat could become focal areas for adjusting management prescriptions to favor habitat maintenance.

NEED FOR THE PROJECT

A. Statement of Problem

Marbled murrelets were injured by the *Exxon Valdez* oil spill. Marbled murrelet populations in Prince William Sound are reportedly not yet recovering from the spill and from the pre-spill population decline (*Exxon Valdez* Oil Spill Trustee Council 1995).

B. Rationale

The *Exxon Valdez* Oil Spill Restoration Plan specifies marbled murrelet population stability or increase as a restoration objective (*Exxon Valdez* Oil Spill Trustee Council 1995). Protection of habitat is thought to be an important strategy for assisting in population recovery. Using the best available scientific information, the proposed work would provide a digital map of potential nesting habitat of the marbled murrelet. Public land managers could directly use this map product in identifying and managing alternative sites with the greatest potential towards ensuring population recovery.

C. Summary of Major Hypotheses and Objectives

Potential habitat of the marbled murrelet in Prince William Sound would be mapped by linking habitat models (i.e., hypotheses) described in DeVelice et al. (1995) and Kuletz et al. (1994) to spatial databases of vegetation and physical site characteristics. To meet this objective, a spatial database of vegetation types based on satellite imagery would need to be completed as part of this project. A draft version of this digital map (developed by USGS EROS Alaska Field Office and USFS Forest Sciences Laboratory personnel, in cooperation with the Chugach National Forest) is currently available for Prince William Sound. This project would verify and refine this vegetation database.

D. Completion Date

This project would be completed by December of 1996.

COMMUNITY INVOLVEMENT

Prince William Sound residents with knowledge of marbled murrelet nesting habitat requirements would be sought to review the habitat models utilized in this project. Map outputs from this project (showing potential nesting habitat of the marbled murrelet) would be made available for review by the public and scientific community late in calendar year 1996.

FY 96 BUDGET

Personnel (1.6 FTE)	44.2
Travel	4.7
Contractual (boat charter)	60.0
Commodities	0.5
Equipment	3.0
Subtotal	112.4
General Administration	10.8
Total	123.2
FY 97 project close-out cost	20.0

PROJECT DESIGN

A. Objectives

This project would identify potential habitat of the marbled murrelet in Prince William Sound by linking habitat models to geographic databases of vegetation and physical site characteristics.

B. Methods

DeVelice et al. (1995) and Kuletz et al. (1994) describe both conceptual and statistical models that relate marbled murrelet occurrences to vegetation and physical site attributes. For example, both reports highlight a preference of marbled murrelets for forested habitats, particularly older forests with numerous mossy platforms (potential nest sites) in the trees. Additionally, DeVelice et al. (1995) indicates that marbled murrelet sightings increase with the proportion of coniferous forest in an area. Both reports show a higher occurrence of marbled murrelets in more sheltered landscape positions (e.g., heads of bays; aspects protected from major storms). Models described in these and other studies relating marbled murrelet occurrences to vegetation type and landscape features would be applied in queries of the digital vegetation type and digital elevation model databases. Ultimately, this process will result in a digital map of potential marbled murrelet habitat in Prince William Sound. Interim and final products of this project (including habitat models and potential habitat maps) would be submitted to review by marbled murrelet biologists in other agency's and institutions.

The proposed methodological steps involved in this project are as follows:

1. The DRAFT digital vegetation type map of Prince William Sound (based on satellite imagery) must be verified and refined before the habitat models can be effectively applied. Existing survey data will be used for initial refinement. Currently, almost 800 detailed sample plots spanning the range of vegetation types are available in the Chugach National Forest vegetation ecology database for Prince William Sound.

These plots, 40 randomly-located 1-km radius digital vegetation maps from Prince William Sound, and a digital vegetation map covering Naked, Storey, and Peak islands will be the primary input to the initial supervised classification of the digital vegetation map. All of these plot and polygon coverages reside in digital databases on the Chugach National Forest.

Forested vegetation at low elevations (e.g., elevations below 300 m) will be the focus of high resolution vegetation mapping since marbled murrelet upland habitat within Prince William Sound has been observed to occur primarily within such areas (Kuletz et al. 1994). Broad forest types (e.g., closed needleleaf forest; open mixed forest) have already been mapped using satellite imagery. The proposed work will develop and apply rule-based models (e.g., Coughlan and Running 1989) relating forest type to landscape features (e.g., elevation, slope, aspect) and bioclimate (DeVelice and Hagenstein 1995) to further divide these broad groupings into specific forest types (e.g., Sitka spruce/devil's club riparian forest; mountain hemlock/copperbush forested peatland). Forest types characterized by trees of large average diameter and numerous mossy platforms that are in sheltered locations would be identified as having a higher potential as marbled murrelet nesting habitat than non-forest types and forests characterized by stunted trees on exposed headlands.

2. The marble murrelet habitat models based on vegetation type and landscape features will be linked (via GIS technology) to the digital vegetation map and digital elevation model (basically, a computerized topographical map) covering Prince William Sound. These habitat models will basically be a set of rules (*sensu* Couglan and Running 1989) derived from Kuletz et al. (1994) and DeVelice et al. (1995) that identify areas with the highest POTENTIAL as nesting habitat as extensive old-growth forests (i.e., structurally complex forests characterized by trees of large average diameter) in sheltered locations at low elevations.

3. During the summer of 1996, field surveys throughout Prince William Sound will be conducted to fill in gaps in the database of vegetation and physical sites for use in verification and refinement of the digital vegetation type map. The survey crews will be directed to sites that, in the aggregate, represent the full range of forest and physical site combinations present within Prince William Sound. These sample sites will be complementary to those sites already in the Chugach National Forest databases. The vegetation type classification developed by DeVelice et al. (1995) will be used in the identification of vegetation types at each verification site. The precise location of each site will be quantified using a geographical positioning system (GPS).

4. Use the data from the summer of 1996 for the supervised classification of the digital vegetation map of Prince William Sound. The marbled murrelet habitat models would then be reapplied to this database (and the digital elevation and bioclimatic models) to produce a digital map of potential marbled murrelet habitat. Although the digital vegetation map will initially be applied towards mapping potential habitat of the marbled murrelet, the potential applications of the digital

map are vast. Among these applications are: mapping potential habitat for Kittlitz's murrelet; assessing biodiversity patterns at the landscape level; and assessing the ecological representativeness of alternative networks of nature preserves. A digital vegetation map coverage for Prince William Sound is a basic need for ecosystem analysis and assessment within the Sound (including marine, upland, and freshwater aquatic systems). Such a coverage does not presently exist but would likely be one of the most heavily utilized products developed through EVOS funding.

C. Contracts and Other Agency Assistance

To accomplish the necessary travel to remote field study sites, this project will require chartering a boat for 60 days duration.

D. Location

The study area covers all islands and the mainland areas of Prince William Sound from sea level through the alpine zone.

SCHEDULE

A. Measurable Project Tasks for FY 96

October 1995:	provide GIS/remote sensing analyst with vegetation plot and polygon data for initial verification of digital vegetation map based on satellite imagery
November - December:	revise vegetation map based on plot and polygon data
January 1996:	create models of marbled murrelet potential habitat that can be linked to the digital vegetation map and the digital elevation model
February - April:	apply the models to the digital vegetation and elevation coverages and make initial assessments of their validity
March:	secure charter vessel for use in vegetation map verification advertize for field personnel
April:	hire field personnel (two biotechnicians) prepare for field work (e.g., organize training for field crew; acquire maps and aerial photographs; order necessary equipment; generate sufficient copies of field forms)
May:	safety training vegetation/characterization training identification of locations of field verification sites
June - August:	Prince William Sound vegetation map verification surveys
September - October:	data entry and refinement of digital vegetation map
November - December:	final analysis and report writing
April 15, 1997:	final report submitted

B. Project Milestones and Endpoints

May 1, 1996:	initial draft identification of potential habitat of the marbled murrelet in Prince William Sound based on the unverified vegetation map coverage and the digital elevation model
December 31, 1996:	draft final identification of potential habitat based on the refined vegetation map and the digital elevation model
April 15, 1997:	final report submitted

C. Project Reports

The final report will be submitted to the Chief Scientist by April 15, 1997.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will be independent of other known restoration projects proposed for fiscal year 1996. However, at least five of the projects recommended or deferred for funding in FY 1996 by the EVOS Trustee Council could benefit from information generated by project 96122 (and visa versa). These projects include:

96031 "Development of a Protected Index to Monitor the Reproductive Success of Marbled and Kittlitz's Murrelets in Prince William Sound, Alaska"

This study would identify coastal and marine features that best predict juvenile murrelet abundance. Incorporating these predictors could potentially improve the reliability of the habitat models used in Project 96122.

96163 "APEX: Apex Predator Ecosystem Experiment in Prince William Sound and the Gulf of Alaska"

This study would test the hypothesis that changes in the food environment in Prince William Sound may be responsible for nonrecovery of seabirds. Data collected in this project (and in project 96031) on forage fish abundance patterns could potentially be used by project 96122 to identify upland areas with the highest overall favorablility as nesting habitat. For example, upland areas with favorable nesting habitat that are adjacent to areas with abundant forage fish would likely have the highest overall rating as potential marbled murrelet habitat.

96159 "Surveys to Monitor Marine Bird Abundance in Prince William Sound During Winter and Summer of 1996"

This project would monitor the distribution and abundance of marine birds. Such data would be invaluable in testing and refining the potential habitat predictions generated in project 96122.

96142-BAA "Status and Ecology of Kittlitz's Murrelet in Prince William Sound"

This study would evaluated the abundance, distribution, and productivity of Kittlitz's Murrelet in northwestern Prince William Sound. The highest resolution vegetation mapping proposed in project 96122 will be within forested habitats. However, all vegetation types within Prince William Sound will be mapped at least to level III of the Alaska vegetation classification system (Viereck et al. 1992). Projects 96122 and 96142-BAA could potentially share information towards developing a upland habitat map of the Kittlitz's murrelet.

96320 "Sound Ecosystem Assessment (SEA)"
This study would examine factors controlling production of pink salmon and Pacific herring in Prince William Sound. Project 96122 could provide valuable characterizations of upland habitats adjacent to steams that potentially affect production of pink salmon.

ENVIRONMENTAL COMPLIANCE

No environmental compliance measures will be required.

PERSONNEL

This project will require 18.5 person months of effort. Ecological support will be provided by R.L. DeVelice (six months, to be funded by USFS NOT EVOS; Chugach NF) and C. Hubbard (two months; Chugach NF). Habitat capability modeling support will be provided by L. Suring (one month; Chugach NF). GIS/remote sensing analysis will provided by K. Winterberger (three months; Forest Sciences Laboratory). Field work will largely be accomplished by two biotechnicians (total of six months).

Computational, analytic, and data archiving support will be provided by the USFS and Forest Sciences Laboratory, and USGS EROS Alaska Field Office (including the extensive use of personal computers and GIS workstations that will be required).

Robert L. DeVelice received his Ph.D. in plant ecology from New Mexico State University, Las Cruces, in 1983. His dissertation involved the development of a vegetation type classification in the southern Rocky Mountains. Robert was a post-doctoral fellow in New Zealand from 1984 - 1987 where he conducted preserves selection and design research. From 1987 - 1989 Robert worked as a contract scientist working on global climatic change research for the US Environmental Protection Agency. Prior to joining the staff of the Chugach National Forest in 1992, Robert worked as the Montana state ecologist for The Nature Conservancy. The focus of much of Robert's work and experience is field vegetation ecology and quantitative plant community analysis. Robert was a co-leader of the study entitled "Characterization of Upland Nesting Habitat of the Marbled Murrelet in the *Exxon Valdez* Oil Spill Area (Project 93051 Part B)" completed in

April of 1994. Robert also recently led the development of a Chugach National Forest bioclimatic data layer (DeVelice and Hagenstein 1995). In this study, weather data from five discrete climate stations were extrapolated (using a climatic simulation model) across the Forest and classified into bioclimatic types.

Connie Hubbard received her M.S. in forest science from Oregon State University. Her thesis involved developing a plant association classification for the College of Forestry's research forest lands. Connie has worked for the USFS as Forester, Silviculturalist, and Ecologist. She has also worked for both state and private resource management agencies in Idaho and Montana. Connie is currently the District Ecologist for the Glacier Ranger District of the Chugach National Forest. The emphasis of this position is the development and application of community classifications for the Forest, including plant association classification in Prince William Sound. Connie was a co-leader of the study entitled "Characterization of Upland Nesting Habitat of the Marbled Murrelet in the *Exxon Valdez* Oil Spill Area (Project 93051 Part B)" completed in April of 1994.

Lowell H. Suring received his M.S. in wildlife science from Oregon State University, Corvallis, in 1974. His thesis involved assessing habitat use and activity patterns of Columbian white-tailed deer along the lower Columbia River. Lowell was a leader of the Endangered Species and Wildlife Biometrics units in New York State between 1974 and 1977. From 1977 - 1978 he conducted research on secondary succession in pinyon-juniper woodlands in northwest Colorado. From 1978 - 1984 Lowell held biologist positions with the DOI-FWS and USFS in New Mexico and Minnesota. Since 1984 Lowell has been a major player in the development of wildlife habitat relationships models in the Alaska Region of the USFS (this included chairing an interagency effort to assess viability concerns for wildlife species associated with old-growth forests in southeast Alaska). Lowell's professional expertise and interests focus on analyzing habitat use patterns of wildlife and the development/application of habitat assessment techniques. Currently, Lowell is employed by the Chugach National Forest where he is developing and implementing analytic techniques and tools that may be used to evaluate the capability of habitats to support wildlife and the effects of land management activities on habitat capability.

Kenneth C. Winterberger has done graduate work at the University of Idaho studying remote sensing and it's use in forest mensuration. Ken has worked for the Pacific Northwest Experiment Station, in Alaska, as a remote sensing and inventory specialist since 1976. He has been responsible for land cover classification and inventory projects throughout the state of Alaska; a current project involves the development of a land cover classification derived from Landsat TM and SPOT data. Ken is presently working with a group from the International Boreal Forest Research Association defining and delineating the boreal forest zone on a worldwide basis. Ken is also working with scientists from the Sukachev Institute of Forests in Kasnoyarsk, Russia to develop a methodology to use NOAA AVHRR data to detect and monitor catastrophic forest damage over large areas.

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7/24/95
Date prepared

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel		$44.2						
Travel		$4.7						
Contractual		$60.0						
Commodities		$0.5						
Equipment		$3.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$112.4	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration		$10.8						
Project Total	$0.0	$123.2	$20.0					
Full-time Equivalents (FTE)		1.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources		$0.0						

Comments:
- this project has not been previously funded
- none of the total has been requested for NEPA compliance activities
- $2.9 of the personnel costs ($44.2 total) are for program management
- the $60.0 in contractual expenditures covers chartering a boat for 60 days duration (to travel to remote field sites)

1996

Prepared: 1 of 4

Project Number: 96122
Project Title: Mapping Potential Nesting Habitat of the Marbled Murrelet in Prince William Sound Using Habitat Models Linked to Geographic Databases
Agency: USDA

FORM 3A
AGENCY
PROJECT
DETAIL
7/24/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
	R. DeVelice	ecologist	GS12/3			0	0.0
	C. Hubbard	ecologist	GS9/4	2.0	3,720	0	7.4
	L. Suring	wildlife biologist	GS12/7	1.0	5,320	0	5.3
	K. Winterberger	GIS/remote sensing analyst	GS12/6	3.0	5,180	0	15.5
	2	technicians	GS7/1	6.0	2,180	0	13.1
*	R. Thompson	program manager	GS13	0.6	4,900	0	2.9
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		12.6	21,300	0	
Those costs associated with program management should be indicated by placement of an *.						**Personnel Total**	$44.2

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
	Anchorage/Cordova flights to rendevous with field vessel (3 travellers)	225	9			2.0
	field survey per diem (3 travellers x 60days = 180 days)			180	15	2.7
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					**Travel Total**	$4.7

1996

Project Number:
Project Title: Mapping Potential Nesting Habitat of the Marbled Murrelet in Prince William Sound Using Habitat Models Linked to Geographic Databases
Agency: USFS

FORM 3B
Personnel
& Travel
DETAIL

7/24/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Contractual Costs:	Proposed
Description	FFY 1996
boat charter to access field sites in Prince William Sound (60 days x$1000/day)	60.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$60.0

Commodities Costs:	Proposed
Description	FFY 1996
miscellaneous office supplies; field data forms	0.5
Commodities Total	$0.5

1996

Project Number:
Project Title:
Agency:

FORM 3B
Contractual &
Commodities
DETAIL

7/24/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
Geographic Positioning System to document study site locations	1	2,000	2.0
miscellaneous field gear (e.g., rain parkas; tents)	1	500	0.5
aerial photographs	100	5	0.5
			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**	$3.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
GIS workstation	1	USFS
Pentium personal computer	1	USFS

1996

Project Number:

Project Title: Mapping Potential Nesting Habitat of the Marbled Murrelet in Prince William Sound Using Habitat Models Linked to Geographic Databases

Agency: USFS

FORM 3B Equipment DETAIL

7/24/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
Personnel		$44.2						
Travel		$4.7						
Contractual		$60.0						
Commodities		$0.5						
Equipment		$3.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$112.4						
General Administration		$10.8						
Project Total	$0.0	$123.2	$20.0					
Full-time Equivalents (FTE)		1.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources		$0.0						

Comments:
- this project has not been previously funded
- none of the total has been requested for NEPA compliance activities
- $2.9 of the personnel costs ($44.2 total) are for program management
- the $60.0 in contractual expenditures covers chartering a boat for 60 days duration (to travel to remote field sites)

1996

Prepared: 1 of 4

Project Number:
Project Title: Mapping Potential Nesting Habitat of the Marbled Murrelet in Prince William Sound Using Habitat Models Linked to Geographic Databases
Agency: USDA

FORM 3A
AGENCY
PROJECT
DETAIL
7/24/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
	R. DeVelice	ecologist	GS12/3			0	0.0
	C. Hubbard	ecologist	GS9/4	2.0	3,720	0	7.4
	L. Suring	wildlife biologist	GS12/7	1.0	5,320	0	5.3
	K. Winterberger	GIS/remote sensing analyst	GS12/6	3.0	5,180	0	15.5
	2	technicians	GS7/1	6.0	2,180	0	13.1
*	R. Thompson	program manager	GS13	0.6	4,900	0	2.9
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		12.6	21,300	0	
Those costs associated with program management should be indicated by placement of an *.						Personnel Total	$44.2

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
	Anchorage/Cordova flights to rendevous with field vessel (3 travellers)	225	9			2.0
	field survey per diem (3 travellers x 60days = 180 days)			180	15	2.7
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					Travel Total	$4.7

1996

Project Number:

Project Title: Mapping Potential Nesting Habitat of the Marbled Murrelet in Prince William Sound Using Habitat Models Linked to Geographic Databases

Agency: USFS

FORM 3B Personnel & Travel DETAIL

7/24/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Contractual Costs:	Proposed
Description	FFY 1996
boat charter to access field sites in Prince William Sound (60 days x$1000/day)	60.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$60.0

Commodities Costs:	Proposed
Description	FFY 1996
miscellaneous office supplies; field data forms	0.5
Commodities Total	$0.5

1996

Project Number:
Project Title:
Agency:

FORM 3B
Contractual &
Commodities
DETAIL

7/24/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
Geographic Positioning System to document study site locations	1	2,000	2.0
miscellaneous field gear (e.g., rain parkas; tents)	1	500	0.5
aerial photographs	100	5	0.5
			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**	$3.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency
GIS workstation	1	USFS
Pentium personal computer	1	USFS

1996

Project Number:
Project Title: Mapping Potential Nesting Habitat of the Marbled Murrelet in Prince William Sound Using Habitat Models Linked to Geographic Databases
Agency: USFS

FORM 3B
Equipment
DETAIL

7/24/95

Habitat Protection and Acquisition Support

Project Number:	96126
Restoration Category:	Habitat Protection
Proposer:	AK Dept. of Natural Resources
Lead Trustee Agency:	ADNR, USFS
Cooperating Agencies:	ADF&G, USFS, DOI
Duration:	FFY 1996 - TBD
Cost FY 96:	~~817.6~~ 841.6
Cost FY 97:	TBD
Cost FY 98:	TBD
Cost FY 99:	TBD
Geographic Area:	Prince William Sound, Kenai Peninsula, Alaska Peninsula Kodiak Archipelago
Injured Resource/Service:	Multiple Resources

ABSTRACT

Project 96126 provides negotiation support to the Trustee Council in order to reach closure on habitat protection priorities. This support includes those services such as title reports, appraisals, on site inspections, hazardous materials surveys, surveys, timber cruises and reviews, and other services necessary for the successful completion of habitat protection negotiations.

INTRODUCTION

This project is designed to support habitat protection activities of the Trustee Council and is a continuation of the Comprehensive Habitat Protection Process. These activities include evaluations by the Habitat Work Group, appraisals, title searches, hazardous materials surveys and other efforts necessary for the Trustee Council to achieve habitat protection objectives. In 1993 the Restoration Team, Habitat Protection Work Group conducted a survey and assessment of selected large parcels of private land (>1000 acres) within the oil spill zone. The lands were mapped, scored and ranked to determine the restoration value of these areas to injured resources and services and the benefits that could be achieved through habitat protection. Successful negotiations were conducted with owners of lands within Kachemak Bay State Park and on northern Afognak Island resulting in the purchase of the park inholdings and in the establishment of the Afognak Island State Park.

During 1995, technical support continues to be provided to the Executive Director, negotiators and appraisers engaged in negotiations with landowners. Parcel boundaries were refined by HWG in order to capture the key habitats within the smallest possible land area. Packages of ranked parcels, selected either by the negotiators or by HWG, as logical negotiation units, were evaluated and ranked. The results were provided to the negotiators and to the Executive Director. Secondary evaluations were conducted on acquisition proposals wherein *less than fee simple* interests were negotiated. Presentation materials including numerous maps were produced and used by the Executive Director and negotiators in presentations to the Trustee Council and the public.

In 1995, Volume III of the Comprehensive Habitat Protection Process, *Small Parcel Process, Evaluation and Ranking* was completed. Responses to the solicitation for nominations of small parcels were processed and evaluated. A second round of small parcel nominations were received and evaluated. It is expected that the Trustee Council will move forward with a suite of small parcel nominations that best meet the restoration goals and objectives identified by the Trustee Council.

Negotiations continue with several large parcel landowners as well as with numerous small parcel landowners. It is expected that Trustee Council efforts in this area while reaching closure on many fronts will continue in the near term.

NEED FOR THE PROJECT

The objective of habitat protection is to identify and protect essential wildlife and fisheries habitats and associated services and to prevent further environmental damage to resources injured by the *Exxon Valdez* oil spill. Nineteen resources and services injured by the spill are linked to protection of upland and nearshore habitats (See Section D). Protection of lands containing these habitats prevents additional injury to resources and services and natural support systems while recovery is taking place. Active negotiations with landowners for packages of ranked parcels are currently taking place and anticipated to continue into the Fall. Evaluations, starting with field surveys, of large and small parcels submitted this Spring will also continue into the Fall. This project provides support for HWG to provide technical support to the negotiators and the Executive Director and to conduct these additional evaluations.

COMMUNITY INVOLVEMENT

The public has reviewed and commented favorably on all habitat protection efforts and has been highly supportive of habitat protection as a major restoration strategy into the future. All reports published as part of the Comprehensive Habitat Protection Process have been reviewed by the public. Input from natural resource and services specialists in the public sector was collected in a workshop conducted by The Nature Conservancy.

Members of local communities have previously had the opportunity to review habitat protection evaluation and ranking results and Trustee Council priorities. This project is the completion of the habitat protection effort and no further community involvement is expected at this time. The Trustee Council is always willing to entertain comment from interested individuals.

FY 96 BUDGET

Personnel	419.0
Travel	27.4
Contractual	308.5
Commodities	2.5
Equipment	0.0
Subtotal	757.4
Gen. Admin.	84.4
Total	841.8

PROJECT DESIGN

A. Objectives

Habitat protection and acquisition is designed to protect lands linked to resources and services that were injured by the Exxon Valdez oil spill. Protection of these lands prevents additional injury to living resources and habitats, services and natural support systems while recovery is taking place. Habitat protection addresses cases where existing regulations affecting private land use are inadequate to protect essential habitats of recovering resources and services. In situations where natural recovery is slow to occur or where direct restoration is neither technically feasible or cost effective, other measures need to be considered to mitigate injury. These may include replacement of injured resources and services with those that are equivalent {Replacement or acquisition of the equivalent means compensation for an injured, lost or destroyed resource by substituting another resource that provides the same or substantially similar services as the injured resource (56 Federal Register **8899 [March 1, 1991]).**

The affected injured resources and associated services are listed below. Habitat protection objectives and benefits for each of these resources and services would differ depending on the particular parcel and the options acquired, however, general objectives and benefits are outlined below.

