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

Project Number:	99341
Restoration Category:	Research
Proposer:	University of Alaska Fairbanks
Lead Trustee Agency:	ADFG
Cooperating Agencies:	none
Alaska SeaLife Center:	yes
Duration:	2nd year, 4-year project
Cost FY 99:	$124,700
Cost FY 00:	$124,100
Cost FY 01:	$85,400
Cost FY 02:	none
Geographic Area:	Kenai Peninsula, Seward
Injured Resource/Service:	Harbor seal

ABSTRACT

This program continues a long-term study that will quantify the impact of feeding specific fish diets on the health and body condition of harbor seals. The ability to conduct such investigations, under controlled conditions, is now available at the Alaska SeaLife Center. This program will establish whether specific diets are nutritionally adequate to maintain seal health. Even though health status biomarkers for marine mammals in Prince William Sound were established during EVOS supported field trials, the critical test of how each marker varies in an individual as a result of a specific prey item has not been established. While this project will focus on the issue of harbor seal health, the approach is potentially applicable to any of the injured top predators.

INTRODUCTION

An underlying component of the ecosystem-based research approach supported by the Trustee Council has been the hypothesis that food limitation could be inhibiting the recovery of injured species in the Prince William Sound (PWS). Inherent in this concept is the assumption that food stressed animals can be distinguished by population-wide surveys of critical health parameters. Following this approach, an extensive sampling effort by multiple projects established a series of biomarkers used to profile the health and body condition of wild populations of marine mammals inside PWS. Population health status and body condition indices were, and continue to be, developed and tested for a range of birds, sea otters and seals. On the basis of this wide-ranging effort, reference range values for these health parameters have been established and are being used to compare whole groups of animals across time and space (1–8). This approach is critical to understanding how these markers work on a population health level.

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

The Trustee Council has supported the population monitoring component of health biomarkers for marine mammals in Prince William Sound. Now, with the creation of the Alaska SeaLife Center (ASLC) in Seward, we are in the position to test those biomarkers under controlled conditions, in the same animals over time (particularly seasonally) and under changing experimental conditions. Of particular interest will be the effect of specific diets on harbor seal physiology. This will address the questions of food limitation more completely, including the suggestion that certain prey may not be nutritionally adequate. Work on birds using the basic elements of this concept has already been initiated (6).

Preliminary work has begun at the University of Alaska Fairbanks (Project 98431) to establish scientific protocols for assessing the assimilation efficiency of harbor seals fed different diets. Steve Trumble (Ph.D. student associated with this project) has been working with Dr. P. Barboza at the University of Alaska to learn tracer techniques which will allow measurement of assimilation efficiency. In addition, he has participated in two field expeditions (supported by ADF&G) in which he was responsible for measuring health biomarkers in harbor seal pups. Feeding protocols have been established in conjunction with the ASLC veterinarian and pinniped

staff. The Alaska SeaLife Center will take possession of eight harbor seals during April 1998 and the preliminary acclimation and monitoring phase of the study will begin. The animals will be closely monitored (weight, morphometrics and weekly blood samples) during acclimation and, starting in September, animals will be placed on experimental diets of specific prey items.

NEED FOR THE PROJECT

A. Statement of Problem

The Restoration Program has established a strong field component that has tested a series of health and body condition biomarkers for many of the top-level predators in the Sound (2, 3, 5–7), including harbor seals (1, 4, 8). Many of these indices are related to metabolic alterations that might occur in animals that are food limited, or stressed. These include markers for fat, protein and carbohydrate metabolism (fatty acid patterns, blood urea nitrogen, ketone bodies, glucose), water balance (plasma and whole blood water), blubber quality in harbor seals (energetic density, lipid distribution, histology) and total body fat. Other markers have addressed more health or contaminant related issues such as indicators of oil contamination (P450, PAH), whole body inflammatory response (haptoglobin, interleukin), organic residue contamination (PCB) and clinical indicators of disease state (clinical chemistry panels, blood hemograms).

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

B. Rationale/Link to Restoration

The rationale for this project is if we theorize that various health and body condition markers react in the field to ecosystem wide changes in food availability or animal health, then we should be able to quantify those mechanisms in the laboratory under controlled conditions. The SeaLife Center will have research animals that are healthy and can be put onto differing diets of specific prey and it will have sick animals that are brought in for rehabilitation. Both groups will allow us to examine how these health markers respond to food and health status. Experiments following the same conceptual protocol have been carried out in Europe on harbor seals fed diets of fish that differed in contaminant loads (9). In those studies, it was found that seals fed contaminated fish showed measurable decreases in immune function. In this proposal, we do not suggest feeding contaminated fish, but rather fish of differing energy densities (pollock, herring, salmon and groundfish) and monitoring sick animals that are at the Center for rehabilitation. These "rehab" animals represent seals whose ability to survive in the wild has been compromised and they present a unique view into the biology of "sick" animals that may have been under-represented in our field studies in the Sound (8).

An additional rationale concerns the "junk food" hypothesis. One of the most popular hypotheses concerning the cause for the decline of marine mammals and birds in Alaskan waters was first voiced at a Sea Grant sponsored workshop in 1991 on whether or not food limitation could account for the observed population patterns (10). At that workshop, the "junk food" hypothesis was proposed. This thesis stated that Alaskan waters had a sufficient biomass of pollock to support the harbor seals and Steller sea lions populations, ***but*** pollock was nutritionally poor compared to other less common species, such as herring and capelin. Because the marine ecosystem of Alaska experienced a "regime shift" in the late 1970s that moved the system from a groundfish/herring based food web to a pollock dominated food web, the high-energy food that pinnipeds used to eat simply disappeared. Thus, the hypothesis proposes that seals and sea lions may be starving in a sea full of pollock. The presence of The Alaska SeaLife Center will allow us to critically test this hypothesis.

C. Location

The experiments for this work will be conducted at the Alaska SeaLife Center in Seward. Similar experiments are proposed for birds and sea otters. Thus, there should be considerable collaboration between the projects and the possibility of significant sharing of resources and personnel. The Principal Investigator (Castellini) has also proposed a program to the National Science Foundation for support to conduct identical experiments on Steller sea lions and northern fur seals at the Center.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The field work on harbor seals has involved integral collaboration with Native communities throughout the Gulf region in conjunction with the BIOSAMPLING program (Project /244) and we anticipate Native collaboration to continue. Given that the Alaska SeaLife Center, the EVOS Trustee Council, the Alaska Native Science Commission and the Alaska Native Harbor Seal Commission are all currently working on joint scientific collaboration, we expect this project to include involvement with Native communities. Since harbor seals are important food items for these communities, it is likely that the results of this work will be of interest to the Alaska Native Harbor Seal Commission. The findings of this and previously funded studies have been, and will continue to be, shared with the Native communities at the Alaska Native Harbor Seal Commission meetings.

An important mission of the Alaska SeaLife Center is to educate the public about unique Alaskan habitats and the importance of stewardship. It will spotlight the role that research plays in understanding and contributing to the stewardship of that environment. Research done at the SeaLife Center will be highly visible both to local communities as well as thousands of visitors each year.

PROJECT DESIGN

A. Objectives

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

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

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

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

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

B. Methods

Feeding schedules and timing patterns of controlled diets are currently being developed in conjunction with the ASLC veterinarian and pinniped staff. It is understood that there may be other research personnel interested in taking advantage of controlled diet protocols and it is our expectation to accommodate these additional needs.

The first of eight