Pink salmon, sockeye salmon, cutthroat trout, Dolly varden, herring: ensure maintenance of adequate water quality, riparian habitat and intertidal habitat for spawning and rearing.

Bald eagle: ensure maintenance of adequate nesting habitat and reduce disturbance in feeding and roosting areas.

Black oystercatcher: reduce disturbance to feeding and nesting sites.

Common murre: reduce disturbance in nearshore feeding areas and near nesting colonies.

Harbor seal and sea otters: reduce disturbance at haul-out sites, pupping sites, and in nearshore feeding areas.

Harlequin duck: ensure maintenance of adequate riparian habitat for nesting and brood rearing, and reduce disturbance to nearshore feeding, molting, and brood-rearing habitats.

Intertidal/subtidal biota: maintain water quality along shoreline and reduce disturbance in nearshore areas.

Marbled murrelet: ensure maintenance of adequate nesting habitat and reduce disturbance to nearshore feeding and broodrearing habitats.

River otter: ensure maintenance of adequate riparian and shoreline habitats for feeding and denning.

Recreation: Maintain or enhance public access for recreational opportunities, reduce disturbances that would create visual impacts.

Wilderness: Maintain wilderness qualities, reduce impacts to wilderness qualities.

Cultural resources: Maintain or reduce disturbance to cultural resource sites.

Subsistence: Ensure subsistence opportunities in known harvest areas.

B. Methods:

The *Habitat Protection and Acquisition Process* is the method for acquiring lands or partial interests in lands that contain habitats linked to resources and/or services injured by the oil spill. Protection tools that will be considered for use by the Trustee Council include: fee acquisition, conservation easements, acquisition of partial interests, cooperative management agreements, and others. Following purchase, acquired parcels will be managed by the appropriate resource agency in a manner that is consistent with the restoration of the affected resources and/or services. The Trustee Council will decide which agency will manage the land or may create a new management authority.

Funds from this project will be used to acquire full title or partial interests in lands, subject to approval by the Trustee Council, that contain habitats/sites linked to resources and services that were injured by the Exxon Valdez oil spill. Acquisition of lands or interests in lands will be accomplished according to accepted realty principles and practices. All acquisitions will require title evidence, appraisals of fair market value, litigation reports, hazardous substances surveys, legal review of title, and negotiations. Some acquisitions may require land surveys and additional ecological surveys.

C. Contracts and Other Agency Assistance

Various components of this project will be contracted out to the private sector. Contracting is managed by the agency responsible for acquisition of habitat protection rights and future management. Various agencies handle various realty requirements differently depending upon agency requirements and in house expertise.

D. Locations

This project is based primarily in Anchorage, with travel to various locations to inspect parcels. This project represents an area wide approach to habitat protection. Contractual work is focused regionally as needed.

SCHEDULE

This project is a continuation of 93064, 94126, 95126, and does not lend itself to a specific timetable. Activities associated with this project are subject to influence from landowners, negotiators and various contractors.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

All habitat protection efforts including this project are dependent upon the results of on-going research and monitoring projects. For example, the Large Parcel Element used information from the anadromous fish stream catalog, colonial seabird catalog, bald eagle nesting maps, and data from Trustee Council funded studies on black oystercatchers, marbled murrelets and pigeon guillemots.

ENVIRONMENTAL COMPLIANCE

Previous acquisitions have received a categorical exclusions. The appropriate federal agencies, US Dept. of the Interior or US Forest Service will comply with NEPA where appropriate.

PERSONNEL

Project Leader

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1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996	PROPOSED FFY 1996 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	NPS	FWS
				$20.0	$170.4	$116.8	$16.2	$426.9
Personnel	$188.0	$419.0						
Travel	$37.3	$27.4						
Contractual	$558.0	$308.5						
Commodities	$11.5	$2.5						
Equipment	$3.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$797.8	$757.4	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration	$60.0	$84.4						
Project Total	$857.8	$841.8	$170.0	$115.0	$115.0	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)	1.0	7.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Comments:

1996

Prepared:

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Lead Agency: AK Dept. of Natural Resources

FORM 2A
PROJECT
DETAIL

1996 EXXON VALDEZ TRUSTEE ɪNCIL PROJECT BUDGET

October 1, 1995 - Sepᴜᴇɪnber 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel	$49.0	$14.0						
Travel	$5.3	$3.5						
Contractual	$273.0	$154.0						
Commodities	$3.5	$1.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$330.8	$172.5	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration	$20.8	$12.9						
Project Total	$351.6	$185.4	$100.0	$50.0	$50.0			
Full-time Equivalents (FTE)	0.6	0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1996

Prepared:

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: AK Dept. of Natural Resources

FORM 3A
AGENCY
PROJECT
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1996
PM	Name	Position Description					
	TBD	Natural Resource Manager II	20	2.0	7,000	0	14.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		2.0	7,000	0	
Those costs associated with program management should be indicated by placement of an *.						**Personnel Total**	$14.0

Travel Costs:		Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FFY 1996
PM	Description					
						0.0
						0.0
	Travel to Prince William Sound and Gulf of Alaska for purposes of survey, title verification, and recordation, appraisal review and site inspections.	300	5	5	150	2.3
						0.0
						0.0
	Travel to Juneau for Trustee Council briefings, presentations.	444	2	2	150	1.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					**Travel Total**	$3.5

1996

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: AK Dept. of Natural Resources

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs: Description	Proposed FFY 1996
Printing and Map Production, maps and data analysis for negotiators, appraisers, title verifications	25.0
Aircraft charters to uplands to further refine parcel boundaries (8 hours @ $250.00/hour)	2.0
Services necessary for the Trustee Council to reach closure on purchase agreement for parcels under negotiation. This may include, title reports, litigation reports, appraisal reviews, timber reviews, hazardous materials assessments.	108.0
Document production and printing costs.	5.0
Recordation of final title documents, surveys, purchase agreements. This will include travel to specific court recording offices.	14.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$154.0

Commodities Costs: Description	Proposed FFY 1996
Office and field supplies (toner cartridges, data cassettes, waterproof notebooks)	1.0
Commodities Total	$1.0

1996

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: AK Dept. of Natural Resources

FORM 3B
Contractual & Commodities
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1996

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: AK Dept. of Natural Resources

FORM 3B
Equipment
DETAIL

5/3/95

1996 EXXON VALDEZ TRUSTEE NCIL PROJECT BUDGET

October 1, 1995 - S ,.. nber 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel	$36.0	$13.0						
Travel	$6.0	$3.5						
Contractual	$3.0	$1.0						
Commodities	$4.0	$0.5						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$49.0	$18.0	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration	$5.6	$2.0						
Project Total	$54.6	$20.0	$20.0	$15.0	$15.0			
Full-time Equivalents (FTE)		0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1996

Prepared:

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: AK Dept. of Fish & Game

FORM 3A
AGENCY
PROJECT
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
	TBD	Habitat Biologist III	18	2.0	6,500		13.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		2.0	6,500	0	
Those costs associated with program management should be indicated by placement of an *.						**Personnel Total**	$13.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
						0.0
	Travel to PWS and Gulf of Alaska to address post acquisition	350	4	6	150	2.3
	management concerns.					0.0
						0.0
	Travel to Juneau to attend Trustee Council briefings re small parcel					0.0
	acquisitions.	444	2	2	150	1.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					**Travel Total**	$3.5

1996

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: AK Dept. of Fish & Game

FORM 3B
Personnel
& Travel
DETAIL

1996 EXXON VALDEZ TRUSTEE NCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Contractual Costs: Description	Proposed FFY 1996
Phone, telecommunications.	0.7
Document reproduction.	0.3
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$1.0

Commodities Costs: Description	Proposed FFY 1996
Office supplies, paper, toner cartridges.	0.5
Commodities Total	$0.5

1996

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: AK Dept. of Fish & Game

FORM 3B
Contractual & Commodities
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1996

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: AK Dept. of Fish & Game

FORM 3B
Equipment
DETAIL

1996 EXXON VALDEZ TRUSTEE NCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel	$28.0	$11.8						
Travel	$2.0	$2.6						
Contractual	$0.0	$0.0						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$30.0	$14.4	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration	$4.2	$1.8						
Project Total	$34.2	$16.2						
Full-time Equivalents (FTE)	0.4	0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1996	Project Number: 95126 Project Title: Habitat Protection & Acquisition Support Agency: Dept. of Interior, National Park Service	FORM 3A AGENCY PROJECT DETAIL

Prepared:

5/3/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
							0.0
	Charles Gilbert	Realty Officer	13	1.0	5,900		5.9
	Stuart Snyder	Appraiser	13	1.0	5,900		5.9
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		2.0	11,800	0	
Those costs associated with program management should be indicated by placement of an *.						**Personnel Total**	$11.8

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
						0.0
	Travel to Seward to conduct site visits, meet with negotiators.	100	4	4	150	1.0
	Travel to Port Graham and English Bay to conduct site visits and meet with negotiators.	250	4	4	150	1.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					**Travel Total**	$2.6

1996

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: Dept. of Interior, National Park Service

FORM 3B
Personnel
& Travel
DETAIL

Contractual Costs:	Proposed
Description	FFY 1996
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.0

Commodities Costs:	Proposed
Description	FFY 1996
Commodities Total	$0.0

1996

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: Dept. of Interior, National Park Service

FORM 3B
Contractual &
Commodities
DETAIL

5/3/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1996

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: Dept. of Interior, National Park Service

FORM 3B
Equipment
DETAIL

1996 EXXON VALDEZ TRUSTEE NCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel		$321.2						
Travel		$8.4						
Contractual		$116.5						
Commodities		$1.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$447.1	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration		$56.3						
Project Total	$0.0	$503.4						
Full-time Equivalents (FTE)		6.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1996

Prepared:

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: Dept. of Interior, Fish & Wildlife Service

FORM 3A AGENCY PROJECT DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
		Realty Specialist I	9	9.0	3,507		31.6
		Realty Specialist I	9	3.0	3,507		10.5
		Realty Specialist II	12	9.0	5,661		50.9
		Realty Specialist II	12	3.0	5,661		17.0
		Cartographer I	7	12.0	2,840		34.1
		Biologist	12	12.0	4,343		52.1
		Realty Tech	6	1.0	2,000		2.0
		Reviewer	13	6.0	7,232		43.4
		Realty Specialist III	12	4.5	5,661		25.5
		Realty Tech	6	5.1	1,719		8.8
		Appraiser	12	9.0	5,037		45.3
							0.0
		Subtotal		73.6	47,168	0	
Those costs associated with program management should be indicated by placement of an *.						Personnel Total	$321.2

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
						0.0
	Travel to Kodiak to finalize large parcel negotiations.	178	3	9	139	1.8
	Inlcudes 3 trips for a negotiator for a total of 9 days, one trip each	178	2	4	139	0.9
	for a reviewer and a biologist for 2 days each.					0.0
						0.0
	Travel to Kenai and Kodiak to conduct small parcel negotiations.	178	4	12	139	2.4
	Kodiak travel for a negotiator, and appraiser for 2 trips for a total of 6 days					0.0
	Kodiak travel for a reviewer and a biologist for 1 trip each for 3 days.	178	2	6	139	1.2
	Kenai travel for a negotiator for 3 trips for a total of 6 days.	130	3	6	178	1.5
	Keani travel for a reviewer and a biologist for 1 trip each for 1 day.	130	2	2	178	0.6
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					Travel Total	$8.4

1996

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: Dept. of Interior, Fish & Wildlife Service

FORM 3B
Personnel
& Travel
DETAIL

1996 EXXON VALDEZ TRUSTEE \CIL PROJECT BUDGET
October 1, 1995 - Sepiember 30, 1996

Contractual Costs: Description	Proposed FFY 1996
Large Parcel Surveys, AKI, OLD, KON.	25.0
Large Parcel Title work, AKI, OLD, KON.	15.0
Appraisal Contract	50.0
Small Parcel Surveys, Salamatof, KNA	20.0
Small Parcel Title Work	5.0
OAS Flight time as part of Kodiak travel (8 hours @ $175/hour)	1.5
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$116.5

Commodities Costs: Description	Proposed FFY 1996
Office Supplies	1.0
Commodities Total	$1.0

1996

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: Dept. of Interior, Fish & Wildlife Service

FORM 3B
Contractual &
Commodities
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FFY 1996
			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	Inventory
Description	of Units	Agency

1996

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: Dept. of Interior, Fish & Wildlife Service

FORM 3B
Equipment
DETAIL

1996 EXXON VALDEZ TRUSTEE ʼNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel	$75.0	$59.0						
Travel	$24.0	$9.4						
Contractual	$282.0	$37.0						
Commodities	$4.0	$0.0						
Equipment	$3.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$388.0	$105.4	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration	$29.4	$11.4						
Project Total	$417.4	$116.8	$50.0	$50.0	$50.0			
Full-time Equivalents (FTE)		0.9						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1996

Prepared:

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: Dept. of Agriculture, Forest Service

FORM 3A
AGENCY
PROJECT
DETAIL

5/3/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
	R. Thompson	Program Manager	13.0	0.5	6,000		3.0
	J. Harmening	Negotiator	13	6.0	6,000		36.0
	R. Goosens	Review Appraiser	12	2.0	5,000		10.0
	TBD	Realty/Land Specialist	12	2.0	5,000		10.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		10.5	22,000	0	
Those costs associated with program management should be indicated by placement of an *.						Personnel Total	$59.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
						0.0
	RT Juneau to Anchorage to meet with review appraisers, contract appraisers and negotiators.	444	11	20	225	9.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					Travel Total	$9.4

1996

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: Dept. of Agriculture, Forest Service

FORM 3B
Personnel
& Travel
DETAIL

1996 EXXON VALDEZ TRUSTEE NCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Contractual Costs: Description	Proposed FFY 1996
Small Parcel Appraisals	25.0
Recordation of Title Documents, final title reports, surveys, purchase agreements etc.	12.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$37.0

Commodities Costs: Description	Proposed FFY 1996
Commodities Total	$0.0

1996

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: Dept. of Agriculture, Forest Service

FORM 3B
Contractual &
Commodities
DETAIL

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1996

Project Number: 95126
Project Title: Habitat Protection & Acquisition Support
Agency: Dept. of Agriculture, Forest Service

FORM 3B
Equipment
DETAIL

Project Title: Tatitlek Coho Salmon Release

Project Number:	96127
Restoration Category:	General Restoration
Proposer:	Tatitlek IRA Council
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	Tatitlek IRA Council
Duration:	Ongoing
Cost FY 96:	$38.5
Cost FY 97:	$32.8
Cost FY 98 & beyond:	$30.0
Geographic Area:	Boulder Bay, Prince William Sound
Injured Resource/Service:	Salmon/Subsistence

ABSTRACT

Project will create a coho salmon return to Boulder Bay near Tatitlek village. Enough coho eggs to produce 20,000 smolts will be collected from an ADF&G approved stream, incubated and reared to smolt at the Solomon Gulch Hatchery transported and held for two weeks in net pens in Boulder Bay before release. Release will produce a 2,000 to 3,000 adult return to Boulder Bay for harvest in a subsistence fishery.

A. INTRODUCTION

Subsistence fisheries available to residents of Tatitlek village were severely disrupted by the Exxon Valdez oil spill. This project is intended to enhance subsistence resources near Tatitlek by creating a 2,000 to 3,000 coho salmon return to Boulder Bay, which is immediately adjacent to Tatitlek village. This resource is intended to partially replace, for the near term, other subsistence resources, such as harbor seals, that were injured by the spill.

This coho salmon return will be created through an annual release of 20,000 coho salmon smolts into Boulder Bay. The smolts are produced at the Solomon Gulch Salmon Hatchery under an agreement between its operator, the Valdez Fisheries Development Corporation and the Tatitlek IRA Council. The coho salmon eggs needed to produce the smolts come from a wild coho run that has been approved by ADF&G for the egg take. The eggs are taken to the Solomon Gulch hatchery for incubation and rearing to the smolt stage. The sea ready smolts are then transported by boat to Boulder Bay and are imprinted to the bay by placing them in net pens for about a two week period before being released into the wild.

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

NEED FOR THE PROJECT

A. Statement of Problem

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

B. Rationale

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

C. Summary of Major Hypotheses and Objectives

Objective 1. Continue agreement with the Valdez Fisheries Development Corporation to produce 20,000 coho salmon smolts for release in Boulder Bay.

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

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

D. Completion Date

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

COMMUNITY INVOLVEMENT

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

FY 96 BUDGET

Personnel	$2.5
Travel	$0.0
Contractual	$21.5
Commodities	$2.5
Equipment	$10.0

Indirect Costs		$2.0
Total	$	38.5

PROJECT DESIGN

A. Objectives

1. Continue agreement with the Valdez Fisheries Development Corporation to produce 20,000 coho salmon smolts for release into Boulder Bay.

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

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

B. Methods

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

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

The eggs are taken from a coho run approved by ADF&G for use in this project. Enough eggs are taken to produce 20,000 smolts. They are taken to the Solomon Gulch hatchery where standard fish culture practices are utilized to incubate the eggs and rear the resultant fry to the smolt stage. The smolts are then transported by boat to Boulder Bay where they are placed in net pens and held (and fed) for a two week period during which time they imprint to Boulder Bay. The smolts are then released into the wild and proceed to their ocean rearing grounds returning back to Boulder Bay approximately 12 months later as adults. Around 2,000 to 3,000 adult coho salmon return to Boulder Bay from the smolt release. As many of these fish as possible (usually 75% to 85%) are harvested in a subsistence fishery that has been set up specifically for this purpose. The unharvested fish die without spawning.

C. Contracts and Other Agency Assistance

The Tatitlek IRA Council is contracted by ADF&G to oversee this project. The council in turn contracts with the Valdez Fisheries Development Corporation to take tha eggs and produce the smolts.

D. Location

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

SCHEDULE

A. Measurable Project Tasks for FY 96

August, 1995:	Egg take
May 20 to 25, 1996:	Smolt transported to Boulder Bay and placed in net pens.
June 3 to 8, 1996:	Smolt released into Boulder Bay
August, 1996:	Egg take

B. Project Milestones and Endpoints

Objective 1. Initial agreement in place. Will be reviewed and renewed by April 15 each year.

Objective 2. Completed by June 15 each year.

Objective 3. Ccmpleted by July 15 annually.

C. Project Reports

Annual reports: Describe project activities for each fiscal year. Due April 1 following the fiscal year being reported on.

Final report: Synopsis of each year's activities and analysis of project as a whole. Due April 1 following the year in which the final adult return occurs.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

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

ENVIRONMENTAL COMPLIANCE

NEPA review was conducted by ADF&G and an environmental assessment prepared in FY 95.

PERSONNEL

The Tatitlek IRA Council will oversee the project. The egg take and smolt production will be undertaken by the Valdez Fisheries Development Corporation at its Solomon Gulch Salmon Hatchery.

Gary Kompkoff is president of the Tatitlek IRA Council. In his 16 year as president of the council Mr. Kompkoff has overseen numerous village projects of various types. His experience makes him amply qualified to oversee this project.

Gary Kompkoff, President
Tatitlek IRA Council
Box 171
Tatitlek, AK 99677
Phone (907) 325-2311
Fax (907) 325-2298

April 26, 1995
Date Prepared

[illegible]

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel	$5.0	$6.3						
Travel		$0.0						
Contractual		$18.1						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$5.0	$24.4	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration		$2.2						
Project Total	$5.0	$26.6	$15.9	$15.9	$15.9	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)		0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:
The $5.0k allocated in FFY95 was used to prepare an Environmental Assessment for the Tatitlek coho release.

Funding for this project would be contracted through the Prince William Sound Economic Development Council via a Standard Agreement written by the ADF&G. They would in turn subcontract with the Tatitlek IRA council.

The VFDA, Solomon Gulch Hatchery will provide 20,000 coho smolts to the project at no charge. They will also provide the fish food necessary for the net pen rearing.

1996

Prepared:

Project Number: 96127
Project Title: Tatitlek Coho Salmon Release
Agency: AK Dept. of Fish & Game

FORM 3A
AGENCY
PROJECT
DETAIL

7/31/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
*	PCN 117021	FB III	18L	1.0	$6,333		6.3
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		1.0	6,333	0	
Those costs associated with program management should be indicated by placement of an *.						Personnel Total	$6.3

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					Travel Total	$0.0

1996

Project Number: 96127
Project Title: Tatitlek Coho Salmon Release
Agency: AK Dept. of Fish & Game

FORM 3B
Personnel
& Travel
DETAIL

7/31/95

Contractual Costs: Description	Proposed FFY 1996
Contract with Prince William Sound Economic Development Council	18.1
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$18.1

Commodities Costs: Description	Proposed FFY 1996
Commodities Total	$0.0

1996

Project Number: 96127
Project Title: Tatitlek Coho Salmon Release
Agency: AK Dept. of Fish & Game

FORM 3B
Contractual &
Commodities
DETAIL

7/31/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1996

Project Number: 96127
Project Title: Tatitlek Coho Salmon Release
Agency: AK Dept. of Fish & Game

FORM 3B
Equipment
DETAIL

7/31/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel		$2.6						
Travel		$0.0						
Contractual		$2.0						
Commodities		$1.5						
Equipment		$10.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$16.1	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
Indirect		$2.0						
Project Total	$0.0	$18.1	$32.8	$30.0	$30.0	$30.0	$30.0	$30.0
Full-time Equivalents (FTE)		0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: Funding for this project would be contracted through the Prince William Sound Economic Development Council via a Standard Agreement written by the ADF&G. They would in turn subcontract with the Tatitlek IRA council.

1996

Prepared:

Project Number: 96127
Project Title: Tatitlek Coho Salmon Release
Name: Tatitlek IRA Council

FORM 4A
Non-Trustee
DETAIL

7/31/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Personnel Costs:							
	Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1996
		Net pen worker		0.5	$2,500		1.3
		Net Pen worker		0.5	$2,500		1.3
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		1.0	5,000	0	
						Personnel Total	$2.6

Travel Costs:						
	Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FFY 1996
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$0.0

1996

Project Number: 96127
Project Title: Tatitlek Coho Salmon Release
Name: Tatitlek IRA Council

FORM 4B
Personnel
& Travel
DETAIL

7/31/95

Contractual Costs: Description	Proposed FFY 1996
Boat charter to transport 20,000 coho smolts from Solomon Gulch Hatchery to Tatitlek @ 2 trips	2.0
Contractual Total	$2.0

Commodities Costs: Description	Proposed FFY 1996
Safety gear	1.0
Misc supplies	0.5
Commodities Total	$1.5

1996

Project Number: 96127
Project Title: Tatitlek Coho Salmon Release
Name: Tatitlek IRA Council

FORM 4B
Contractual &
Commodities
DETAIL

7/31/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
Net pens	4	$2,500	10.0
			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	$10.0

Existing Equipment Usage: Description	Number of Units

1996	Project Number: 96127 Project Title: Tatitlek Coho Salmon Release Name: Tatitlek IRA Council	FORM 4B Equipment DETAIL

7/31/95

96131

Project Title: Chugach Native Region Clam Restoration

Project Number: 96131
Restoration Category: General Restoration
Lead Trustee Agency: Alaska Department of Fish & Game
Cooperating Agencies: Chugach Regional Resources Commission, Native Villages of Tatitlek, Nanwalek, Port Graham, Eyak and Chenega Bay
Duration: Four Years
Cost FY 96: $373.4
Cost FY 97: $381.3
Cost FY 98: $385.0
Cost FY 99 $385.0
Geographic Area: Port Graham/Nanwalek, Chenega Bay, Eyak, Tatitlek and Ouzinkie areas, and Qutekcak Shellfish Hatchery in Seward
Injured Resource/Service: Clams/Subsistence

ABSTRACT

Subsistence clam populations near the Native villages of Port Graham, Nanwalek, Chenega Bay, Tatitlek, Eyak and Ouzinkie will be established. The Qutekcak hatchery in Seward will annually provide about 800,000 juvenile littleneck clams, cockles and, if possible, butter clams for seeding. Historical information, local and agency expertise, and research will be used to identify areas to seed and methods used. Total seeded area will not exceed 5 hectares. Follow-up research on success of seeding will be conducted.

A. INTRODUCTION

The purpose of this project is to establish populations of clams in areas that are readily accessible from the villages of Tatitlek, Nanwalek, Port Graham, Chenega Bay and Eyak in the Chugach Native Region and the village of Ouzinkie on Kodiak. These clams will be used as a source for subsistence food to replace the natural clam resource that has been lost, damaged or depleted.

Clams were once an important subsistence food in the Native villages. Clam populations in areas that are reasonably accessible to the villages have decreased to very low levels in recent years. Consequently, the role of clams in the subsistence diet in these villages has been greatly reduced. And, with a few exceptions, the role of clams in the subsistence diet of most Native villages in the oil spill area is a lot less than it was historically.

There are likely a number of reasons why local clam populations are currently at low levels. Since clams are basically an unmanaged resource in the oil spill area, there are no quantifiable data available that could point to the actual circumstances that lead to the sharp reduction in these clam populations. However, there are events that likely played a major role. These include changes in beach configurations resulting from the 1964 earthquake, increasingly heavy sea otter predation, human over-harvest and the Exxon Valdez oil spill.

The oil spill impacted the wild clam populations and their importance as a subsistence food in two ways. First, many clam beds suffered from direct oiling. The impact of the oil on the clam beds in Windy Bay, for instance, destroyed one of the more important clam beds in the lower Kenai Peninsula. With the current timber harvesting operations soon to provide road access from Port Graham and Nanwalek to the Windy Bay area, the loss of the clam resource there had a major impact on these villages. Second, even though many clams weren't killed from the oil, they have a tendency to accumulate and concentrate the toxic contaminants from non-lethal amounts of oil. This has badly eroded the confidence of the villagers in the healthfulness of the remaining wild clam populations as a subsistence food.

In order to reestablish local clam populations as a subsistence resource for the Native villages a program needs to be developed to enhance the depleted stocks and replace damaged ones. Over the past ten years the nursery systems and field growout technologies have sufficiently evolved to make clam enhancement and reseeding efforts feasible. This technology can be readily applied to increasing the clam resource near the villages to determine which applications would be best suited for the task at hand.

This program was initiated in FY 95 as a demonstration project to demonstrate the potential of the Qutekcak Shellfish Hatchery to produce seed for the project, and to develop the system for identifying the growout areas near the villages of Port Graham/Nanwalek and Tatitlek. At this point the hatchery has produced several 200,000 to 300,000 batches of littleneck clam (Protothaca staminea) seed. The most recent batch was grown to the 5mm size within the 19 week time objective set by this project. This spring and summer work will concentrate on developing nursery techniques that produce 10mm to 15mm seed within the 12 week project objective time frame.

A broodstock source for cockles (Clinocardium nutalli) has been identified and application made for a permit to allow the broodstock to be brought into the hatchery. It is hoped that work to develop seed production techniques for cockles can begin this summer.

As part of the study to identify growout areas near the villages, a literature search was conducted through the University of Alaska to identify all previous research on littleneck clam life histories and population surveys. Time is now being spent with Alaska Department of Fish & Game (ADF&G) shellfish biologists from lower Cook Inlet and Prince William Sound to review and discuss clam surveys and management plans. This spring residents of the villages of Port Graham, Nanwalek and Tatitlek will be interviewed to identify nearby areas that either now or once had significant populations of littleneck clams.

This summer field surveys will be initiated on areas that have been identified as clam producers. These areas will be surveyed for the presence, size ranges and densities of clams. Information on substrate, location within the intertidal range, beach exposure (high or low energy) and similar parameters will also be collected. The surveys will be set up and the results analyzed in consultation with experts in this field. These experts will also assist in identifying areas to initiate seeding operations. Once sites have been identified the appropriate permits will be obtained to allow seeding them. It is possible that some of these sites will be seeded this season depending on the quantity and quality of seed available and if the appropriate permits are obtained soon enough.

In FY 96 the project will expand to incorporate the villages of Chenega Bay, Eyak and Ouzinkie. The site identification procedure developed for Tatitlek and Port Graham/Nanwalek will be used to identify sites near these villages after which permits will be obtained to allow seeding them.

It is likely that work will have to continue into FY 96 before a reliable and adequate source of cockles is developed. A decision will also be made on whether or not a seed production program will be attempted for butter clams (Saxidomus giganteus). This decision will mainly be based on the availability of space in the hatchery. Seeding operations in Tatitlek and Port Graham/ Nanwalek for littleneck clams and perhaps cockles will begin in FY 96 (or continued if seeding operations are actually begun in FY 95).

Razor clams were a common clam resource for the village of Eyak. There are apparently areas near Eyak where small razor clams can be found, but it is difficult to find razor clams large enough to eat. Permits will be obtained, and hopefully work begun, in FY 96 to cover test areas containing small razor clams with anti-predator netting to see if this will give the small clams the opportunity to grow to an edible size.

Two other tasks will be undertaken in FY 96. The first will be to begin investigations into remote nursery systems particularly a system developed in North Carolina that uses tidal currents to feed young clams in a floating container. Information on this system is being gathered now and, if it appears feasible, a prototype will be constructed and tested in FY 96. Having the ability to operate nursery systems remote from the hatchery will free up valuable hatchery space as well as make the program more efficient.

The second task will be to involve the Native villages in the oil spill area that are outside the Chugach Native Region. Although this project was initially designed for Chugach region villages, there has been some indication that villages in the Kodiak area are also interested in clam reseeding. The village of Ouzinkie on Kodiak specifically requested that it be included in this project for FY 96. During FY 96 other villages within the spill area outside the Chugach region will be provided information about the clam project. If any of them are interested in becoming included in this project they will be added to the FY 97 budget. If the Kodiak region is interested in establishing its own program it will be provided with whatever information is needed to help it develop a proposal.

NEED FOR THE PROJECT

A. Statement of Problem

Local shellfish populations, especially clams have been severely reduced as a subsistence food source for Native villages. Part of the reduced use is a loss of confidence in the safety of consuming shellfish as a result of the Exxon Valdez Oil Spill. In addition, local shellfish populations have been greatly reduced as result of hydrocarbon toxicity, sea otter predation, human overharvest and beach changes from the 1964 earthquake.

B. Rationale

This project will accomplish two things. One, it will help restore the clam resource base in the oil spill area, and two, it will enhance subsistence gathering by providing a safe, easily accessible source of clams for subsistence use.

C. Summary of Major Hypotheses and Objectives

Objective 1. Hatchery Processes- Develop and improve hatchery techniques for the littleneck clam (Protothaca staminea), the cockle (Clinocardium nutalli) and, if hatchery resources allow, the butter clam (Saxidomus gigantus). Produce a 5mm seed in the hatchery within 19 weeks after spawning.

Objective 2. Nursery- Develop techniques to grow 5mm seed from the hatchery to an outplanting size of 10mm - 15mm within 12 weeks. Review needs and possible alternatives of substrate for nursery and growout. Test remote nursery systems.

Objective 3. Growout - Describe current local clam populations through interviews and resource assessments. Locate sites and develop growout techniques and evaluate the efficacy of proposed methods. Develop permanent subsistence beaches.

Objective 4. Safety Testing - Set up a program for testing clams from the subsistence beaches for the presence of paralytic shellfish poisoning (PSP).

D. Completion Date

Work on this project, which is essentially the development phase of a clam development program for subsistence, is scheduled for completion in FY 99. The addition of other villages or other areas of the oil spill area may cause the extension of the scheduled completion date.

COMMUNITY INVOLVEMENT

The communities named in this project will be directly involved. Each community decided whether or not it wanted to be involved in the project initially. Local residents will be heavily relied upon to help locate existing clam populations and the areas for reseeding. Project work involving the villages will be done with local labor. Community leaders will be kept appraised of how the project is progressing.

FY 96 BUDGET

Personnel	$92.4
Travel	$8.9
Contractual	$195.0
Commodities	$12.6
Equipment	$27.5
Indirect Costs	$37.0
Total	$ 373.4

PROJECT DESIGN

A. Objectives

1. Hatchery Processes- Develop and improve hatchery techniques for the littleneck clam (Protothaca staminea), the cockle (Clinocardium nutalli) and, if hatchery resources allow, the butter clam (Saxidomus gigantus). Produce a 5mm seed in the hatchery within 19 weeks after spawning.

2. Nursery- Develop techniques to grow 5mm seed from the hatchery to an outplanting size of 10mm - 15mm within 12 weeks. Review needs and possible alternatives of substrate for nursery and growout. Test remote nursery systems.

3. Growout - Describe current local clam populations through interviews and resource assessments. Locate sites and develop growout techniques and evaluate the efficacy of proposed methods. Develop permanent subsistence beaches.

4. Safety Testing - Set up a program for testing clams from the subsistence beaches for the presence of paralytic shellfish poisoning (PSP).

B. Methods

The following is an outline of the methods that will be applied to accomplish each objective. In the pursuit of all the objectives the principal investigators will rely heavily on the advise and assistance of experts in the field. The technology for hard clam aquaculture on both the east and west coasts of the U. S. and Canada has been advancing rapidly in recent years. In order to keep abreast of the developments, determine which ones would be best suited for adapting to Alaska and avoid repeating mistakes that others have made, it will be necessary to keep in contact with the leaders of this technological advance.

In most cases this contact will take the form of literature review, phone conversations and occasional visits by the principal investigators to areas of interests. In some cases experts will be brought to Alaska to work directly on various aspects of this project.

OBJECTIVE 1. HATCHERY

The Qutekcak Shellfish Hatchery has been in operation since October 1993. During this time the hatchery was designed and assembled and has evolved into a production scale operation. The staff has successfully set larvae of the Pacific oyster Crossastrea gigas and raised them to 15mm for the aquatic farm industry. In addition, the hatchery has successfully conditioned, spawned, set and raised the native littleneck Protothaca staminea to 10mm and will attempt to overwinter the clams both in the hatchery and on local beaches. This project will also attempt to develop broodstock and produce cockle Clinocardium nutalli seed, and, if possible, butter clam Clinocardium nutalli seed.

The systems and techniques that will be used to produce seed for growout under this project are outlined below.

A. Water system

The water source for Qutekcak Shellfish Hatchery is from a 60 meter deep intake which brings up nutrient rich seawater void of many organisms and is well suited for shellfish culture. The hatchery has two head tanks with electric heaters, an on demand heater, bag filters, 2mm and 10mm cartridge filters and ultraviolet light for additional disinfection. Water from shellfish held in quarantine is chlorinated before discharge into Resurrection Bay.

B. Algae

Hatchery production of larval and juvenile bivalves requires a reliable supply of high quality algae. The Qutekcak Shellfish Hatchery (QSH) cultures four species: Chaetoceros calcitrans, Thalassiosira psuedonana, Tetraselmis suecica and Tahitian isochrysis.

The techniques for raising these species are well documented. Algae is cultured in three phases 1) stock cultures, 2) 20 liter carboys, and 3) 200 liter Kalwal tanks.

Water for stock cultures and for inoculating carboys is sterilized in a microwave for several minutes. Stock cultures are maintained under strict conditions and are handled only under a laboratory hood. The seawater is inoculated with nutrients such as nitrogen, phosphorous, vitamins and trace minerals. Light intensity and wavelengths are controlled for each species to manipulate growth depending on the need for each. The pH is adjusted with carbon dioxide to maintain the optimum range of 7.8 to 8.4.

Algae cultures go through three phases of growth; lag phase, exponential phase and stationary phase. Algae in the exponential phase is of the highest quality for inoculating additional algae cultures and for clam nutrition.

QSH uses batch culture techniques for producing algae. 20 liter carboys are used to inoculate 200 liter Kalwal tanks for production feeding. Water used for the Kalwal tanks is chlorinated (2-5ppm) for 24 hours and deactivated with sodium thiosulfate. Generally, it takes 4-6 days for a culture to reach its maximum density and several more days to harvest the culture for feed. Several species are always in production to insure all nutrient requirements are met for the juvenile shellfish under culture.

The hatchery staff also keeps several liters of preserved <u>Chaetacerous</u> on hand to supplement feeding of setting larvae and as a back up in case cultures become contaminated.

C. Broodstock Conditioning

The gonadal development of shellfish can be controlled by adjusting feeding rates and temperatures. When properly conditioned, shellfish can be induced to spawn by manipulating the temperature.

At QSH broodstock are conditioned in static 60 liter tanks. Water temperature is controlled through aquarium heaters and changed daily. During the spawning season the clams are held at 16° C - 18° C. During the winter months the temperature is lowered to 8° C - 10° C. Broodstock are held in family units of ten in mesh bags which help keep pressure on the hinges. Families are marked to record the spawning history and track the development of the progeny. Broodstock are fed daily to maintain body weight and when ready to spawn are fed to saturation. Prior to the spawning cycle temperatures are raised to accelerate gametogenesis. Gamete development is tracked by dissecting broodstock to assess development. Gamete quality has been the most important factor at QSH in determining the success at setting.

D. Spawning and Larvae Culture

Spawning episodes have occurred at regular cycles throughout the production year. To induce spawning, clams are removed from the broodstock tanks and allowed to dry for several hours. They are then placed in water baths at 22° C -24° C. Hatchery personnel watch for the appearance of spawn in the spawning tank. This process is often repeated several times until the clams are induced to spawn.

When the shellfish have finished spawning the water is filtered and the fertilized eggs placed in larval culture tanks. Notations are made identifying the families and if possible the individuals involved in spawning.

The larvae are fed several times a day at 50,000 cells/ml. The development of the larvae are tracked daily. After almost four weeks of development, the larvae reach 240 microns and are ready to set.

E. Setting

The setting process is slow with littleneck clams. One of the most important variables for successful setting appears to be the time in which the clams are placed from the larvae tanks to the setting system. When the majority of the larvae are sessile and appear to be pedal feeding they are transferred to the airlift system on the down welling mode. Ground oyster shell sifted at 150mm is placed on a 120mm nitex screen. Up to 2 million larvae are placed on the 1500cm^2 screen in a 130 liter airlift system. The clams are fed 70,000 cells/ml three times daily and finish the setting process in approximately seven days.

F. Primary Culture

The airlift system is also used for primary culture to raise the clams to 2+mm. The flow is alternated between the upwell and downwell mode. Although the clams feed better on the downwell mode, elimination of metabolites are flushed during the upwell cycle. Clams are fed to saturation by feeding enough algae so that the clams "clear" the water within two hours. The amount of feed needed increases to 150,000 cells/ml.

G. Secondary Culture

After almost six weeks of culture the clams are sorted through screens. Those that are 2mm or greater are transferred to a "Heath Tray" incubation system. The vertical incubator allows water to flow through a stack of ten trays of shellfish. The water is recirculated through the stack to maintain water temperature and changed daily to remove metabolites. Feed is added to a headbox and the clams are fed to saturation. 200,000 clams require up to 40 liters of algae at densities of 3 million cells/ ml.

Growth rates of the clams are highly variable requiring constant sorting to insure that smaller clams are not out competed by their cohorts. Size groups are maintained in different trays of the heath systems.

H. Hatchery Production Summary

A. Broodstock Conditioning	8 weeks
B. Spawning- Larvae culture	4 weeks
C. Setting	1 week
D. Primary Culture to 2mm	6 weeks
E. Secondary Culture to 5mm	8 weeks

The hatchery production schedule has been determined from 1994 data. Hatchery personnel believe the time the clams spend in the primary and secondary systems can be reduced significantly if more feed were available. The 1995 production plan calls for tripling the algae capacity.

OBJECTIVE 2. NURSERY SYSTEM

A. Algae Production Pond

The QSH utilizes a 1 million liter pond to culture algae for its nursery. The 10m by 10m pond is 3 meters at it's deepest point. Raw seawater from a 60 meter deep intake is pumped into the pond to bring in nutrient rich water. The flow is controlled to allow for adequate flushing yet maintain the ambient air temperature. An air pump is used to bubble and circulate water in the pond for adequate mixing and prohibit stratification. Water temperature and salinity are monitored daily and nitrogen phosphorous and silica levels checked weekly. The pond is fertilized daily in an attempt to keep nitrate levels at 3.0 ppm to 3.5 ppm and phosphate at 1.2 ppm to 1.5 ppm. Equally important is to keep the ratio at 7N:P.

The flora of the pond changes seasonally with Chatecerous dominating in the early months of the summer and pennate diatoms taking over after July. Natural cell densities of Resurrection Bay are 5,000 cells/ml while the pond is manipulated to produce 250,000 cells/ml for feeding the shellfish.

Two 8,000 liter tanks have been installed at the nursery complex to produce mass volumes of axenic cultures outdoors. Preliminary results in 1994 were encouraging and these tanks may be an additional source of large volumes of algae.

B. Nursery Phase

Clams from the hatchery that are 5mm or greater are transferred to shallow raceways adjacent to the pond. Water is pumped into the raceways and flows passively through the clam upwell tanks. The clams are seeded at 50 cm^2 initially on 1mm vexar screen. The screens are cleaned and the clams stirred several times a week. Experimentation is ongoing to determine which system and substrate perform the best.

Many species of clams require substrate to support their hinges when they reach a certain size. To date, this has not been noticed in the native littlenecks, however this will be closely observed and if necessary substrate both natural and artificial will need to be employed.

C. Remote Nursery Systems

Remote nursery systems offer several advantages over nursery culture at the hatchery. One is that it frees up hatchery space and personnel that can be better used in hatchery production. Another is that several remote nursery systems offer a redundancy of supply in case one of the systems fails. A third is that remote nursery systems can be located near the growout areas thus reducing transport costs. The big disadvantage to remote nursery systems is that the cost of pumping water at a remote location in Alaska made them impractical.

Recently, work conducted under the South Carolina Sea Grant program lead to the development of a tidally driven remote nursery system. This system, called a Tidally Driven Floating Upwelling System (tidal FLUPSY) uses the strength of tidal currents to force sea water, with its accompanying load of phytoplankton, through cages containing small clams. The system appears to work quite well and is easy to maintain. Because the system is driven by a natural energy source readily available in Alaska, it appears to have great promise here.

Further literature review and contact with the South Carolina Sea Grant program will be undertaken to determine if a tidal FLUPSY does have potential in Alaska. If so, a prototype will be built and tested here (either in Tatitlek or Chenega Bay where the unit can be subjected to various tidal current speeds in areas that offer fairly good protection from the weather). If the tests prove out, the technology will be utilized in those areas that meet the criteria for an efficient operation.

OBJECTIVE 3. GROWOUT

A. Baseline Data

1. Historical Information

It will be necessary to do baseline research on the local beaches prior to planting the clams for growout. Local residents, especially elders, will be canvassed to gather information on old and existing beaches near the villages. An individual, most likely a team leader, from each village will be selected to be the focal point for collecting information.

Staff at the University of Alaska, biologists from ADFG and project leaders from pertinent EVOS research projects will be interviewed and a literature search conducted to see what information is available on species composition and local abundance of shellfish. This will include work conducted by EVOS funded project Fish/Shellfish 13.

2. Field Surveys

Three person field survey crews will be selected and trained from each of the villages. ADFG will assist with the sampling design and statistical analysis.

1. For each area surveyed the following information will be gathered:

   a. Type and abundance of benthic organism both mobile and sedentary will be gathered using the random plot sampling method.

   b. Composition of substrate will be evaluated using the graduated sieve method.

2. From the surveys an estimate will be made on the abundance of clams that are currently in the area and a profile developed of what constitutes a good clam growing area such as substrate composition, exposure, slope, tide height and other factors.

B. Growout Techniques

Several methods for growout will be tested and analyzed. These include seeding candidate intertidal areas, adapted hanging culture techniques and tray culture. Seeding and hanging culture methods will be explored to determine how suitable they would be in developing clam resources for subsistence use. Although tray culture may prove to be a viable method for producing harvestable quantities of clams, it initially will be used to evaluate various substrate compositions to determine which mixtures are best for seeding clams.

1. Seeding Intertidal Areas

Seeding beaches is the most common and probably least expensive method for developing a clam resource. For developing a subsistence clam resource near the Native villages beach seeding appears to the most reasonable approach.

Because of the predation problems clams encounter, from starfish and crabs on seed to sea otters on large sized clams, protecting seeded beds against predators is a must. The nylon or plastic screening that has been developed for this purpose should be satisfactory.

The following steps will be followed for seeding and monitoring intertidal areas:

1. Locate areas for clam seeding

    a. Two criteria will be used to locate intertidal areas for seeding.

        i. Ease of access- Location must be easily accessible from the villages in most weather. Areas that can be accessed by walking from the village would be the best, but easy boat access is acceptable.

        ii. Good chance of successful seeding- Profile developed from abundance surveys will be used to identify potential beaches.

2. Obtain permits for seeding selected intertidal areas

3. Prepare intertidal area for seeding.

    a. Individual plots will be 10 feet by 50 feet. A plot this size should produce approximately 5,000 harvestable clams. Initially there will be one plot installed in each area. Successful sites will eventually be expanded. The following steps will be taken in seeding an area:

        i. Removal of logs and other debris and obstacles.

        ii. Rake the area to prepare the ground for seed.

    b. The process of baking the first few inches of the substrate in growout areas to remove unwanted organisms, yet retain the natural chemistry is a technique that may have application here. The project will conduct tests of this process to determine its ease of application, level of success and cost/benefit ratio.

4. Seeding

    a. The prepared area will be seeded at a density of 75, 10mm+ clams per square foot. Tests will later be conducted to help determine optimum seeding densities for these beaches

5. Predator control

   a. Predator netting, ("car cover") will be placed on top of the clams and securely anchored. The cover is usually trenched 6 inches or more around the perimeter to dissuade crabs and other animals which cannot burrow too deeply. The mesh of the car cover can be changed as the clams increase in size.

   b. In order to validate the need for predator netting and determine the impact that netting may have on clam growth, a prepared beach area adjacent to the area with the predator cover will be seeded with clams at the same density but not covered with netting.

   c. To evaluate the potential for increasing clam populations by affording them protection against predators, another prepared beach area near a. and b. will be covered with predator netting but not seeded.

6. Inspection/Sampling

   a. The growout sites will be inspected weekly by the field teams to insure that the area remains as designed.

   b. Clam samples will be collected monthly and be measured for length and weight increases. Water and substrate temperatures will also be collected.

   c. Local shellfish will be analyzed for Paralytic Shellfish Poisoning (PSP) on a regular basis as recommended by the Alaska Department of Environmental Conservation.

2. Hanging Culture Techniques

Hanging culture involves growing bivalve shellfish in a subtidal area in culture gear suspended from a floating longline. Hanging culture is commonly used for growing oysters, mussels and scallops. It is rarely used for extended clam culture but may work well for species such as cockles whose natural habitat is at or near the substrate surface. It may also be possible to adapt hanging culture to work with burrowing clams.

Hanging culture methods could be useful from a subsistence standpoint for two reasons. First, hanging culture would make it possible to locate a source of clams within easy reach of a village regardless of local beach conditions, and second, if an oil spill or some other catastrophic pollution arises, the hanging culture operation can be moved to a safe location or even brought to shore and stored in a moist environment. The disadvantage of the hanging culture method is that it would require more equipment and maintenance than beach culture methods.

Types of Hanging Culture

a. Floating Racks - Floating racks are made of plywood with Styrofoam floatation. Gravel/rock substrate is placed in the plywood boxes and tidal flush and water movement provide feed for the clams.

b. Hanging Trays - Stackable plastic trays are suspended from a longline and the clams feed from the water column. Trays can be filled with natural or artificial substrate or left without substrate.

Location of Suitable Sites

a. Both Tatitlek and Port Graham/Nanwalek areas already have hanging culture sites for commercial oyster culture operations (Tatitlek's are fully permitted; Port Graham has a site suitability permit). These sites will be used to locate hanging culture experiments with clams.

b. The permits at both Tatitlek and Port Graham will need to be altered to allow for hanging culture experiments with clams. Permits for the other villages will need to be obtained.

Growout Tests

a. The growout methods used will be evaluated on survival, growth rate as determined by weight and length measurements and ease and expense of culture. Methods may be altered or abandoned as appropriate.

3. Alternative Growout Methods

Other growout methods that are now being introduced will be tested here. An example of this is the biodegradable cone. Growout trays will be used to test the efficacy of different mixtures and types of substrate. Growout trays (2ft x 2ft) containing different substrate mixtures, but in all other ways the same, will be set up side-by-side on a beach and seeded at the same density. Differences in growth and survival will be measured. Growout trays will also be used to determine optimum beach locations and seeding densities.

C. Subsistence Beaches

Near the completion of the project, after sites are identified and techniques developed, a long-term management plans will be drawn up in concert with appropriate state resource management agencies and in compliance with regulations and policies of the Alaska Board of Fisheries. The plans will include permitting procedures, reseeding schedules, procedures for expanding to new areas and harvesting schedules for each species as appropriate.

The purpose of the plans is to help ensure that the beaches are managed in a manner that will sustain production over the long term.

OBJECTIVE 4. PSP TESTING

Paralytic shellfish poisoning (PSP) is a perennial threat to those who eat shellfish. To ensure that the clams from the subsistence beaches that will be established as a result of this project are safe to eat a system needs to be established that will test the clams at regular intervals for the presence of PSP.

This project will work with the Alaska Department of Environmental Conservation (DEC) to set up a long term PSP testing program for the subsistence clam beaches that is efficient, effective and puts a minimal strain on the DEC testing lab.

C. Contracts and Other Agency Assistance

This project will be conducted by the Chugach Regional Resources Commission (CRRC), a consortium of Native villages and associations in the Chugach Native Region that deals with natural resource issues and development, under a Memorandum of Agreement with the Alaska Department of Fish & Game. CRRC will be contracting with the Qutekcak Shellfish Hatchery in Seward to develop spawning and culturing techniques for clams and the 10 mm to 15 mm seed for growout. CRRC may also be contracting with various mariculture experts for technical advise and assistance.

D. Location

The hatchery and nursery work will be carried out at the Qutekcak Shellfish Hatchery/Nursery in Seward. Growout operations and sampling will occur in the area around the villages of Tatitlek, Eyak and Chenega Bay in Prince William Sound, in the Port Graham/Nanwalek area in Lower Cook Inlet and the village of Ouzinkie on Kodiak. Pathology work will be conducted in Anchorage and Juneau. PSP sampling will occur at the DEC lab in Palmer. Data Analysis and project oversight will be conducted from CRRC offices in Anchorage and Moose Pass.

SCHEDULE

A. Measurable Project Tasks for FY 96

10/95 - 4/96:	Continue to collect broodstock, obtain clearance and transport to hatchery.
4/96 - 8/96:	Continue to develop techniques to mature and spawn broodstock.
10/95 - 4/96:	Continue to develop techniques for producing 5 mm seed.
3/96 - 5/96:	Transfer 5 mm seed to nursery.
4/1/96:	Submit annual project report for FY 95.

4/96 - 9/96:	Continue develop techniques for producing 10 mm to 15 mm seed for growout.
10/95 - 4/96:	Obtain permits, construct and install intertidal FLUPSY at either Tatitlek or Chenega Bay, set up monitoring and maintenance schedule.
10/95 - 1/96:	Collect information on past and current location, history, abundance, etc., of clam beds near Eyak, Chenega Bay and Ouzinkie.
10/95 - 8/96:	Obtain permits and sample areas near Eyak, Chenega Bay and Ouzinkie villages for current clam abundance and identification of intertidal areas for seeding.
5/96 - 9/96:	Identify areas for seeding and hanging culture experiments near Eyak, Chenega Bay and Ouzinkie villages; obtain permits.
10/95 - 9/96:	Initiate beach seeding and hanging culture experiments in Tatitlek and Port Graham/Nanwalek areas; set up monitoring schedule.
4/1/97:	Submit annual project report for FY 96.

B. Project Milestones and Endpoints

Objective 1.

Completed	Littleneck clam
June, 1996	Cockle
Uncertain	Butter clam

Objective 2.

September, 1995	Littleneck clam in hatchery
September, 1996	Cockle in hatchery
Uncertain	Butter clam
September, 1997	Complete tests on tidal FLUPSY

Objective 3.

August, 1995 Describe current local clam populations for Tatitlek and Port Graham/ Nanwalek areas.
September, 1995 Locate sites in Tatitlek and Port Graham/Nanwalek areas for developing beach and hanging culture growout methods.
March, 1996 Obtain permits and begin field work at growout sites at Tatitlek and Port Graham/Nanwalek
June, 1996 Describe current local clam populations for Eyak, Chenega Bay and Ouzinkie.
July, 1996 Locate sites in Eyak, Chenega Bay and Ouzinkie for developing beach and hanging

culture growout methods.

March, 1997 Obtain permits and begin field work at growout sites at Eyak, Chenega Bay and Ouzinkie.

September, 1998 Initiate process for establishing permanent subsistence beaches at Tatitlek and Port Graham/Nanwalek.

September, 1999 Initiate process for establishing permanent subsistence beaches at Eyak, Chenega Bay and Ouzinkie.

Objective 4.

September, 1997 Have PSP sampling program in place at Tatitlek and Port Graham/ Nanwalek.

September, 1998 Have PSP sampling program in place at Eyak, Chenega Bay and Ouzinkie.

C. Project Reports

April 1, 1996	FY 95 annual report due. Report will discuss progress to date, compare accomplishments against stated objectives and make recommendations regarding future work.
April 1, 1997	FY 96 annual report due. Report will discuss progress to date, compare accomplishments against stated objectives and make recommendations regarding future work.
April 1, 1998	FY 97 annual report due. Report will discuss progress to date, compare accomplishments against stated objectives and make recommendations regarding future work.
April 1, 1999	FY 98 annual report due. Report will discuss progress to date, compare accomplishments against stated objectives and make recommendations regarding future work.
April 1, 2000	FY 99 annual report due. Report will discuss progress to date and compare accomplishments against stated objectives.
June 30, 2000	Final report due.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The project (95131) will complement Fish/Shellfish Study 13 Effects of Hydrocarbons on Bivalves conducted under State/Federal Natural Resource Damage Assessment. That project studied shellfish populations throughout the oil impacted area and conducted growth and mortality studies, collected age and size information and examined reciprocal transplants from oiled and control beaches. It was determined that littleneck clam populations were adversely affected through increased mortality and reduced growth rates.

The Clam Restoration Project (95131) will provide future resources for subsistence harvest and will be valuable for Projects 95279(Subsistence Restoration Projects Food Safety) and 95052 (Community Interaction/ Traditional Knowledge) to develop harvest plans. Information from 95052 can be used in the community survey, population assessment described in Objective 3.

ENVIRONMENTAL COMPLIANCE

For FY 95 the project received a categorical exclusion because of its status as a pilot project. In FY 96 the project will lose its pilot status and an environmental assessment (EA) will be required. The EA will be completed in FY 95. The lead agency is the National Oceanic and Atmospheric Administration (NOAA) under the Department of Commerce represented by Mr. Byron Morris.

ADF&G presently, provides oversight for the Hatchery and Nursery System through its Mariculture Coordinator (James O. Cochran). Shellfish Transport Permits are reviewed by all Departments of ADFG and rely on recommendations of the Pathology Section (Dr. Ted Meyers) and Genetics Section (Dr. Jim Seeb). Permits for operating the Shellfish Hatchery and Nursery are issued by ADFG and are current through 1996. Broodstock certification is complete for Tatitlek littleneck clams and will be requested cockles in all areas and littleneck clams in all areas except Tatitlek.

Review of efforts involving beach alteration or manipulation will involve interagency cooperation from ADFG, ADNR, and local upland owners. The framework for this activity is outlined in the Alaska Coastal Management Plan (ACMP) with a consistency review. Transport and seeding permits will be issued by DFG and DNR.

PSP samples will be analyzed by the DEC Palmer Lab (Dick Barret)

A final harvest management plan will be developed in concert with the Regional Shellfish Biologist.

PERSONNEL

PATRICIA BROWN SCHWALENBERG
6450 Andover Drive
Anchorage, Alaska 99516
907 345-2187

Employment:
June 1994 to Present: Executive Director Chugach Regional Resource Commission. Responsible for Natural Resource and Fisheries development for the seven native villages in the Chugach region. This includes administering office staff, village projects in mariculture and fisheries and protecting and enhancing subsistence opportunities.

October 92 to June 1994: Office Manager Bering Sea Commercial Fisheries Development Foundation. Responsibilities included maintaining all management systems for the organization including financial, personnel, property and central filing. Responsible for financial management and accountability of all grants of the Foundation payroll, taxes and financial statements, organizing and overseeing Foundation public relations.

October 1987 to June 1992 Society Administrator /Public Relations Director. Native American Fish and Wildlife Society. Assisted in the establishment and development of a national office for the Native American Fish and Wildlife Society. Implemented personnel policies and procedures, property management policies, record and financial management systems. Implemented strategies to obtain goals and objectives of the society.

Education:
Business Administration University of Alaska-Anchorage (ongoing).
Certification of Completion. 1977 Humboldt Institute

DAVID DAISY
3936 Westwood Drive
Anchorage, Alaska 99517
(907) 243-8544

Employment:
October, 1987-Present: Fisheries consultant with emphasis on aquaculture. Contractor to Chugach Regional Resource Commission developing salmonid hatcheries at Port Graham and Nanwalek and oyster mariculture operations at Tatitlek and Chenega Bay. Oversight and management of these projects involves grant writing and financial and activity reporting to granting agencies.

February, 1979 to October, 1987: Regional Program Manager, Region II, Fisheries Rehabilitation, Enhancement and Development (FRED) Division, Alaska Department of Fish & Game. Under general supervision of the FRED Director, responsible for the planning, development, operation and control of the State's salmonid enhancement and rehabilitation program in Region II which encompasses all of Alaska except Southeast.

November, 1977 to February, 1979: Regional Project Manager: Cook Inlet - Prince William Sound, Fisheries Rehabilitation, Enhancement and Development (FRED) Division, Alaska Department of Fish & Game. Under supervision of the Regional Program Manager responsible for the implementation and control of salmon enhancement research and development projects in the Prince William Sound and Cook Inlet areas. Assisted the Regional Program Manager in hatchery development planning.

April, 1968 to February, 1979: Management Biologist, Commercial Fisheries Division, Alaska Department of Fish and Game. Ketchikan, Cook Inlet and Upper Cook Inlet. Oversaw various management projects (weirs, counting towers, fisheries sampling) determined and set fishing periods for herring and salmon and responsible for meeting escapement and recruitment goals.

Education:
B.S. Fisheries, University of Massachusetts, Amherst, 1965.

JEFF HETRICK
P.O. Box 7
Moose Pass, Alaska 99631
(907) 288-3667

Employment:
1987- Present: Hatchery Manager Cook Inlet Aquaculture Association. Manage Trail Lakes Hatchery which produces 12 million sockeye salmon fry and 2 million sockeye salmon smolts annually.

1988-Present: Consultant for Shellfish Culture. Clients include: Chugach Regional Resource Commission- develop oyster farms at Chenega Bay and Tatitlek. Included permitting, farm design, training and marketing.
Qutekcak Native Tribe- Design and develop first shellfish hatchery in Alaska.

1983-1987 Assistant Manager. Alaska Department of Fish and Game. Assistant manager at Main Bay (Chum and Sockeye Salmon) and Cannery Creek (Pink Salmon) Hatcheries in Prince William Sound.

Education:
M.B.A. California Coast University- Thesis under review
B.S. Biological Sciences. University of Maryland, 1980

Patricia Brown Schwalenberg, Executive Director
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April 27, 1995
Date prepared

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Adams, C. et al. 1991. Investing in Commercial Hardclam Culture: A Comprehensive Guide to the South Atlantic States. Florida Sea Grant College Program (SGR-104).

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1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel		$6.3						
Travel		$0.0						
Contractual		$373.4						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$379.7	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration		$20.9						
Project Total	$0.0	$400.6	$413.6	$417.4	$417.4	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)		0.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1996

Prepared:

Project Number: 96131
Project Title: Chugach Native Region Clam Restoration
Agency: AK Dept. of Fish & Game

FORM 3A
AGENCY
PROJECT
DETAIL

7/18/95
Revised

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
*	PCN 117021	FB-III	18L	1.0	6,333		6.3
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		1.0	6,333	0	
Those costs associated with program management should be indicated by placement of an *.						Personnel Total	$6.3

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					Travel Total	$0.0

1996

Project Number: 96131
Project Title: Chugach Native Region Clam Restoration
Agency: AK Dept. of Fish & Game

FORM 3B
Personnel
& Travel
DETAIL

7/18/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Contractual Costs:	Proposed
Description	FFY 1996
Contract with non-trustee agency	373.4
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$373.4

Commodities Costs:	Proposed
Description	FFY 1996
Commodities Total	$0.0

1996

Project Number: 96131
Project Title: Chugach Native Region Clam Restoration
Agency: AK Dept. of Fish & Game

FORM 3B
Contractual &
Commodities
DETAIL

7/18/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1996

Project Number: 96131
Project Title: Chugach Native Region Clam Restoration
Agency: AK Dept. of Fish & Game

FORM 3B
Equipment
DETAIL

1996 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel	$21.5	$92.4						
Travel	$4.2	$8.9						
Contractual	$135.0	$195.0						
Commodities	$5.5	$12.6						
Equipment	$21.0	$27.5	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$187.2	$336.4	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
Indirect	$21.1	$37.0						
Project Total	$208.3	$373.4	$381.3	$385.0	$385.0	$0.0	$0.0	$0.0
Full-time Equivalents (FTE)		3.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1996

Prepared:

Project Number: 96131
Project Title: Chugach Native Region Clam Restoration
Name: Chugach Regional Resources Commission

FORM 4A
Non-Trustee
DETAIL

7/18/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Personnel Costs:			Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1996
Name	Position Description					
5 positions	villlage project leader		20.0	$2,562		51.2
10 positions	village project worker		15.0	$2,412		36.2
1 position	village administrator - Ouzinkie		2.0	$2,492		5.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		37.0	7,466	0	
					Personnel Total	$92.4

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FFY 1996
Description					
Staff meeting/ training session - Seward	430	9	3	100	4.2
Travel from villages to Seward					0.0
					0.0
Meet with experts/tour facilities U.S. & Canada	850	4	11	120	4.7
(Washington State, Vancouver Island, Virginia, South Carolina,					0.0
Florida)					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$8.9

1996

Project Number: 96131
Project Title: Chugach Native Region Clam Restoration
Name: Chugach Regional Resources Commission

FORM 4B
Personnel
& Travel
DETAIL

7/18/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Contractual Costs:	Proposed
Description	FFY 1996
Broodstock development and seed production at Qutekcak Shellfish Hatchery	120.0
Contracts for technical assistance in hatchery, nursery and growout operations	70.0
Skiff rental - Chenega Bay and Eyak (40 days @$125/day)	5.0
Contractual Total	$195.0

Commodities Costs:	Proposed
Description	FFY 1996
Field and safety gear for 9 field crew members (includes: 6- cold weather float suits @ $305 ea. , 6-life jackets @ $150 ea., 2-radio sets @ $400 ea., 2-sets work boat safety gear @ $300 ea and misc.)	4.5
Sampling gear	1.5
Workboat fuel/oil	2.2
Clam growout gear (vexar bags, predator covering, hanging culture bags, anchoring systems	3.7
Misc.	0.7
Commodities Total	$12.6

1996

Project Number: 96131
Project Title: Chugach Native Region Clam Restoration
Name: Chugach Regional Resources Commission

FORM 4B
Contractual &
Commodities
DETAIL

7/18/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
Tidal FLUPSY	1	17,000	17.0
(Described in the DPD)			0.0
			0.0
Workboat for Ouzinkie, 18 ft broad beam aluminum skiff with a 40 hp outboard	1	10,500	10.5
			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	$27.5

Existing Equipment Usage: Description	Number of Units

1996	Project Number: 96131 Project Title: Chugach Native Region Clam Restoration Name: Chugach Regional Resources Commission	FORM 4B Equipment DETAIL

7/18/95

96139A1

Salmon Instream Habitat and Stock Restoration - L. Waterfall Barrier Bypass Improvement

FY 96 DETAILED PROJECT DESCRIPTION

Project ID number: 96139A1

Restoration Category: General Restoration

Proposer: Alaska Department of Fish and Game

Lead Trustee Agency: Alaska Department of Fish and Game

Cooperating Agencies: None

Duration: January, 1998

Cost FY96: $55.0

Cost FY97: $35.0

Cost FY98: $15.0

Geographic Area: Afognak Island (Kodiak Island)

Injured Resource/Service: The project is intended to mitigate for and restore pink salmon resources on Afognak Island.

ABSTRACT

This proposal will provide for continuation of Project 95139A including completion of barrier bypass improvement at Little Waterfall Creek. It will also provide for evaluation of the improvements as indicated by pink (*Onchorynchus gorbuscha*) and coho salmon (*Onchorynchus kisutch*) use of the the bypass once construction is complete. The project will facilitate increased spawning habitat use by pink and coho salmon by decreasing grades on an existing bypass structure, thus will increase salmon production to optimum levels in ensueing years.

INTRODUCTION

The proposed project is a continuation of restoration efforts initiated in 1994 (Project 94139A1) which began as result of surveys (Restoration Study 105) conducted on Kodiak Island which evaluated instream habitat and stock restoration techniques for wild salmon stocks (Honnold 1994). The emphasis of this evaluation was to improve or develop spawning habitat at systems with barriers to salmon passage which have historically prevented access. Surveys focused on systems which were directly impacted or were located in proximity to areas impacted by the *Exxon Valdez* oil spill with the intent of mitigating for injured spawning habitat (Figure 1). Data collected from these surveys was analyzed, including a cost to benefit analysis, to determine the most effective mitigation techniques for Kodiak Island salmon systems. As result of these surveys, The **Exxon Valdez Oil Spill Trustee Council** selected L. Waterfall Creek as a site for spawning habitat mitigation.

In FY95, pre-construction production parameters were assessed (coho salmon escapement), final engineering surveys completed, and design for bypass improvements finalized. Presently, project specifications are being completed for the contract bidding process. Construction is expected to begin in July, and be completed near the end of the fiscal year (September 30, 1995). In FY96, evaluation of the project will begin with salmon escapement and juvenile rearing abundance surveys, and egg to fry abundance estimates. Prior to evaluation of the project, any additional work required to complete bypass improvements as result of delays in the FY95 construction schedule (high flows or logistical problems could potentially occur to delay construction) will be conducted.

NEED FOR THE PROJECT

A. Statement of Problem

Several beaches on Afognak Island were heavily oiled in 1989, and remained oiled in 1990 (Barnhart personal communication). Little Waterfall Bay (Little Waterfall Creek drainage) was directly impacted by oil. Similar impacts in Prince William Sound (PWS) damaged salmon stocks.

Three barriers in Little Waterfall Creek have been bypassed with structures allowing increased pink and coho salmon passage to previously unused spawning habitat (Figure 2). The largest barrier bypass structure, however, has not operated efficiently and has impeded salmon passage into the largest portion of spawning habitat. This habitat (~17,000 m^2) comprises approximately 80% of the total stream habitat and can support 24,000 and 2,700 pink and coho salmon, respectively. The result of an evaluation of the present design and operation or the largest bypass structure determined several deficiencies, impacting salmon passage. The grade of the bypass is 27%, which is considered too steep (Bruce McCurtain, ADF&G, personal communication). For example, a slope of 22% or less is recommended for sockeye salmon when resting pools (similar to those at Little Waterfall) are employed (Blackett 1987). Pink salmon, a less vigorous fish, may require even less slope. Thus, the gradient of this bypass must be reduced. Initial engineering data indicates that the existing concrete resting tanks will need to be removed, the lower portion of the bypass extended, and two new resting tanks added (Figure 3).

B. Rationale

Pink and coho salmon production will increase as result of these improvements. The potential harvest, from each years additional production, will be approximately 24,000 and 15,000 pink and coho salmon, respectively (Honnold 1994). Cost to benefit data indicates that this project would have benefits greater than costs of production (Hartman and Richardson 1993).

This project will assist in acheiving the objective, stated in the *Exxon Valdez Oil Spill Restoration Plan*, of accelerating the rate of recovery of damaged pink salmon resources on Afognak Island, and will also mitigate for injured spawning habitat in other areas of Kodiak

Island.

C. Summary of Major Hypotheses and Objectives

The project objectives for FY96 are to supervise the completion of construction to improve the bypass (if not completed on schedule in FY95), and evaluate the success of the project by determining salmon spawning numbers and juvenile salmon relative abundance in habitat upstream of the improved bypass. Lastly, to provide necessary documentation of project progress and results.

The primary hypothesis for the proposed project is that decreased accessibility to upstream habitat due to the deficiencies of the present barrier bypass, has limited increased spawning activity and salmon production.

D. Completion Date

The project is scheduled to be completed by the end of FY96 (September 30, 1996). If construction is not completed on schedule by the end of FY95 (September 30, 1995), then the project may extend into FY97 to complete evaluation tasks.

COMMUNITY INVOLVEMENT

The residents of Kodiak and Afognak Islands will continue to be involved in this project through the EVOS Trustee Council planning process. Information is provided to the communities through restoration work sessions, project planning documents, and media coverage. In addition, members of the Kodiak Regional Aquaculture Association (KRAA), composed of area fishers, are informed of project proposals and status of ongoing projects at board meeting open to the public. The Kodiak Regional Planning Team, composed of KRAA, ADF&G and U.S. Fish and Wildlife Service participants assists with development of project proposals.

FY 96 BUDGET

Personnel	22.3
Travel	1.1
Contractual	26.1
Commodities	0.3
Equipment	0.0
Subtotal	49.8
Gen. Admin.	5.2
Total	55.0

PROJECT DESIGN

A. Objectives:

The project objectives for FY96 are:

1. to supervise the completion of construction to improve the bypass (if not completed on schedule in FY95).

2. evaluate the success of the project by:
   a) estimating the salmon spawning numbers in habitat upstream of the improved bypass.

   b) determining the juvenile salmon relative abundance in habitat upstream of the improved bypass.

3. Document project progress and results.

B. Methods:

If scheduled construction is extended into FY 96, compliance with the contract will be supervised by the Project Leader. Barrier bypass improvements at Little Waterfall Creek will focus on construction and modification of the present bypass structure at the third upstream barrier (Figure 3). The bypass grade will be reduced by removing the existing concrete resting tanks and extending the bypass to lower the gradient. This will require extending the bypass, adding two resting tanks, and an entrance tank.

Salmon spawning habitat usage will be determined upon completion of the improvement to the bypass. This will be accomplished by conducting foot surveys of L.Waterfall Creek from 15 August through 30 September. Live and dead salmon will enumerated during each survey in each section of the creek. Peak live counts will be used to determine indexed escapement of pink and coho salmon to upstream habitat.

Prior to fry emergence, spawning redds downstream and upstream of the barrier will be sampled for a relative index of egg-to-fry survival. Ten redds, in both locations, will be pumped to capture eggs and fry which will be enumerated by species. The relative abundance (catch-per-unit-effort) of juvenile coho salmon rearing downstream and upstream of the barrier will also be determined. Minnow traps will be set for two 24 hour periods at permanent sampling locations. All juvenile fish captured will enumerated by species and released.

The necessary documentation of project progress and results will be accomplished on schedule as outlined by the Trustee Council.

C. Contracts and Other Agency Assistance:

The scheduled barrier bypass improvement will be accomplished by formal contract. The awarding of the contract in FY 95 and will be based on technical experience, previous work quality, and cost estimates. Previous barrier bypass construction projects by the State of Alaska, U.S. Forest Service and other state and federal agencies have been completed by construction contractors. This project is expected to require similar expertise. The present Project Design will require construction to be completed by October 31, 1995 (FY 96). Encumberance of funds, however, will occur in FY 95. Project maintenance and evaluation will be conducted by ADF&G personnel.

D. Location

The project will be located at Little Waterfall Creek (stream number 251-822) on Afognak Island (Figure 1). Little Waterfall Creek drains into Little Waterfall Bay on northern Afognak Island. The benefits of this project will be realized by increasing pink and coho salmon returns to this system, providing more than 24,000 and 15,000 pink and coho salmon for harvest, respectively. The residents of the city of Kodiak, northern Afognak Island will benefit economically from this project through direct commercial fishery receipts and all associated business enhancement. In addition, sport fishers, guides, and lodge owners as well as subsistence fishers, will benefit directly and provide direct economic return to the associated communities.

SCHEDULE

A. Measurable Project Tasks for FY 96

This project will oversee completion of construction to improve the bypass structure and include a period of evaluation to determine the effectiveness of barrier bypass improvement and subsequent use of upstream spawning habitat. The FY 96 work plan is outlined in Table 1.

Table 1. Proposed schedule for Little Waterfall instream habitat improvement project.

Task	Dates
Project construction and oversight	Start up - October 31
Report writing, planning, administration	November 1 - March 10
Egg-to-fry survival sampling	March 15 - March 30
Juvenile coho abundance sampling	May 15 - June 15
Spawner abundance and distribution surveys	August 10 - September 30
Submit FY96 annual report	April 1997?

B. Project Milestones and Endpoints

The following objectives will be accomplished in FY 96 and future years if necessary:

1. to supervise the completion of construction to improve the bypass (if not completed on schedule in FY95).

   Completion: October 31, 1995

2. evaluate the success of the project by:

   a) estimating the salmon spawning numbers in habitat upstream of the improved bypass.

   Completion: September 30, 1996

   b) determining the juvenile salmon relative abundance in habitat upstream of the improved bypass.

   Completion: June 30, 1997

3. Document project progress and results.

   Completion: September 30, 1997

C. Project Reports

A project report will be submitted for peer review March 30, 1996. Once peer review is complete the report will be submitted to the Cheif Scientist by April 15, 1996. A final report will be completed by January 1, 1998.

COORDINATION OF INTEGRATED RESEARCH EFFORT

This project will be coordinated with existing ADF&G restoration studies in the northern Afognak area. Ongoing restoration and development programs at Little Waterfall Creek will assist this project by providing technical and logistical support. Previous methodology employed by ADF&G staff such as barrier bypass construction and maintenance, spawner enumeration, and egg-to-fry survival estimates, will be utilized on this project. This project will build on a program at Little Waterfall that was initiated in the 1970's, as well as other similar programs on Afognak Island, initiated as early as 1952. Project planning, permitting, operation, data analysis and reporting, will be coordinated through the Kodiak CFMD Division staff and Regional Director of KRAA.

This project compliments ADF&G management programs, as well as KRAA enhancement activities by providing data on escapements, and juvenile salmon survivals that are not normal agency duties. Likewise, staffing, equipment, and baseline data that have been and are currently part of the ADF&G and KRAA programs at L. Waterfall and nearby areas assist with this project.

ENVIRONMENTAL COMPLIANCE

Little Waterfall Creek drainage is located on Afognak Native Corporation (ANC) land. The present program for fishery development has an existing lease with ANC to operate on this land. The construction and maintenance portions of this project are categorically excluded from the National Environmental Policy Act (NEPA). Other evaluation and monitoring activities fall within the existing fishery collection (and related scientific sampling) permits issued to ADF&G. General Waterway/Waterbody and Coastal Zone Consistency application/questionnaires will be submitted to ADF&G, Habitat and Restoration (H&R) Division as required to conduct project construction. No other permits or other coordination activities are required for this project.

PERSONNEL

Steven G. Honnold
Commercial Fisheries Management and Development Division
211 Mission Road
Kodiak, Alaska 99615
(907)486-1873

March, 1989 to present. Fisheries Biologist - Assistant Area Biologist, Fisheries Enhancement Rehabilitation and Development Division (FRED), Alaska Department of Fish and Game (ADF&G), Kodiak, Alaska. The recent merger of FRED and Commercial Fisheries Divisions of ADF&G upgraded this position to Area Development Biologist.

Responsibilities include: planning, implementation, data analysis, and report writing for all Kodiak FRED/OSIAR (H&R) Division damage assessment studies and restoration programs, as result of EVOS. Studies included early marine life history damage assessment (this study was in the late planning phase when canceled), juvenile sockeye damage assessment via hydroacoustic surveys and limnological assessment of Red and Akalura Lakes, Red Lake restoration planning and NEPA reporting, and instream habitat and stock restoration feasibility - barrier bypass technique evaluation. Additional responsibilities include all Kodiak and Afognak Island rehabilitation, enhancement or development projects conducted by the Development Section of CFMD Division. Projects include Spiridon Lake sockeye salmon development, Kitoi Hatchery evaluation, Kodiak lake limnology, Perenosa Rehab./Enhance., Malina and Afognak Lakes Rehabilitation, Ugak Development and Hidden Lake Development. Duties associated with these projects include: barrier bypass construction, maintenance and evaluation, sockeye stocking and subsequent smolt and fingerling monitoring and evaluation, lake limnology studies, and all associated planning, personnel supervision, data quality control and analysis, budget development, report writing, and presentation of results at professional and public forums. Lastly, he is responsible for a program on the Alaska Peninsula to assess the feasibility of coho and sockeye salmon development.

LITERATURE CITED

Blackett, R. F. 1987. Development and performance of an Alaska steeppass fishway for sockeye salmon (*Oncorhynchus nerka*). Canadian Journal of Fisheries and Aquatic Sciences. Vol. 44, No. 1. p. 66-76.

Hartman, J. L. and J. Richardson. 1993. Applying cost-benefit analysis to salmon restoration projects studies in the "Restoration Survey" of the EVOS Restoration program. In review.

Honnold, S. G. 1994. Survey and evaluation of instream habitat and stock restoration techniques for wild pink, chum, coho and sockeye salmon Oil Spill Restoration Study 105 - Kodiak Island Component. In review.

Appendix A. Additional Information

Resources and/or Associated Services:

This project is located on northern Afognak Island, part of the Kodiak Island archipelago (Figure 1). The heaviest oiling of beaches and salmon systems occurred on northern Afognak Island, potentially damaging fisheries resources. In addition, commercial, subsistence and sport fisheries were closed as result of the 1989 EVOS, seriously impacting the economies of all fishing communities in the region.

The Little Waterfall system is the largest producer of non-hatchery pink salmon on Afognak Island. Pink salmon production from the Little Waterfall system, since enhancement activity began in the late 1970's, early 1980's, has provided a significant portion of the commercial catch in the area. Production, however, has not reached optimum levels. The pink salmon escapement to the upper-most optimum spawning habitat has averaged only 8,600, while the optimum number of spawners for this area is ~ 24,000. Thus, production of pink salmon, and the potential commercial harvest, will be increased by implementation of the project and the consequent enhanced use of the aforementioned barrier bypass structure.

Coho production has been minimal at Little Waterfall Creek. There are few major producers of coho on Afognak Island, with the majority of fishing effort concentrated at two systems (Paul's and Portage). This project, at Little Waterfall Creek, will increase production of coho in the northern Afognak area, thus provide increased benefits to users of the resource.

Relation to Other Damage Assessment/Restoration Work:

Restoration study R105, sponsored by the Trustee Council, was the predecessor to this project and concluded in 1993. This study determined the methodology and feasibility of barrier bypass improvement necessary to enhance pink and coho production by increasing spawning habitat at Little Waterfall Creek. The intent of the study was to mitigate for oil spill damage occurring at nearby systems or restore production that may have been negatively impacted at

Little Waterfall Creek.

Technical Support:

General administrative support is provided by the Administrative, Habitat and Restoration Division, and Commercial Management and Development Divisions (CFMD) of the Alaska Department of Fish and Game (ADF&G). The project leader of this project is primarily funded by general funds and program receipts (Kodiak Regional Aquaculture Association - KRAA - cooperative funding) from the State of Alaska. Engineering support is provided by CFMD of the ADF&G, funded by general funds from the State of Alaska. This study is directly associated with ongoing rehabilitation and enhancement projects funded by program receipts provided by KRAA. The KRAA project at Little Waterfall will provide logistical support and personnel during portions of this project. Lastly, the CFMD Division of ADF&G will provide logistical and personnel support for a portion of the evaluation of this project.

The Project Leader (Steven G. Honnold - PCN 11-7045) and associated support personnel contribute significant time to the project with funding provided by existing agency programs as described below.

EXISTING AGENCY PROGRAM

The ADF&G, CFMD Division, Development Section operates a sockeye and pink salmon development project at Little Waterfall Creek. Little Waterfall Creek has three existing barrier bypass structures which currently enhance pink salmon production. Little Waterfall Lake is stocked with sockeye salmon from Pillar Creek Hatchery which is operated by KRAA. The Department conducts all maintenance, monitoring and evaluation activities associated with this fisheries development program with funding provide by KRAA through program receipts. This includes lake enrichment, smolt sampling, limnological sampling, and weir operation. In addition, the Finfish Management Section of CFMD Division conducts fisheries management operations in the area which includes egg-to-fry survival indexing at Little Waterfall Creek.

Other programs that are operated in the northern Afognak area by the ADF&G include: Paul's Lake adult salmon weir, Paul's, Laura and Gretchen Creek barrier bypass operation; lake assessment and smolt studies at Laura, Paul's, Portage, and Hidden Lakes; lake enrichment at Portage, Little Waterfall, and Laura Lakes; and egg-to-fry survival indexing at various streams. With the exception of egg-to-fry survival indexing, all portions of these programs are funded through KRAA program receipts. Also, KRAA operates a sockeye stocking program facilitated through Pillar Creek Hatchery, at Hidden Lake. In addition, KRAA operates Kitoi Bay Hatchery on northern Afognak Island, producing pink, coho, chum and sockeye salmon for commercial harvest. All evaluation associated with Pillar Creek and Kitoi Bay hatcheries is conducted by ADF&G with funds provided by KRAA program receipts. Lastly, the Alaska Department of Natural Resources, Kodiak State Parks operates several coho escapement weirs on Shuyak Island, located just north of Afognak Island. The ADF&G provides equipment and logistical support, as well as conducting aerial salmon escapement surveys in the area.

The commercial fishery management activities associated with all of the preceding programs are provided by ADF&G, CFMD Division with general fund monies.

Table 2. Agency and non-agency contributions to this project or relating to the resource or service area.

Program	Funding Source	Amount FY94
Perenosa Rehab/Dev.	ADF&G-Program Receipts	46.0
L. Waterfall		
Portage		
Paul's		
Lake Assess	ADF&G-Program Receipts	23.0
L.Waterfall		
Portage		
Laura		
Hidden		
L. Kitoi		
B. Kitoi		
Sorg		
Ruth		
Kitoi Eval.	ADF&G-Program Receipts	47.0
Hidden Lake Eval.	ADF&G-Program Receipts	28.0
Pre-emerg. sample	ADF&G-General Funds	5.9
Aerial Surveys	ADF&G-General Funds	1.4
Shuyak Weirs	ADNR-General Funds	10.2
Shuyak support/Mgmt.	ADF&G-General Funds	1.1
Lake Enrich.	KRAA	69.0
L. Waterfall		
Portage		
Laura		
Kitoi Hatchery	KRAA	1264.0
Pillar Hatchery	KRAA	97.2

PERFORMANCE MONITORING

Performance monitoring of this project will be conducted through the ADF&G, CMFD, H&R, and Administrative Divisions. All aspects of the project will be overseen by the standard chain of command as required by standard operating procedures and administrative regulations. This includes contractual compliance, personnel hiring, supervisory standards, and all other ADF&G regulations. If personnel replacement is required, or temporary project problems occur, regional ADF&G expertise and support is available. Project objectives and tasks, data summation and analysis, and status reports will be kept on the required timeline through planning and integration of the project activities as required for all programs of the ADF&G, CFMD Division, Development Section.

The Kodiak Development Section of the CFMD Division implements and operates approximately 10 restoration/development projects on Afognak and Kodiak Islands. On Afognak Island there four systems with barrier bypass projects which have successfully developed salmon production through increased spawning habitat availability. The quality control procedures that have been employed for these programs will be applied to this project. All data collected, analyzed, and incorporated into scientific reports will be subject to internal review within CFMD and H&R Divisions. Publications will be integrated by the Principle Investigator for Peer Review before submission to EVOS Board of Trustees and Chief Scientists. Status reports will be generated for Peer Review as well as a final report after completion of the project.

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Steve Honnold, Principal Investigator
Area Development Biologist
Comm. Fisheries Management and Development Div. (CFMDD)
ADF&G, Kodiak, Alaska

Joe Sullivan
Fisheries Program Manager
Habitat and Restoration Div.
ADF&G, Anchorage, Alaska

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Date Prepared

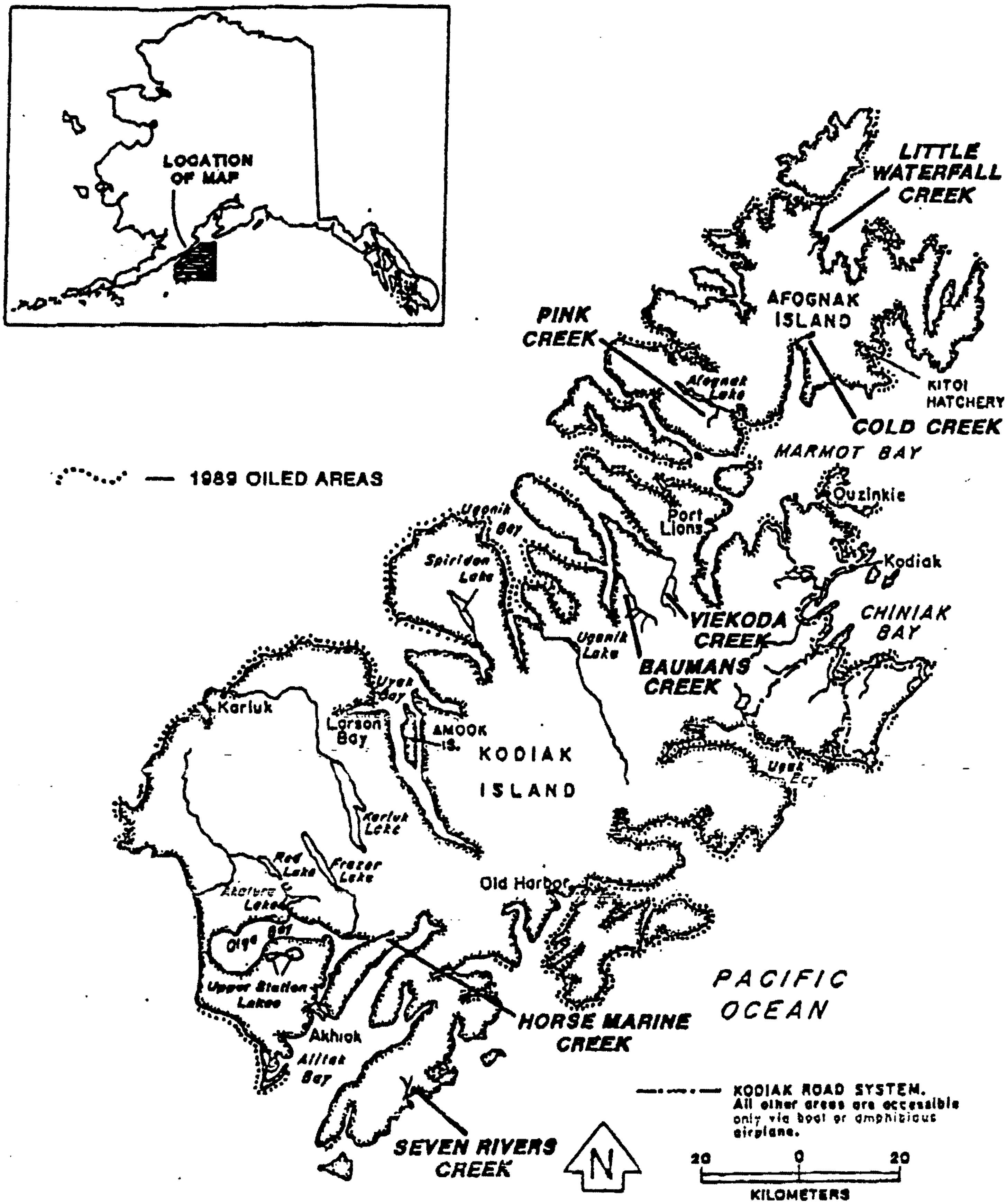

Figure 1. Location of 1989 oiled areas and salmon restoration/mitigation systems.

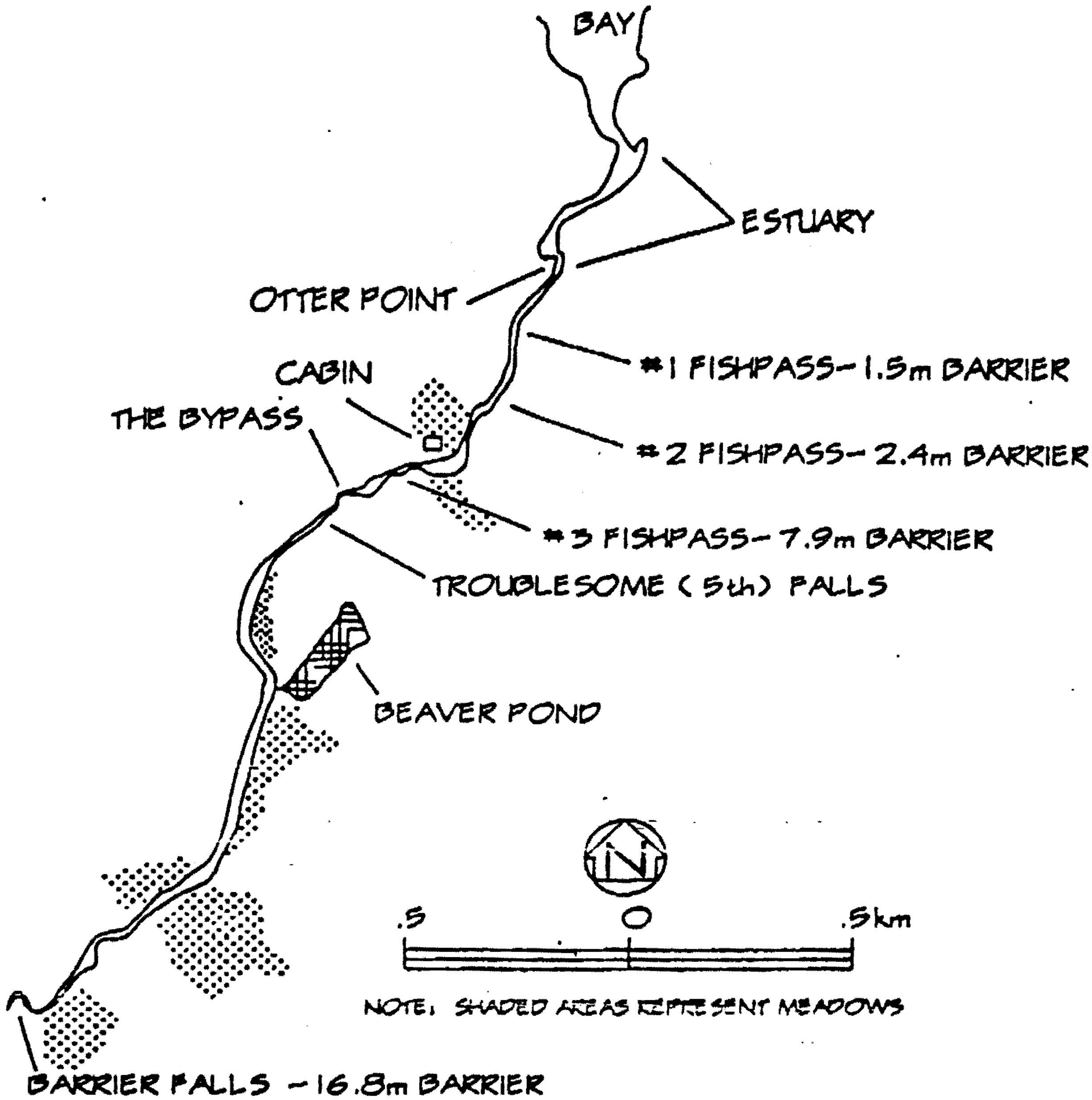

FIGURE 2. LOCATION OF FISHPASSES AND UPSTREAM SPAWNING HABITAT AT LITTLE WATERFALL CREEK.

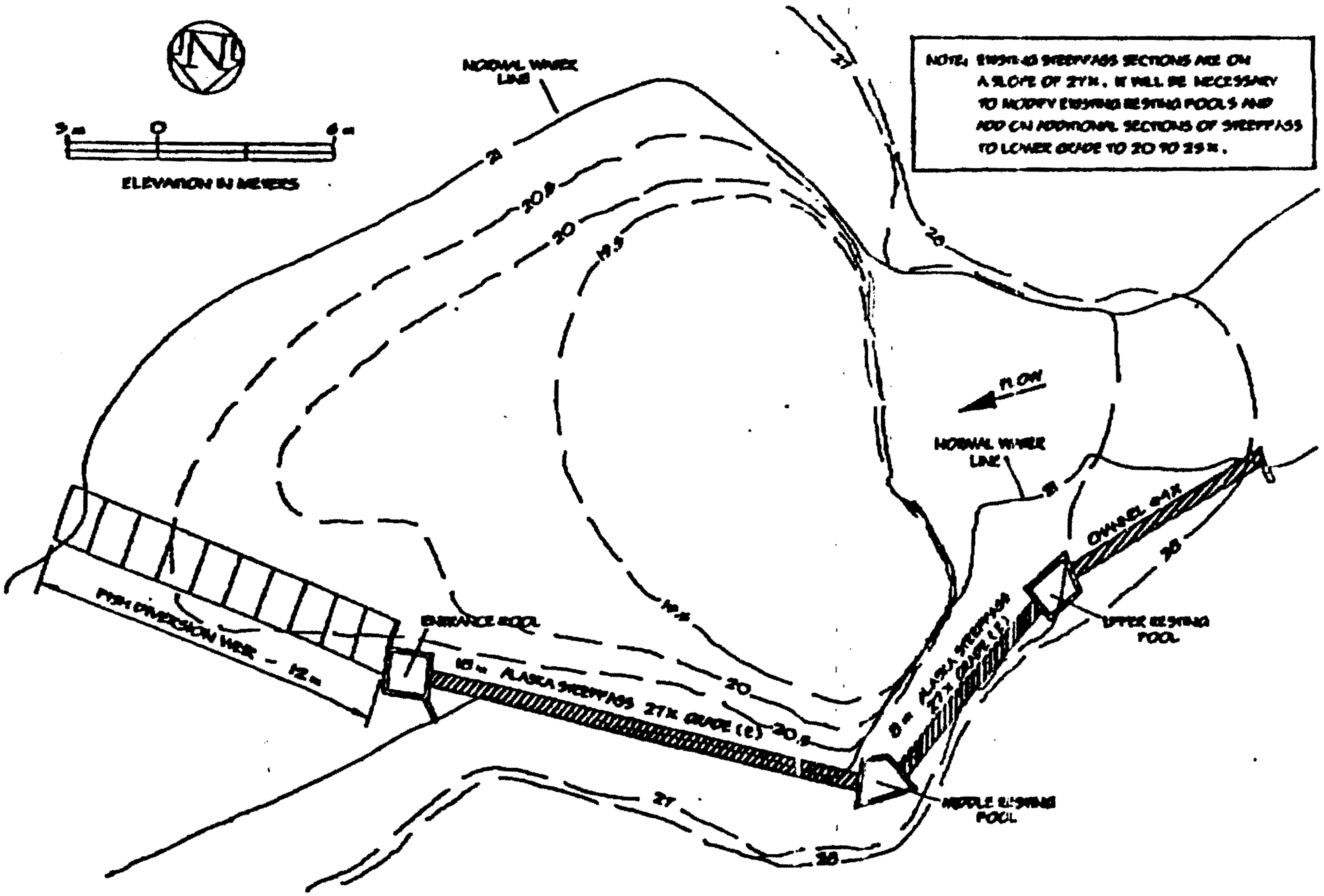

FIGURE 3 . DESIGN OF PRESENT BARRIER BYPASS AT 7.9 METER FALLS AND RECOMMENDED MODIFICATIONS TO IMPROVE SALMON PASSAGE.

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel	$10.7	$22.3						
Travel	$0.3	$1.1						
Contractual	$96.8	$26.1						
Commodities	$0.6	$0.3						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$108.4	$49.8	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration	$6.6	$5.2						
Project Total	$115.0	$55.0	$35.0	$15.0				
Full-time Equivalents (FTE)		0.4						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:
The FFY 1995 budget includes $25,000 supplemental in Contractual, approved during that fiscal year. The FFY 1996 budget includes some Contractual expenses for clean up, repairs and unforseen problems that are expected to result from the constuction in FFY 1995. The budget request for FFY 1997 will be for final evaluation tasks and final report writing.

1996

Project Number: 96139A1
Project Title: Salmon Instream Habitat & Stock Restoration
Sub Project: Little Waterfall Creek Barrier Bypass Improvement
Agency: AK Dept. of Fish & Game

FORM 3A
AGENCY
PROJECT
DETAIL

Preparec

5/2/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
*	PCN 115103	Fishery Biologist IV	20M	1.0	7,432		7.4
*	PCN 116110	Librarian I	17J	0.3	5,530		1.7
	PCN 5270	Fishery Biologist I	14B	2.0	4,505		9.0
	PCN 5297	Fish and Wildl. Tech III	11F	1.0	4,239		4.2
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		4.3	21,706	0	
Those costs associated with program management should be indicated by placement of an *.						Personnel Total	$22.3

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
	Kodiak to Anchorage RD trip fare	180	2	5	150	1.1
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					Travel Total	$1.1

1996

Project Number: 96139A1
Project Title: Salmon Instream Habitat & Stock Restoration
Sub Project: Little Waterfall Creek Barrier Bypass Improvement
Agency: AK Dept. of Fish & Game

FORM 3B
Personnel
& Travel
DETAIL

5/2/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Contractual Costs:	Proposed
Description	FFY 1996
Construction completion and clean up	25.0
air craft charter C206 at $285/hr for 4hr	1.1
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$26.1

Commodities Costs:	Proposed
Description	FFY 1996
Hip boots and field sampling gear	0.2
Office supplies	0.1
Commodities Total	$0.3

1996

Project Number: 96139A1
Project Title: Salmon Instream Habitat & Stock Restoration
Sub Project: Little Waterfall Creek Barrier Bypass Improvement
Agency: AK Dept. of Fish & Game

FORM 3B
Contractual &
Commodities
DETAIL

5/2/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1996

Project Number: 96139A1
Project Title: Salmon Instream Habitat & Stock Restoration
Sub Project: Little Waterfall Creek Barrier Bypass Improvement
Agency: AK Dept. of Fish & Game

FORM 3B
Equipment
DETAIL

5/2/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel		$0.0						
Travel		$0.0						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$0.0	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
Indirect								
Project Total	$0.0	$0.0						
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1996

Prepared

Project Number:
Project Title:
Name:

FORM 4A
Non-Trustee
DETAIL

5/2/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FFY 1996
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.0	0	0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1996
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

1996

Project Number:
Project Title:
Name:

FORM 4B
Personnel
& Travel
DETAIL

5/2/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Contractual Costs:	Proposed
Description	FFY 1996
Contractual Total	$0.0

Commodities Costs:	Proposed
Description	FFY 1996
Commodities Total	$0.0

1996

Project Number:
Project Title:
Name:

FORM 4B
Contractual &
Commodities
DETAIL

5/2/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	

1996

Project Number:
Project Title:
Name:

FORM 4B
Equipment
DETAIL

5/2/95

EXXON VALDEZ TRUSTEE COUNCIL
FY/96 DETAILED PROJECT DESCRIPTION

PROJECT TITLE: Proposed Spawning Channel Construction Project Port Dick Creek, Lower Cook Inlet.

Project Number: 96139-A2

Restoration Category: Instream habitat & wild stock supplementation.

Proposer: Alaska Department of Fish and Game.

Lead Trustee Agency: Alaska Department of Fish and Game.
Cooperating Agency: None

Duration: 5 years, FY/96 through FY/00

Cost FY 96: $223.1

Cost FY 97: $37.0

Cost FY 98: $23.2

Cost FY 99: $15.0

Cost FY 00: $15.0

Cost FY 01: 0

Cost: FY 02: 0

Geographic Area: West Arm Port Dick, Southern Kenai Peninsula, Lower Cook Inlet.

Injured Resource/Service:

The injured resource is the wild pink and chum salmon stocks of Port Dick Creek.

ABSTRACT:
The proposed Port Dick Pink and Chum Salmon Spawning Channel would restore the wild pink and chum salmon stocks. The proposed project would increase the spawning habitat available in Port Dick Creek by restoring formally used tributaries by excavating to stable water sources.

INTRODUCTION:

The portion of Lower Cook Inlet (LCI) along the southern Kenai Peninsula has a significant number of estuarine and intertidal nursery areas important to pink and chum salmon production. The harvest of pink and chum salmon returns to the area provide a significant contribution to the southern Kenai Peninsula economy. The original oil spill restoration survey involved the identification of EVOS impacted areas and the determination of the optimal methods of salmon restoration, in terms of habitat rehabilitation and enhancement methods.

The restoration surveys were initiated in FY/91 and FY/92, resulting in the final selection of Port Dick Creek, on the Outer Gulf Coastal area of the Kenai Peninsula (Figure 1). This system was chosen because it is considered one of the most important pink and chum salmon production streams in the LCI area and it was moderately to heavily oiled by the EVOS (ADF&G 1993). The Exxon Valdez Trustee Council approved funding to further evaluate the feasibility of developing new spawning habitat at this site in 1991 and 1992. A potential spawning channel feasibility analysis at this site was initiated in 1991 and was continued through the spring of 1993 (Figure 2). Although, this proposed project was initially approved for continued funding for FY/94 and FY/95 spending was placed on hold pending further review and discussion at the supplementation workshop.

After further review at the Wild Salmon Stock Supplementation Workshop held in Anchorage January 12 & 13, 1995, staff members from the Habitat and Restoration Office encouraged the resubmission of the Port Dick Spawning Channel project. Peer reviewer, Dr. Mundy's definition of supplementation as "artificial propagation actions with a net positive survival benefit to natural populations", fit the Port Dick project extremely well.

New criteria were developed at the workshop to assess the effectiveness of salmon supplementation projects. Some of the identified criteria included genetic considerations, monitoring and evaluation, mixed stock fisheries and economic issues. Dr. Spies, Chief Scientist for the EVOS Trustee Council, reviewed the Port Dick project under these criteria and developed several recommendations and requested further clarification. The following information attempts to address these concerns.

Genetic Risk:

It was found that the proposed project involves very little genetic risk to the wild salmon stocks. Because the broodstock used for this project is actually the native Port Dick Chum and Pink salmon. Additionally, the supplementation techniques to be used are limited to only on-site egg-take, instream incubation to eyed-egg stage and subsequent eyed egg plants. Thus human intervention to the native stock is minimized and should have very minor if any selective effect on the natural genetic makeup of Port Dick stock.

Mixed Stock Fishery:

The Port Dick Creek pink and chum salmon commercial fisheries are both temporally and spatially segregated from other local stock fisheries. Additionally, in season fisheries management strategies for these natural terminal type fisheries further preclude any possible impact on mixed stock harvests (ADF&G 1993).

Limiting Factors:

The assumption that egg-to-fry survivals within the spawning habitat is the major limiting factor is based on the observed unstable conditions within the main channel of Port Dick Creek. These include wide fluctuations in water levels, extreme flooding effects, inadequate water flow and freeze out conditions (ADF&G 1992/1993). Although escapements have generally been sufficient to fill existing spawning habitat, they have failed to yield significant harvestable surplus in recent years, further indicating that poor egg-to-fry survivals are related to marginal quality of spawning habitat. The proposed Port Dick Spawning Channel project would rehabilitate formally used spawning tributaries taken out of effective production by various physical effects. This spawning channel would provide a much more consistent and stable spawning habitat than that of the main channel of Port Dick Creek.

Linkage to Injured Resources:
Although no damage assessment surveys were funded or conducted in the outer Gulf Coastal areas of the Kenai Peninsula or LCI, studies in the Prince William Sound area indicate differences in pink salmon egg mortality as well as growth in the early marine life stage (ADF&G 1994). These results should be considered applicable as potential impacts on pink and chum salmon stocks in the oil impacted areas of the outer Kenai Peninsula. Most of the streams and associated estuaries, including Port Dick Creek, that were exposed to oiling have demonstrated decreasing pink and chum salmon production trends, some even prior to the spill (Figure 3 & 4). Any further effects from the EVOS or other events could jeopardize long term wild stock salmon production in some of these systems. Moderate to intensive oil clean-up and remediation activities were conducted in only a small portion of the impacted areas in 1989 and 1992.

Monitoring and Evaluation:
A monitoring program to determine the success of the eyed-egg plants as well as the natural seeding of the restored tributaries will be designed with the aid to the biometrician from the Alaska Department of Fish and Game. Methods to capture emergent fry from known redd locations will follow a design by the Oregon State Game Commission (Phillips 1966).

Conclusion:
There exists a need to develop the proposed pink and chum salmon spawning channel project into the final engineering and evaluation phase. This would allow the completion of the actual rehabilitation of a formally effective spawning tributary system which will help to restore the currently depressed wild pink and chum salmon stocks of Port Dick Creek.

NEED FOR THE PROJECT:

Statement of Problem

The targeted resource is the wild pink and chum salmon stocks of Port Dick Creek, in the West Arm of Port Dick Bay. Benefits realized from the spawning channel will accelerate the recovery of the currently depressed wild pink and chum salmon stocks of Port Dick Creek. The LCI area commercial fisheries would benefit from the increased salmon production at Port Dick Creek. The exvessel value of harvested pink and chum salmon would also serve as a base for the economic multiplier effect in the community through processing and other fishery related services.

Rationale

The proposed rehabilitation of the formally used tributaries at Port Dick Creek will restore to former levels the production of wild pink and chum salmon. The additional spawning habitat created would increase egg to fry survivals by expanding stable habitat.

While the benefit-cost ratio is an important aspect, we also believe that this analysis should not be the only criteria used to evaluate the significance of the Port Dick Spawning Channel project. Restoration of these currently depressed wild pink and chum salmon stocks in the EVOS oiled Port Dick Creek should be considered as the primary reason for this effort. It is difficult to assign a monetary value to the restoration of natural resources as the intrinsic value of wild salmon stocks cannot easily be measured.

Summary of Major Hypothesis and Objectives
The ultimate goal of this project is to restore the wild pink and chum salmon stocks of Port Dick Creek. The major hypothesis relates to the theory that the major survival problem occurs during the instream incubation and residence period for both chum and pink salmon. It is theorized that survival problems is caused by the unstable nature of the spawning habitat within the mainstream of Port Dick Creek.
In order to achieve the goal of restoration of the wild stocks, several objectives have been identified including the construction of a stable spawning channel and initiating colonization of the new system by eyed egg planting operations.

Completion Date
Completion of the spawning channel is scheduled for the spring of 1997 with follow up survival monitoring completed in 2000.

COMMUNITY INVOLVEMENT:
The proposed Port Dick Pink and Chum Salmon Spawning Channel was a topic discussed at the Exxon Valdez Oil Spill Trustee Council meetings on January 31, 1994 and the Wild Salmon Stock Supplementation Workshop held in Anchorage January 12 & 13, 1995 with the general public invited. An EVOS public meeting was also held in Homer on April 12, 1995 in which the Port Dick Salmon Spawning Channel was discussed in detail and received favorable public response (see attachments). The Cook Inlet Regional Planning Team will review this project in the near future. Continued public involvement will include, but not be limited to meetings with the Cook Inlet Seiners Association (CISA) and the Cook Inlet Aquaculture Association (CIAA) and the Cook Inlet Regional Planning Team. All documents created by and for the proposed spawning channel will be available to the general public.

FY 96 BUDGET:

Personnel	$57.2
Travel	$1.0
Contractual	$139.3
Commodities	$2.3
Equipment	$5.0
Subtotal	$204.8
Gen. Admin.	$ 18.3
Total	$223.1

PROJECT DESIGN:

A. Objectives

(October 1, 1995 through September 2000)

The ultimate goal of this project is to restore the wild pink and chum salmon stocks of Port Dick Creek.

1. Construct the spawning channel during the spring of 1996.
2. Conduct stream side egg-takes with native salmon stocks and replant the eggs into the new spawning channel at the eyed stage in 1996.
3. Monitor subsequent egg-to-fry survival through on site evaluations beginning in the spring of 1997 through 1999.
4. Monitor adult spawner density and species composition beginning in the summer of 1997.
5. Enumerate the number of adult salmon to develop a return per spawner value.

B. Methods

Ground water level fluctuations will continue using subsurface standpipes and a battery operated stream stage recorder. Groundwater levels were measured during the winters of 1991/92 and 1992/93 and the results will be used to determine the size, depth and configuration of the spawning channel (Figures 2, 5 & 6). Results from the winter of 1994/95 water table measurements are currently being read at Dryden Instrumentation in Anchorage and will be available soon.
The final spawning channel design will be prepared by the engineering section of the Alaska Department of Fish and Game. The design will be advertised through the official state construction bid process. The actual construction project will be awarded to the lowest qualified bidder. Construction of the spawning channel will be conducted with appropriate heavy equipment such as D9 Caterpillar tractors, excavators and front end loaders. Only on-site gravel materials will be used. Mobilization and demobilization of heavy equipment and logistical support materials will be conducted using a 110 ft. landing craft vessel.

Standard fish culture methods will be used to conduct on-site Port Dick Creek chum salmon egg-takes. Instream incubation systems will be used for incubation to the eyed egg stage. Eyed egg planting devices will be used to seed the spawning channel during the first few years to increase the probability of success.

Sample plots or enclosures will be evaluated to determine overwinter survival from the eyed egg to emergent fry stage. These will be monitored during the spring pre-emergent and emergent phase (Phillips 1966).

Periodic stream surveys will be conducted during the spawning runs to determine adult spawner density and species composition. Stream life studies will also be conducted concurrent with this adult portion of the evaluation project.

C. Contracts and Other Agency Assistance

A construction contract will be issued for the excavation of materials to complete the spawning channel. The Department of Fish and Game does not have the equipment necessary to complete the project, therefore, a contract will be awarded to the lowest of three qualified bidders.

D. Location

Port Dick Creek is located at the head end of the West Arm of Port Dick Bay on the outer coast of the Kenai Peninsula (Figure 1). Benefits produced from the salmon spawning channel will be of value to the LCI salmon seining fleet and local seafood processing plants. These benefits will expand into the Homer and nearby communities through the economic multiplier effect.

SCHEDULE:

1. Continue ground water level measurements, data analysis and report writing during the winter of 1995/1996.

2. Construct the spawning channel during the spring/summer of 1996.

3. Complete initial egg take and water hardened egg plant during the fall of 1996 through 1998.

4. Monitor fry survivals beginning in the spring of 1997 through 1998.

5. Monitor and control adult spawner density and species composition beginning in the summer of 1996.

A. Measurable Project Tasks for FY 96

B. Project Milestones and Endpoints

Start up to April 1, 1996: Continue groundwater fluctuation measurements.
Complete environmental assessment.
Develop engineers drawings.
Complete permit requirements.
Continue public education and involvement.

April 2 to June 1, 1996: Receive and award bid package.

June 2 to July 1, 1996 Complete the construction of the channel.

July 2 to August 1, 1996 Conduct stream side egg takes.
Complete any report requirements.

October 1 to October 30, 1996 Plant eyed eggs into the spawning channel.

C. Project Reports : All project reports will be completed when required.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT:

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

ENVIRONMENTAL COMPLIANCE:
The Port Dick Spawning Channel site lies on state lands within the Kachemak Bay Wilderness State Park. An environmental assessment will be written by the State of Alaska to further determine if an environmental impact statement will be necessary.
Permits will be applied for through the U.S. Corps of Engineers, Department of Natural Resources (Division of State Parks) and the Habitat Section of Alaska Department of Fish and Game.

PERSONNEL:

Project leader: Nick C. Dudiak; Lower Cook Inlet Fisheries Resource Development Biologist.

Mr. Dudiak has been a fisheries biologist with the Alaska Department of Fish and Game for the last 17 years. He has been responsible for the commercial and sport fisheries rehabilitation and enhancement work in the Lower Cook Inlet area during those 17 years. In this capacity, he has been responsible for multi-disciplinary work involving the rehabilitation of depleted salmon stocks as well as enhancement activities that have created new and developing commercial and sport fisheries.

Mark Dickson, Fish and Wildlife Technician IV.

Mr. Dickson has been employed as a fish culturist and fish and game technician with the Alaska Department of Fish and Game for the past 17 seasons. He has considerable experience in fish cultural practices in the field and in the hatchery managing projects that restores and enhances sport and commercial fisheries in the Lower Cook Inlet area.

Nick Dudiak, Principal Investigator
Area Development Biologist
Comm. Fisheries Management and Development Div. (CFMDD)
ADF&G, Homer, Alaska

Joseph R. Sullivan

Joe Sullivan
Fisheries Program Manager
Habitat and Restoration Div.
ADF&G, Anchorage, Alaska

Date Prepared

References (Appendix A)

ADF&G. 1993. Survey and Evaluation of Instream habitat and Stock Restoration Techniques for Wild Pink and Chum Salmon. Exxon Valdez Trustee Council. Project No. R105. 1992 Draft Status Report. 78pp.

ADF&G. 1994. 1993 Lower Cook Inlet Area Annual Finfish Management Report. Division of Commercial Fisheries Management & Development.

ADF&G. 1994. Impacts of the Exxon Valdez oil spill on the migration, growth, and survival of juvenile pink salmon in Prince William Sound. 36 pp.

Phillips, Robert W. 1966. A Trap For Capture of Emerging Salmonid Fry. THe Progressive Fish Culturist. vol. 28 p. 107

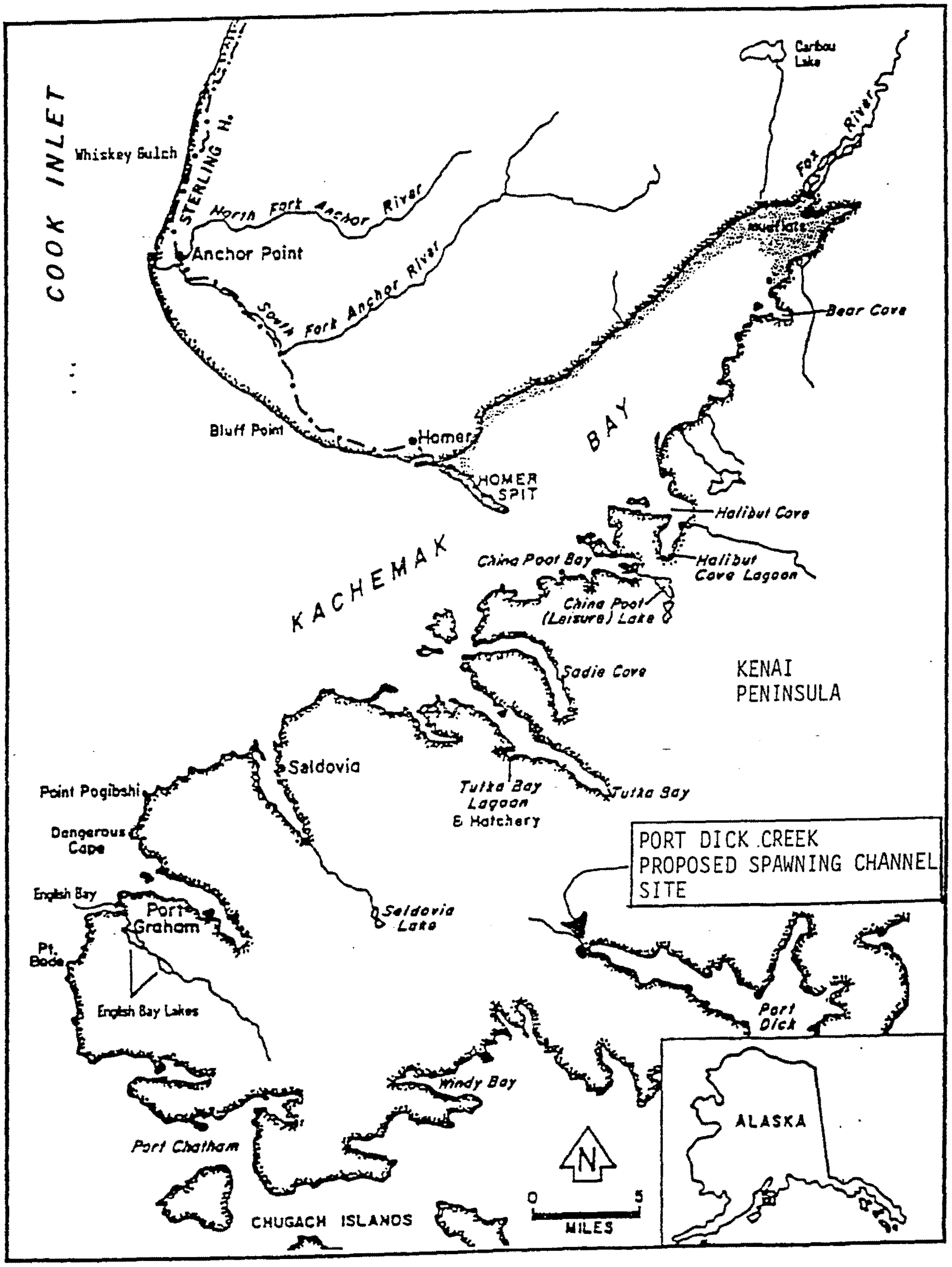

Figure 1. Location map of the Port Dick Creek Proposed Spawning Channel Site, Kenai Peninsula.

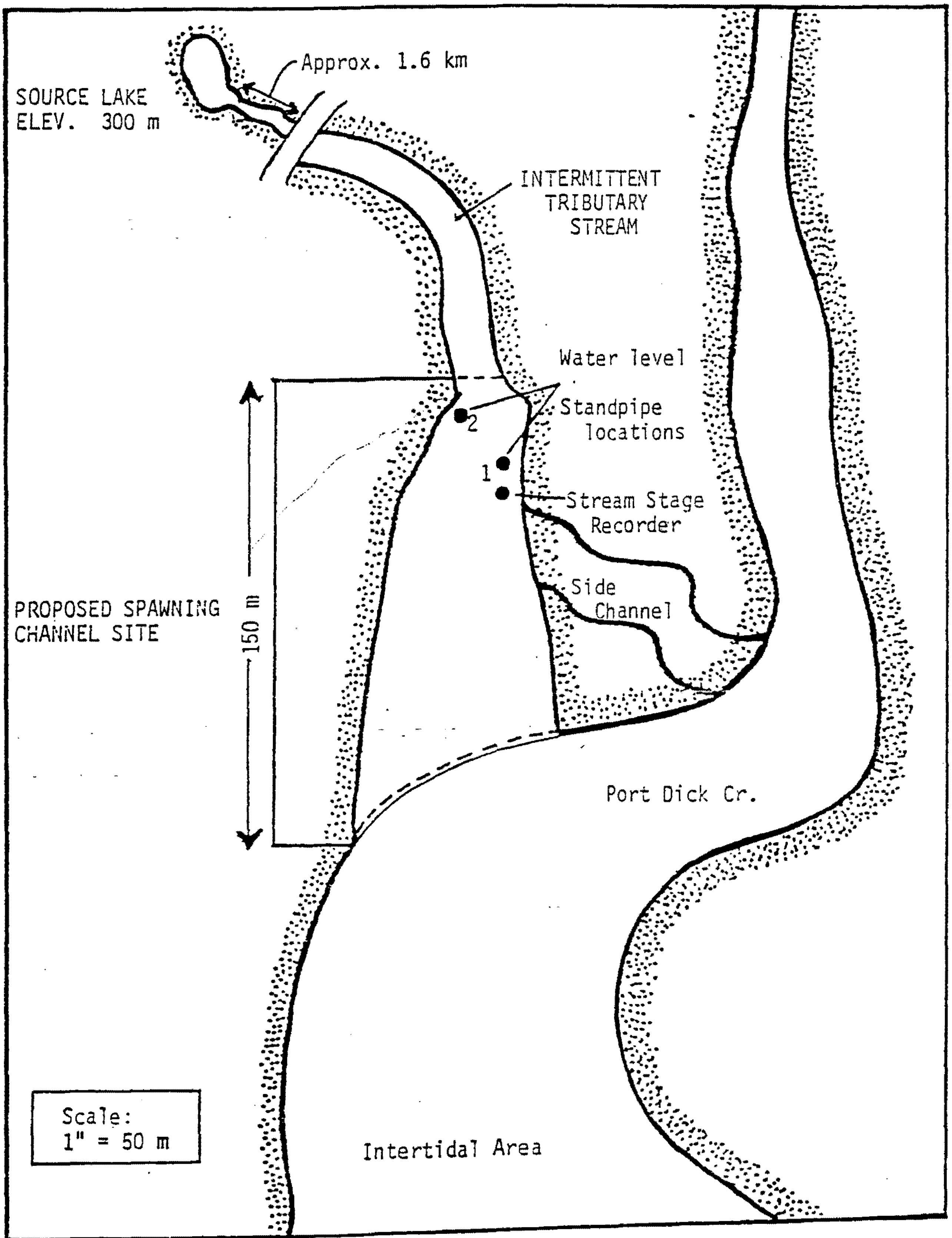

Figure 2. Port Dick Creek, adjacent proposed spawning channel site, and water level standpipe locations.

PORT DICK CREEK CHUM SALMON ESCAPEMENTS
With Commercial Harvests

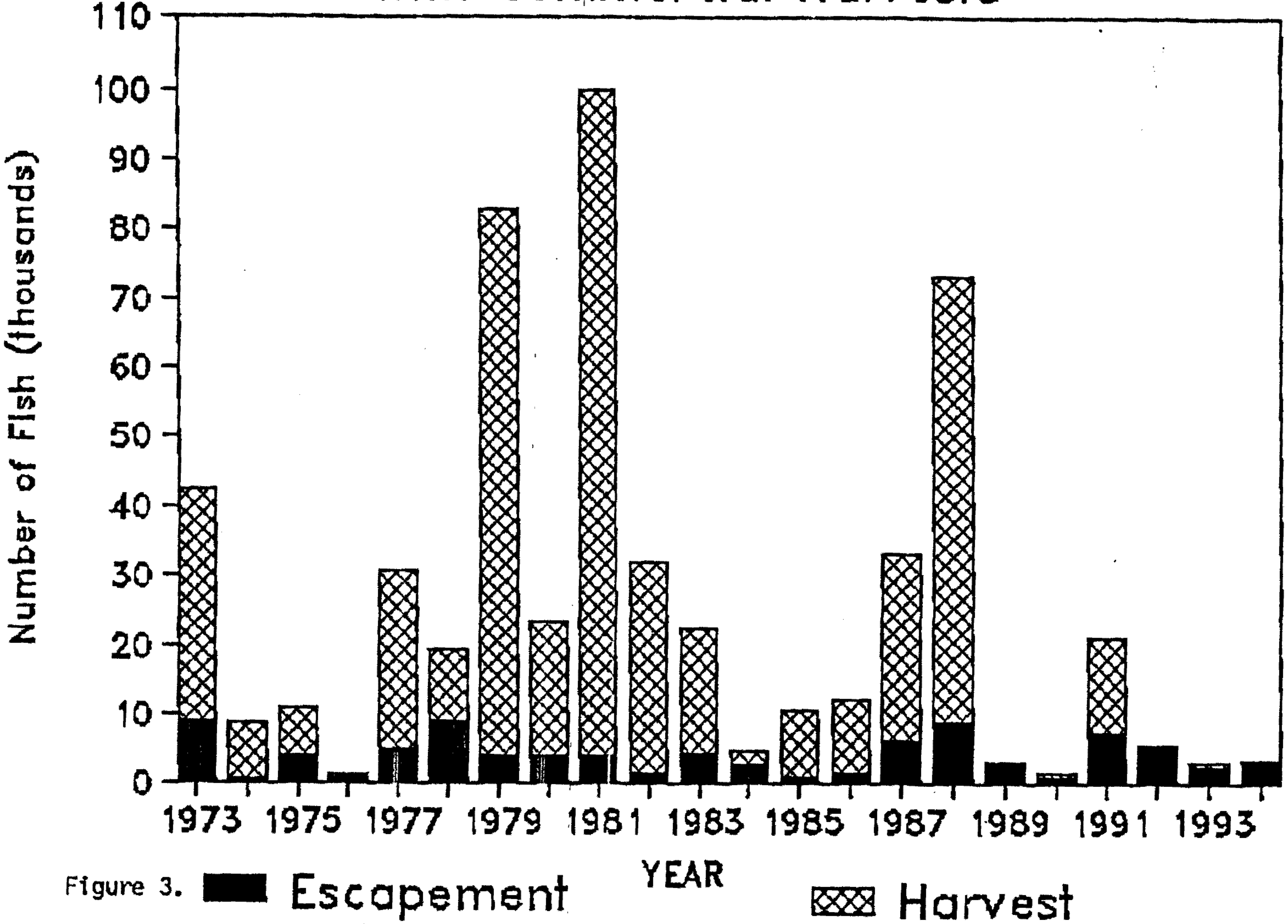

Figure 3.

Port Dick Creek Pink Salmon Escapements With Commercial Harvests

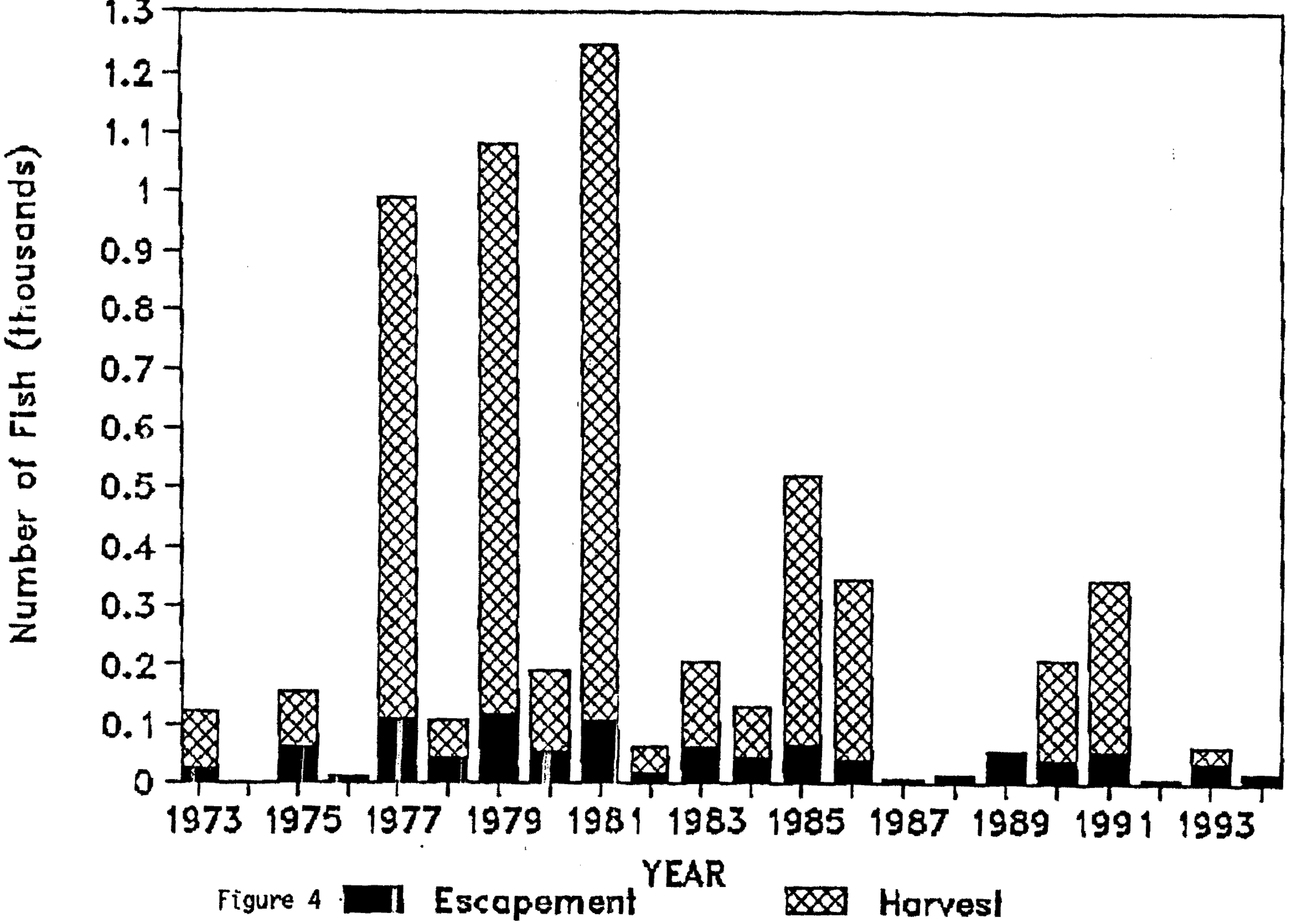

Figure 4

PORT DICK CREEK WATER TABLE LEVELS

Mean Weekly Groundwater Levels

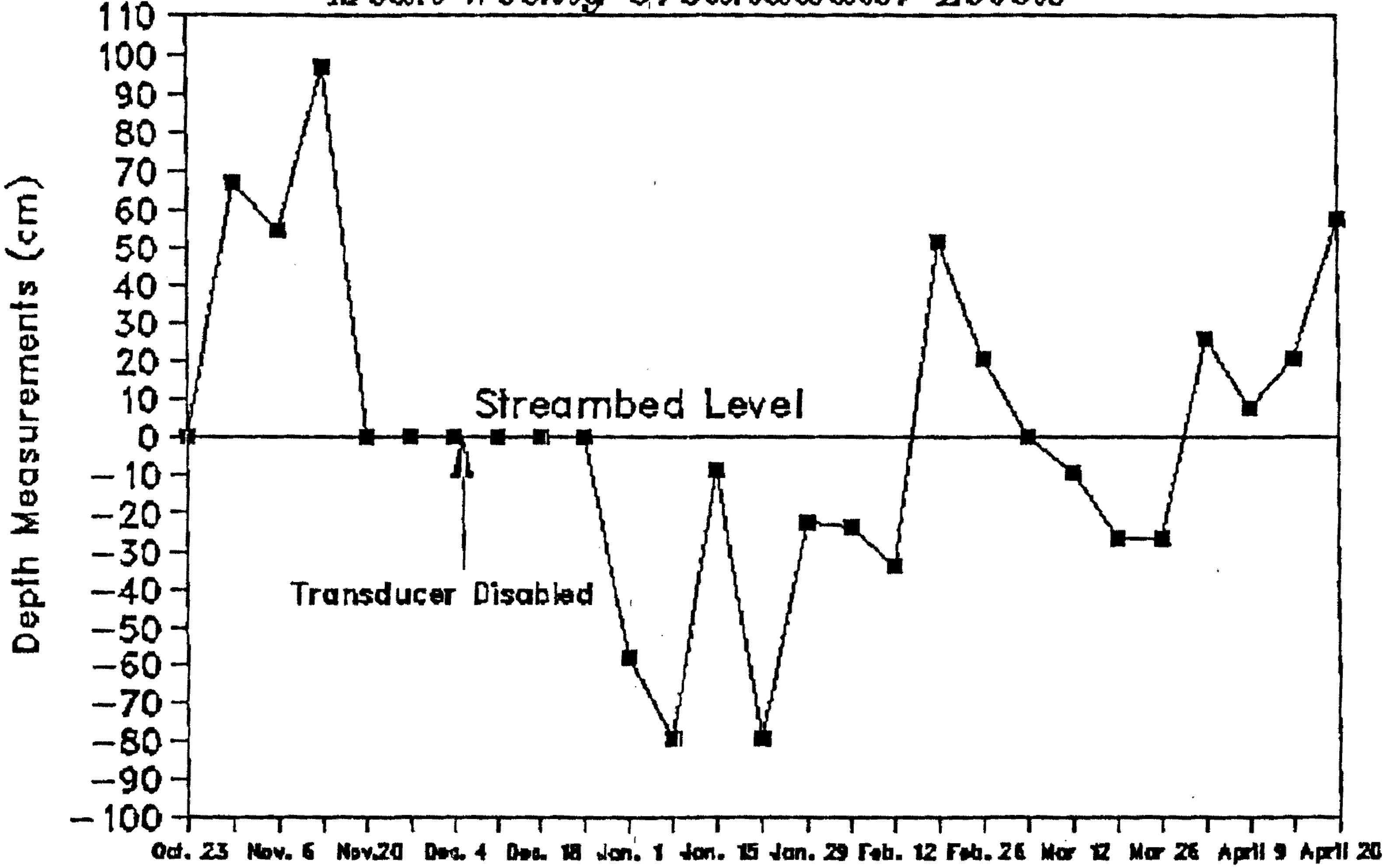

Figure 5. Stream stage recorder measurements, October,92 to April,93

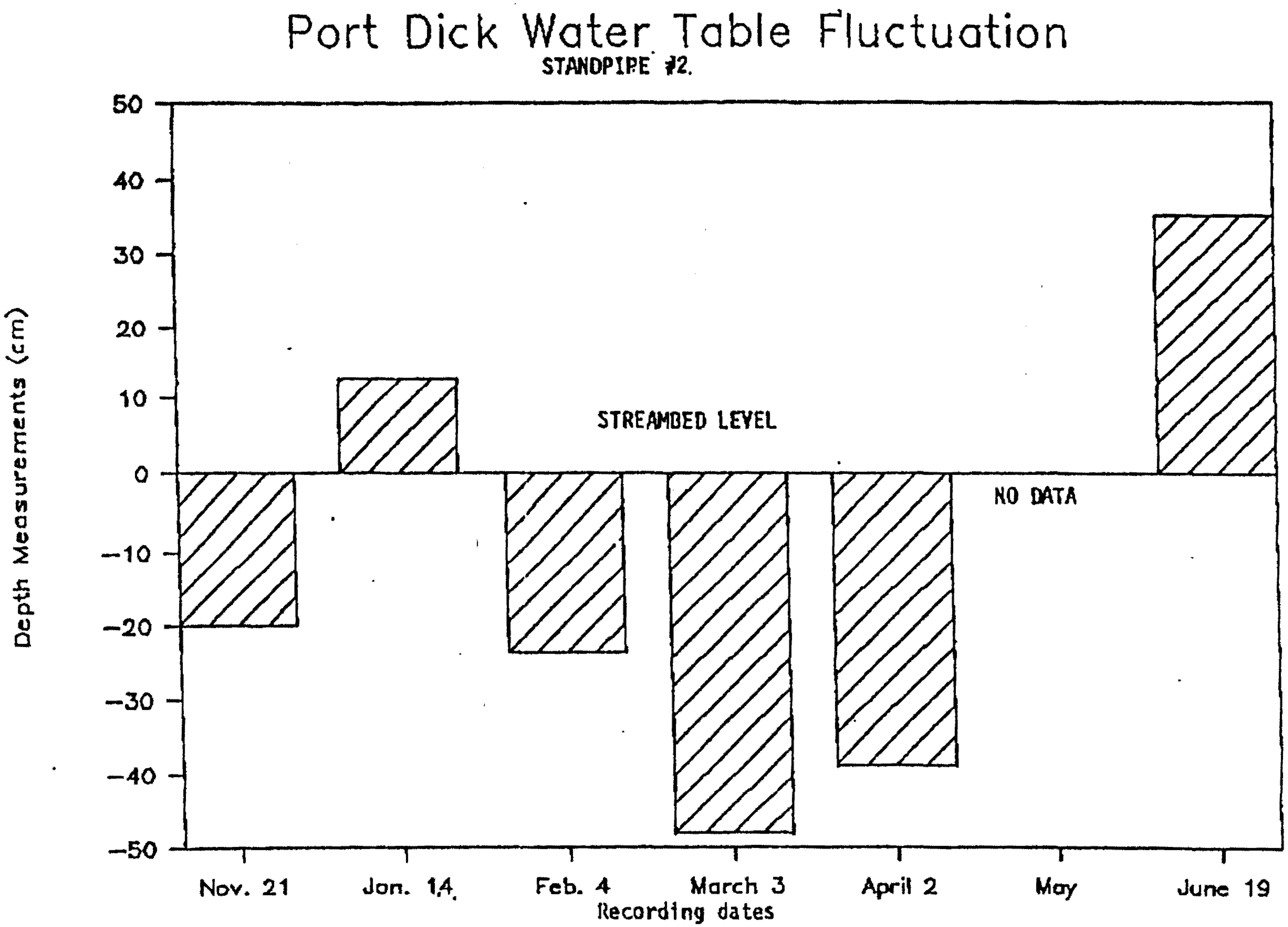

Figure 6. Standpipe #2 Water Table measurements, Port Dick Creek, November 1991 - June 19, 1992.

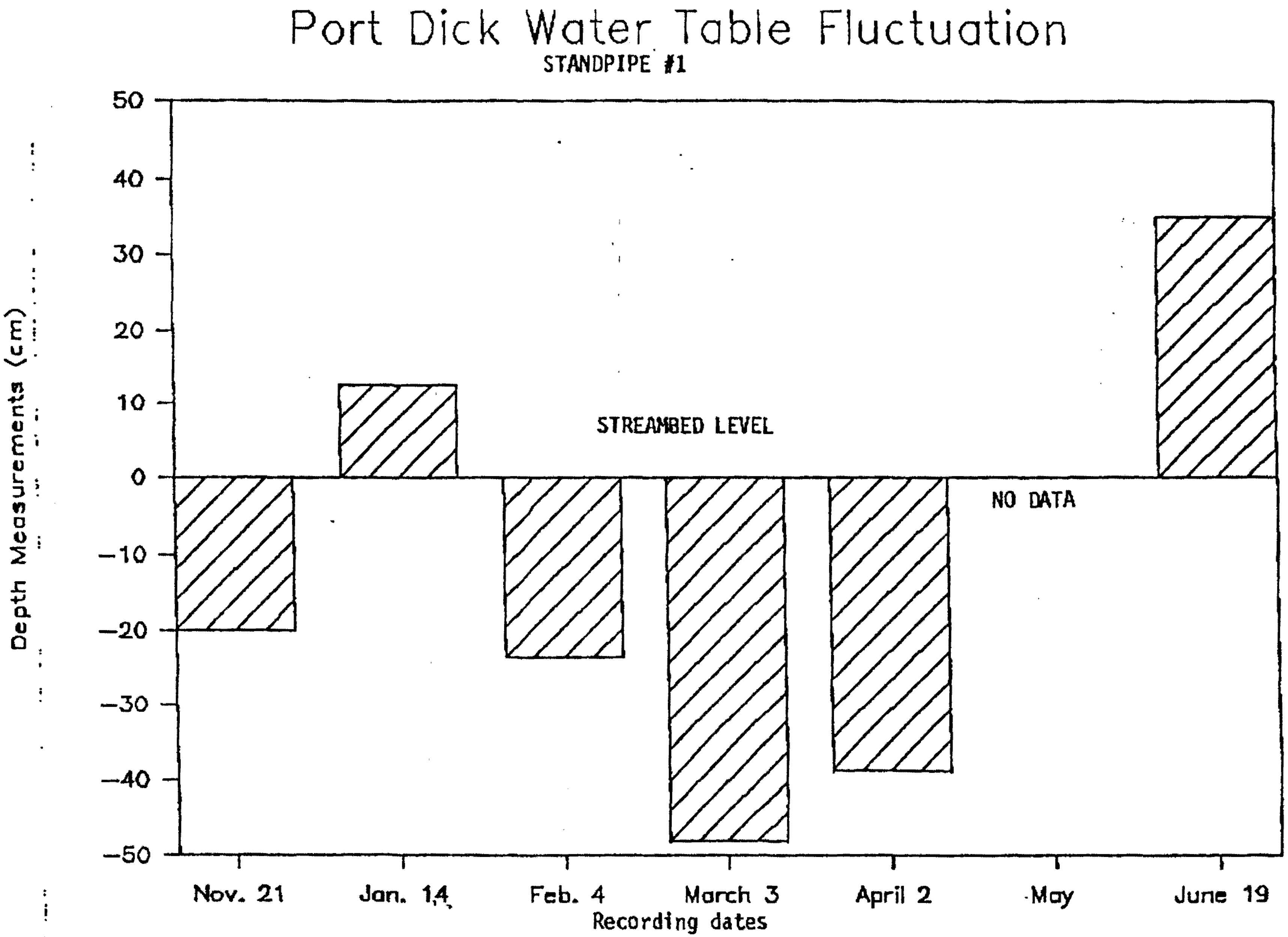

Figure 7. Standpipe #1 Water Table measurements, Port Dick Creek, November 1991 - June 19, 1992.

Cook Inlet Seiners Association

P.O. Box 4311
Homer, Alaska 99603
235-2656

April 12, 1995

Dr. Joe Sullivan
Resource Program Manager
Habitat and Restoration Division
Alaska Department of Fish and Game
333 Raspberry Rd.
Anchorage, Alaska 99518-1599

Re: Proposed Spawning Channel--Project Port Dick Creek, LCt: Project I.D. Number--95139

Dear Dr. Sullivan:

As you know, based on your presentation at our 1992 Annual Membership Meeting and on-going encouragement, Cook Inlet Seiners Association has been actively engaged in the Exxon Valdez Trustee process. CISA has had representatives at most meetings, written many letters, and given testimony as well as provided a number of project proposals for Lower Cook Inlet. Basically our situation has not altered since your visit; even though we have taken an assertive role in presenting our need for restoration in this area, to date, we, astonishingly, still have had no fish related restoration projects funded in LCI.

CISA enthusiastically supports Nick Dudiak's Proposed Spawning Channel--Project Port Dick Creek, Lower Cook Inlet: Project I.D. Number--95139. Not only is this a valuable and worthwhile project, it makes good business sense to finish what has been started so that funds already expended will no be wasted.

CISA firmly believes much needs to be done in LCI to restore our salmon runs to pre-spill health. As you probably know, since the calamitous impact of the spill in 1989, LCI has suffered run failures across almost all species of salmon and throughout most of the geographic area. Prior to this time, the LCI supported healthy salmon fisheries that economically benefitted the entire region as well as the state. Project 95139 will be an initial yet significant step in restoring the oil devastated pink and chum runs in the Port Dick area of the outer coast.

Thank you for the opportunity to participate in the process and for your support over the last few years.

Sincerely,

Charles Walkden, sr.
President, Cook Inlet Seiners Association

April 15, 1995

Joe Sullivan
Resource Program Manager
Habitat and Restoration Division
Alaska Department of Fish and Game
333 Raspberry Rd.
Anchorage, Alaska 99518-1599

Re: Proposed Spawning Channel--Project Port Dick Creek, Lower Cook Inlet: Project I.D. Number--95139

Dear Mr. Sullivan:

I am writing to convey my ideas and concerns about the lack of restoration activities in the outer coast of the Kenai Peninsula. I was unable to attend the Trustee meeting that was held in Homer a couple of days ago.

The Lower Cook Inlet was one of the most heavily oil spill damaged area in Alaska. It is clear to me that no one can dispute that the region was seriously damaged by the spill. (Just take a look at one of the Trustees' own publications--the map on the cover of the Exxon Valdez Oil Spill Restoration 1993 Draft Work Plan.)

Since the 1989 spill, the Lower Cook Inlet has suffered run failure after run failure across most species of salmon in the geographic area. Prior to '89, we had healthy salmon fisheries that economically benefitted the fishermen and related communities as well as the entire region and state.

The frustration level is high in LCI because we have seen no restoration projects in our area even though it is the mission and responsibility of the Trustees to address such situations. Our salmon runs have been affected and yet nothing has been done. I believe that Project # 95139 is a well throughout and workable project that will address some of the spill related issues in the outer coast. As a result, I strongly support funding for this project.

I also request that your office work closely with the Cook Inlet Seiners Association's office to develop other projects. In order for our wild runs in the outer coast to achieve pre-spill levels, they need restorative support.

I know that everyone believes that their project is vital. I would just ask you look at the map that I referred to before. It graphic ally depicts the oil spill area and makes it obvious that we were hit hard.

Thank you for your time and assistance.

Sincerely,

RECEIVED

APR 18 1995

STATE OF ALASKA
FISH & GAME
HABITAT & RESTORATION

April 13, 1995

Dr. Joe Sullivan
Resource Program Manager
Habitat and Restoration Division
Alaska Department of Fish and Game
333 Raspberry Rd.
Anchorage, Alaska 99518-1599

Re: Proposed Spawning Channel--Project Port Dick Creek, Lower Cook Inlet: Project I.D. Number--95139

Dear Dr. Sullivan:

As a long time fishermen and concerned citizen, I am writing in support of Project 95139--Port Dick Spawning Channel. This project is deserving of funding by the Trustee and has the support of area fishermen.

Since 1989, most salmon runs have failed in Lower Cook Inlet. Restoration of affected salmon stocks must be accomplished as soon as possible to preserve these unique natural runs and the fishermen that harvest them. Although damage to Lower Cook Inlet by EVOS is an established fact, little has been done to research or restore damaged fish stocks. It is imperative that restoration of pink, chum, and sockeye stocks is begun <u>immediately</u>. It is with firm belief in and commitment to our environment, that I support restoration in LCI.

In summary, not only do I firmly support Project 95139, I believe that the time to deal with all LCI spill related salmon run failures is well overdue. As a result, I strongly support other restoration projects in the region. Although I do have some ideas, I do not know exactly what all these projects should be. I do intimately know the need for such projects because of how my fishing has been impacted. I welcome the opportunity to discuss any ideas you or your staff may have. This is a serious issue that requires immediate action.

Thank you.

Sincerely,
Nathan A. Weir

RECEIVED
APR 18 1995
STATE OF ALASKA
FISH & GAME
HABITAT & RESTORATION

8/25/9. [illegible]

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel	$0.0	$56.9						
Travel	$0.0	$1.4						
Contractual	$0.0	$148.5						
Commodities	$0.0	$2.3						
Equipment	$0.0	$2.5	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$211.6	Estimated	Estimated	Estimated	Estimated	Estimated	Estimated
General Administration		$18.9	FFY 1997	FFY 1998	FFY 1999	FFY 2000	FFY 2001	FFY 2002
Project Total	$0.0	$230.5	$53.7	$39.7	$31.5	$32.0	$17.0	$0.0
Full-time Equivalents (FTE)		1.1						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

_.This budget includes and combines work previously proposed as Project No. 96139A2 and Project No. 96139D, Supplemental Monitoring for the Proposed Spawning Channel Construction Project, Port Dick, Lower Cook Inlet.

1996

Project Number: 96139 - A2
Project Title: Port Dick Creek Proposed Spawning Channel
Agency: AK Dept. of Fish & Game

FORM 3A
AGENCY
PROJECT
DETAIL

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
	11-5243	Fish and Game Technician IV	13E	6.0	4,075		24.5
	11-5338	Fish and Game Technician III	11A	4.0	3,225		12.9
*	11-5103	Fisheries Biologist IV	20I	1.5	7,182		10.8
*	11-6110	Librarian II	17J	0.3	5,530		1.7
	11-5154	Civil Engineer II	19K	1.0	7,004		7.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		12.8	27,016	0	
Those costs associated with program management should be indicated by placement of an *.						Personnel Total	$56.9

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
*	Round trip, Anchorage to Homer overnight and return	180	1	1	150	0.3
*	Round Trip, Anchorage to Homer and return	180	1	5	150	0.9
	Round trip, Anchorage to Homer and return	180	1	0	0	0.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					Travel Total	$1.4

1996

Project Number: 96139 - A2
Project Title: Port Dick Creek Proposed Spawning Channel
Agency: AK Dept. of Fish & Game

FORM 3B
Personnel
& Travel
DETAIL

7/27/95

1996 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Contractual Costs:	Proposed
Description	FFY 1996
Includes 1. Contract with non-trustee contractor to build spawning channel and 2. contract for hydrologic monitoring.	129.2
9 round trips helicopter, Port Dick-Homer & return to retrieve field data, inspect the channel site and for channel construction supervision at $700/trip.	6.3
4 round trips, float plane for field camp setup and egg-take activities at $630/trip.	2.5
3 days landing craft barge charter to transport heavy equipment to channel site at $3500/day.	10.5
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$148.5

Commodities Costs:	Proposed
Description	FFY 1996
Food for 3 people for 30 days at $15/day/person while on site conducting egg-take and other fish cultural activities.	1.4
3 sets of rain gear at $100/set	0.3
3 sets of hip waders at $75/set.	0.2
Dip nets, spawning knives, plastic bags and other egg-take items valued at approximately $350.	0.4
Commodities Total	$2.3

1996

Project Number: 96139 - A2
Project Title: Port Dick Creek Proposed Spawning Channel
Agency: AK Dept. of Fish & Game

FORM 3B
Contractual &
Commodities
DETAIL

7/27/95

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
1 Weatherport portable shelter to use during adult salmon capture and egg-take operations. 1 Weatherport was located from EVOS property in Cordova and transfered to project 95139-A2	1	0	0.0
1 Motorola Saber Radio with battery charger to be used at Port Dick Creek for reliable communications with town.	1	2,500	2.5
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$2.5

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Equipment to be used purchased with non-Oil Spill funds.		
Data pod data recorder with pressure transducer and battery pack.	2	ADG&G
1 full set camping and cooking set to accommodate 3 people in remote setting.	1	ADF&G
4x4x8 foot holding nets and frames to hold adult salmon.	4	ADF&G
Coleman 1750 watt generator	1	ADF&G

1996

Project Number: 96139 - A2
Project Title: Port Dick Creek Proposed Spawning Channel
Agency: AK Dept. of Fish & Game

FORM 3B
Equipment
DETAIL

1996 EXXON VALDEZ TRU = COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
	0							
Personnel	$0.0	$3.4						
Travel	$0.0	$4.7						
Contractual	$0.0	$121.1						
Co Subtotal	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Project Total	$0.0	$129.2	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
Indirect								
	$0.0	$129.2	$16.5	$16.5	$16.5	$17.0	$17.0	$0.0
Full-time Equivalents (FTE)								
	Dollar amounts are shown in thousands of dollars.							
Other Resources			$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Note: Contractual Services includes:

1. $120.0 K for the spawning channel construction in FY 1996; and,
2. $9.2K for Hadraulic monitoring in FY 1996. (formerly, Project proposal 96139D)

1996

Prepared:

Name

Project Number: 96139 - A2
Project Title: Port Dick Creek Proposed Spawning Channel
Name: Non-Trustee Contractor

FORM 4A
Non-Trustee
DETAIL

7/28/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Pers costs are included in form 4B (contractual costs)	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1996
Coble	Field Technician		3.0	150		0.5
Coble	Data Analist		3.0	960		2.9
						0.0
Note: monthly cost is the cost to perform that task in that month						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		6.0	1,110	0	
Description					Personnel Total	$3.4

Trav round trip helicopter at $750.00 per trip	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FFY 1996
	$750.00	4			3.0
					0.0
float plane for instrument installation	630	1	1	150	0.8
helicopter for instrument inspection and download data	780	1	1	150	0.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$4.7

1996

Project Number: 96139 - A2
Project Title: Port Dick Creek Proposed Spawning Channel
Name: Non-Trustee Contractor

FORM 4B
Personnel
& Travel
DETAIL

7/27/95

1996 EXXON VALDEZ TRL_ . _E COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

		Proposed FFY 1996
Con	Estimated contractual costs associated with the construction of the spawning channel:	
Des	3 pieces of heavy equipment; front-end loader, D-5 and D-3 bulldoser @ $25,000 per month	25.0
	4 man crew @ 10 hrs./day X $45.00/hr. X 30 days*	54.0
	Fuel , fuel storage and equipment maintenance	23.0
	Food, cook/house keeper for 4 man crew for 25 days	15.0
	Contractual costs were determined by way of informal interviews with two local excavators/contractors. Each estimator were shown several pictures of the proposed site, along with topograhical maps, area maps and water table depth measurement taken by ADF&G staff (Figure 5,6,7 FFY96 DPD). Costs also included costs of commodities, new equipment purchases and personnel costs. * Wages are based on Davis-Bacon wage scale.	
	Monitoring equipment rental(current, pressure,temperature, conductivity, data logger, solar cells,batteries)	2.9
	installation supplies and equipment insurance for monitoring equipment	1.2
	Contractual Total	$121.1

		Proposed FFY 1996
Co	Commodity costs are included in the estimate found on form 4B (contractual costs).	
Description		
	Commodities Total	$0.0

1996

Project Number: 96139 - A2
Project Title: Port Dick Creek Proposed Spawning Channel
Name: Non-Trustee Contractor

FORM 4B
Contractual &
Commodities
DETAIL

7/27/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases:	Number of Units	Unit Price	Proposed FFY 1996
Des The department must assume that the selected vendor will use any and all existing equipment at his disposal and owned by the vendor to accomplish the contract.			0.0
	0	0	0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		New Equipment Total	$0.0

Exis The department must assume that the selected vendor will use any and all existing equipment at his Des disposal and owned by the vendor to accomplish the contract.	Number of Units
	0

1996

Project Number: 96139 - A2
Project Title: Port Dick Creek Proposed Spawning Channel
Name: Non-Trustee Contractor

FORM 4B
Equipment
DETAIL

7/27/95

96139C1

8/25/95 Version

Montague Riparian Rehabilitation Monitoring Program

Project Number:	96139C1 Revised
Restoration Category:	Monitoring
Proposer:	USFS
Lead Trustee Agency:	USFS
Cooperating Agencies:	None
Cost FY 96:	$9,700
Cost FY 97:	$0
Duration:	1 year
Geographic Area:	Montague Island, Prince William Sound
Injured Resource/Service:	Commercial Fishing

ABSTRACT

This project is a continuation of 94139 and 95139C1. In FY94, funding was granted to construct 25 to 30 structures in streams flowing through clearcut areas on Montague Island. These structures were designed to improve fish spawning and rearing habitat, prevent erosion, and help restore the natural flows and stream features that existed prior to logging. The 1994 work also included the improvement of 20 acres of riparian vegetation. The 1995 work evaluated the function of the structures and changes to the aquatic habitat. Permanent study sites were established in thinned areas for quantitative assessment of vegetative response. This project proposal is to continue evaluation of structures, and assess additional changes in the aquatic habitat, stream channels, and substrates. The riparian vegetation will continue to be evaluated to determine the effectiveness of vegetative treatments.

INTRODUCTION

This project is a continuation of 94139 and 95139C1. In FY94, the Cordova Ranger District received funding to construct 25 to 30 structures in streams flowing through clearcut areas on Montague Island. These structures were designed to improve fish spawning and rearing habitat, prevent erosion, and help restore natural flows and stream features that existed prior to logging. The 1994 work included the improvement of 20 acres of riparian vegetation. In 1995 monitoring was conducted. This project proposal is to continue evaluation of structures and assess changes in the aquatic habitat, stream channels, and substrates. The riparian thinning will also be evaluated to determine effectiveness of vegetative treatments.

NEED FOR PROJECT

A. Statement of Problem

Montague Island was once a significant producer of chum salmon *(Oncorhyncus keta)* in Prince William Sound. However, since the mid-1960's, chum salmon habitat has been altered and degraded by a series of natural and human-caused events. These events include the 1964 earthquake which uplifted and destabilized intertidal spawning areas, logging operations in the 1960's and 70's which altered stream channels and flow regimes, and later, the 1989 *Exxon Valdez* oil spill.

Chum Salmon populations have not recovered from these disturbances on their own. Only a few remnant populations of Montague Island chum salmon have been reported in recent years. A stocking program in Chalmers River has apparently been successful, but it is uncertain whether the habitat has sufficiently recovered in other streams to make stocking on natural recolonization possible. Given the number of impacts in recent years, it is theorized that the best way to aid in the restoration of chum populations, and other species as well, is to look at the problems of the watersheds as a whole. If the natural conditions of the watersheds can be restored, the chances for chum salmon recovery should be improved.

In many of the former chum producing streams, it is not possible to undo the effects of the earthquake or the oil spill. It is possible, however, to help restore the habitat affected by logging operations and mitigate the impacts to chum salmon production. In most of the clearcut areas, no buffer strips were left around the streams and much of the large woody was taken out of the stream in the belief that this would assist salmon migration and increase spawning riffles. Forest Service habitat surveys have shown that these streams have low levels on woody material, and since pools form around logs and other obstructions, lower amounts of pool area.

Without in-stream large woody material and pools to disperse the energy of the water during high flows, the stream velocities, bedload movement, and erosion all increase. Comparisons of aerial photographs from before and after the logging show stream widening and the development of larger gravel bars. These changes suggest increased bank erosion and increased bedload movement. These conditions can adversely affect chum salmon and other fish by displacing or crushing eggs in spawning areas during periods of high flows and bedload movement. As flows subside, spawning areas can also be adversely affected by siltation from eroded material.

The loss of woody material and pools also limits the amount of juvenile rearing habitat for coho salmon *(Oncorhyncus kisutch)* and other fish species. Juvenile coho prefer low velocity areas such as the pools and backwaters created by woody materials. Logs and other material also provide cover from predators, attract aquatic insects and other food sources, and provide shelter from high flows.

The primary goal of the project was to restore these disturbed watersheds, and thereby improve the conditions for chum salmon production. Other species, such as pink *(Oncorhyncus gorbuscha)* and coho salmon, will also benefit from this work. It will take some time before the fish populations respond to these changes, but by treating the problems of the watershed, in both the riparian and stream areas, we can help assure continued chum salmon production in the future.

B. Rationale

The theory behind the rehabilitation work on Montague Island was based upon the results of a number of different studies and projects in Alaska, the Pacific Northwest, and the rest of the country. There are, for example, a number of papers describing the successful use of instream structures to improve habitat for salmon and trout (Payne and Copes, 1986; Fuller, 1990; House and Boehne, 1986). It has also been widely documented that large woody material, or instream structures functioning as woody material, serve to reduce flows, store sediment, reduce erosion, and generally improve the hydrologic characteristics of streams for salmonids (Swanston, 1991; Chamberlin et al., 1991; Smith et al., 1993). Thinning and removal of competing vegetation has been shown to accelerate the growth of Sitka spruce (Fowells, 1965) and has been a standard silvicultural practice for many years (Smith, 1962). Thus, we feel confident that the methods were sound and the work should have the desired effect.

While instream structures have been used successfully in the Pacific Northwest and in some of the smaller streams on the Cordova Ranger District, FY 94 was the first time such structures had been placed on Montague Island. Because of the climate and topography, the streams on the west side of the island are subject to intense flows. Although we feel confident that the structures will hold up to the flows, these extreme conditions may have some unforeseen effects. This portion of the project will monitor the effects of these structures. If the structures prove to be successful, the same methods could be used to treat streams in other logged areas on Montague Island. The scope of the present structure work has been limited mainly to Hanning Creek, but if this project proves successful, several other streams could benefit from this type of activity. This work might also prove effective in other logged areas in Prince William Sound. The Port Fidalgo area, for example, also has steep slopes, high rainfall, and streams with highly variable flows.

C. Summary of Major Hypotheses and Objectives

Instream structures and thinning of vegetation will improve salmonid habitat on Montague Island.

D. Completion Date

This project is scheduled for completion in FY 96. Further monitoring of the structures will be done by the U.S. Forest Service in conjunction with other activities on Montague Island.

COMMUNITY INVOLVEMENT

None.

FY 96 BUDGET

Personnel	7.7
Travel	0.0
Contractual	0.6
Commodities	0.2
Equipment	0.0
Subtotal	8.5
Gen. Admin.	1.2
Total	9.7

PROJECT DESIGN

A. Objectives

1. Determine the changes in channel structure, fish habitat, and substrate at each of the structure sites and in an untreated area downstream.

2. Assess the riparian vegetation work by determining the survival rate of planted seedlings and the effectiveness of tree thinning.

B. Methods

The monitoring program developed and initiated in 1995 will be continued in 1996.

C. Contracts and Other Agency Assistance

Aircraft may be chartered for transportation of personnel and equipment.

D. Location

This project entails 5 streams on Montague Island in Prince William Sound: Hanning Creek (ADFG stream # 710) Blying Sound D-1, 2 quadrangle, R10E, T3S, section 2 SE 1/4; Swamp Creek (ADFG # 739) Seward A-1 quadrangle, R12E, T1N, section 11, SE 1/4 and section 12, SW 1/4; and ADFG streams 734, 735, 736, Seward A-2 quadrangle, R12E, T1S, section 4 NE 1/4 and section 33 SW 1/4. These streams are all located on Chugach National Forest Land.

SCHEDULE

A. Measurable Project Tasks for FY 96

Structures will be monitored at low flow. Stream channels will be mapped at structures and areas downstream. The use of fish habitat will-be assessed. Vegetation will also be assessed.

B. Project Milestones and Endpoints

The preliminary assessment of the structures showed that they were beginning to function as designed, with the drop pools and scour pools beginning to form as predicted. The erosion control structures also appeared to be protecting the banks. It will take additional high flows, especially during the spring runoff, to truly test the structures. These structures will need to be monitored over a number of years to see how durable they are. It appears, however, that the structures will last a long time.

There is no preliminary assessment of the thinning work yet, other than to say that there is no evidence of erosion, sunburnt stems, or windthrow. It is still too early to adequately assess these matters, however, as well as any assessment of growth.

C. Project Reports

Monitoring of the structures during the first year should be done at high and low flows. Monitoring of the vegetation work can be done after the growing season.

Mid-June to September	Monitor existing structures and progress of vegetation work.
September 30, 1996	Final Project Report.

COORDINATION AND INTEGRATED OF RESEARCH EFFORT

Not applicable.

ENVIRONMENTAL COMPLIANCE

NEPA work on this project has been completed.

PERSONNEL

Ken Hodges will carry out the project, analyze data and write reports. He is a fisheries biologist on the Cordova Ranger District. He has a B.S. degree in fisheries from Humboldt State University. Before coming to the District in 1989, he had worked as a seasonal employee for the Oregon Dept. of Fish and Wildlife and conducted a one-year study on steelhead genetics in Northern California. In Cordova he has worked as a fisheries technician and now as a biologist.

Project Leader:

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Date Prepared

LITERATURE CITED

CHAMBERLIN, T.W., R.D. HJARR, and F.H. EVEREST. 1991. Timber harvesting, silviculture, and watershed processes. In W.R. Meehan (ed.) Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19. Bethesda, Maryland. 1991.

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FULLER, D.D. 1990. Seasonal utilization of instream boulder structures by anadromous salmon*eds in Hurdygurdy Creek, California. USDA Forest Service Pacific Southwest Region. Fish Habitat Relationship Technical Bulletin no. 3.

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HOUSE, R.A. and PL. BOEHNE. 1986. Effects of instream structures on salmonid habitat and populations in Tobe Creek, Oregon. North American Journal of Fisheries Management 6:38-46.

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SMITH, R.D., R.C. SIDLE, and P.E. PORTER. 1993. Effects on bedload transport of experimental removal of woody debris from a forest gravel-bed stream. Earth Surface Processes and Landforms, vol. 18, 455-468.

SWANSTON, D.N. 1991. Natural processes. In W.R. Meehan (ed.) Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19. Bethesda, Maryland. 1991.

8/25/95 Version

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1995 - September 30, 1996

Budget Category:	Authorized FFY 1995	Proposed FFY 1996						
Personnel	$31.7	$7.7						
Travel		$0.0						
Contractual	$4.2	$0.6						
Commodities	$1.8	$0.2						
Equipment	$3.5	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$41.2	$8.5	Estimated FFY 1997	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002
General Administration	$5.0	$1.2						
Project Total	$46.2	$9.7						
Full-time Equivalents (FTE)		0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: This project is a follow up to 94139, 95139C.

1996

Prepared:

Project Number: 96139C1
Project Title: Montague Riparian Rehabilitation Monitoring Program
Agency: USFS

FORM 3A
AGENCY
PROJECT
DETAIL

8/4/95

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1996
	D. Schmid	Fish Biol.ogist	GS-11/4	0.8	4,362		3.5
	K.Hodges	Fish Biol.ogist	GS-9/3	0.5	3,614		1.8
*	R. Thompson	Program Manager	GS-13	0.2	5,928		1.2
	Vacant	Fish Tech	GS-7	0.5	2,300		1.2
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
		Subtotal		2.0	16,204	0	
Those costs associated with program management should be indicated by placement of an *.						Personnel Total	$7.7

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM	Description	Price	Trips	Days	Per Diem	FFY 1996
	RT Cordova to Anchorage	224			225	0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					Travel Total	$0.0

1996

Project Number: 96139C1
Project Title: Montague Riparian Rehabilitation Monitoring Program
Agency: USFS

FORM 3B
Personnel
& Travel
DETAIL

8/4/95

1996 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

Contractual Costs:	Proposed
Description	FFY 1996
Air Charter, Cordova to Montague, 3 **RT** @ $400/ hour 4 hours/ trip	
Boat Rent	0.6
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$0.6

Commodities Costs:	Proposed
Description	FFY 1996
field food, 14 days @ $15/ day	0.2
misc. supplies and materials	
Printing	
Commodities Total	$0.2

1996

Project Number: 96139C1
Project Title: Montague Riparian Rehabilitation Monitoring Program
Agency: USFS

FORM 3B
Contractual & Commodities
DETAIL

8/4/95

1996 EXXON VALDEZ TRU E COUNCIL PROJECT BUDGET
October 1, 1995 - September 30, 1996

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1996
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1996

Project Number: 96139C1
Project Title: Montague Riparian Rehabilitation Monitoring Program
Agency: USFS

FORM 3B
Equipment
DETAIL

8/4/95

96139C2

Salmon Instream Habitat and Stock Restoration - Lowe River and Valdez Arm Drainages

FY 96 DETAILED PROJECT DESCRIPTION

Project ID number:	96139C2
Restoration Category:	General Restoration
Proposer:	Alaska Department of Fish and Game
Lead Trustee Agency:	Alaska Department of Fish and Game
Cooperating Agencies:	United States Forest Service
Duration:	January, 1998
Cost FY96:	$174.6
Cost FY97:	$
Cost FY98:	$
Geographic Area:	Prince William Sound
Injured Resource/Service:	The project is intended to mitigate for injured salmon resources and lost sport fishing opportunities.

INTRODUCTION

Valdez Arm in Prince William Sound supports several popular salt water sport fisheries as well as significant commercial fisheries. Currently, however angling opportunities in freshwater are limited as the majority of the freshwater systems are currently closed to sport fishing. Within the Valdez Arm area there is potential for habitat modifications that could improve or restore freshwater rearing and spawning habitat to increase populations of wild-stock sport fish species. Another restoration project (95139) was previously approved and funded to construct a salmon spawning channel adjacent to the Lowe River at mile 6.5 of the Richardson Highway. This project opportunity was identified after several years of site selection (Willette, et al, 1993) and evaluation (Willette, et al, 1994). It was approved for construction during FY 1995; however, during the public review process of the Draft Environmental Assessment (EA) (Chalk, 1994), several concerns were identified. Consequently, progress for the completion of the EA and the construction plan was halted until these concerns are resolved. This displaced planned field work and construction during FY1995 and has altered the plan of work.

The purpose of this FY 1996 project is to expand the scope of restoration options Valdez Arm through in-depth habitat evaluation throughout the area. This project will include evaluation of natural rearing and spawning habitat, and look at the potential for restoring habitat lost through previous activities in the area. An example of restoring habitat lost to previous activities is Robe Lake where rearing habitat for salmonids and overwintering habitat for Dolly Varden was lost when feeder streams were diverted resulting in increased siltation. Other habitat modifications could include enhanced rearing areas through opening access to areas that are currently inaccessible, to create additional rearing habitat or to develop spawning channels as identified in Restoration Project 95139. This project is also intended to address the concerns identified in the public review of the Draft EA.

The scope of work proposed for FY1996 will include additional field studies to address concerns identified from the Draft EA for the Lowe River spawning channel:

a. Determine the factors that may limit salmon production in Valdez arm drainages (e.g., spawning or rearing, habitat, escapement, etc.)

b. Re-evaluate the planning assumptions and design criteria for the proposed Lowe River spawning channel

NEED FOR THE PROJECT

A. Statement of the Problem

As a result of the *Exxon Valdez* oil spill, salmon species and Dolly Varden were identified as injured resources. Both sport and commercial fishing were identified as lost services. Although the fish populations, the fish habitat and the sport and commercial fisheries of Valdez Arm were not directly affected by the oil spill, development of new habitat and, therefore, wild-stock fish populations and fisheries, will indirectly restore these stocks and the services they provide.

B. Rationale

This project should be considered as a means to restore injured wild stocks in the Prince William Sound oil spill area. Although Valdez Arm stocks were not oiled, all stocks in the spill area were affected in some manner and restoration efforts in this area will indirectly benefit other wild stocks. In addition, fish produced will provide a potential to replace lost services for sport fishing opportunities and some lost services for commercial fishing opportunities.

Recovery objectives for salmon and Dolly Varden will be addressed by improving or providing new spawning or rearing habitat for these species. Restored spawning and rearing habitat and restored populations will provide new fish to meet objectives to supplement lost sport and commercial fishing and angling opportunities. Tourism and recreation recovery objectives will also be addressed because the restored spawning and rearing habitat and fish populations are expected to be available from the Richardson Highway. Recreational, tourist and public education facilities can be incorporated into the design phase of project identified. Previously, few restoration projects that benefit fish, fishing, recreation or tourist restoration objectives adjacent to a road system have been funded by the TC.

C. SUMMARY OF MAJOR HYPOTHESES AND OBJECTIVES

Specific objectives of this proposed project during FY 1996 include:

a. Perform a "limiting factors analysis" in Valdez Arm drainages to determine the quantity and quality of spawning and rearing habitat for salmon, Dolly Varden and cutthroat trout.

b. Identify potential projects to enhance rearing or spawning habitat of salmon species and Dolly Varden.

FY 1996, habitat inventory and project identification
FY 1997, additional project identification and design
FY 1998, continued project design and implementation; monitoring and evaluation of the projects
FY 1999 - FY??, monitoring and evaluation of the projects, to assure that objectives are being met.

COMMUNITY INVOLVEMENT

Direct community involvement is not expected with this project, however, local knowledge about historical populations of salmon, Dolly Varden and cutthroat trout will be considered and incorporated with objective data as the quality, quantity and distribution of the habitat is evaluated.

FY96 BUDGET

Personel	95.0
Travel -	10.0
Contractual	20.0
Commodities	25.0
Equipment	9.0
Subtotal	159.0
Gen. Admin.	15.6
Total	174.6

References:

Chalk, K. 1994. Mile 6.5 Richardson Highway Spawning Channels. Draft Environmental Assessment.

Willette, M., N. Dudiak, S. Honnold and K. Wedemeyer. 1993. Survey and Evaluation of Instream Habitat and Stock Restoration Techniques for Wild Pink and Chum Salmon. Project No. R105, 1992 Draft Status Report. Exxon Valdez Trustee Council. 78pp.

Willette, M., N. Dudiak and S. Honnold. 1994. Survey and Evaluation of Instream Habitat and Stock Restoration Techniques for Wild Pink and Chum Salmon. Project No. 93063. Exxon Valdez Trustee Council.

ADDITIONAL DETAILS FOR THE DPD AND THE DETAILED BUDGET WILL BE AVAILABLE SHORTLY.

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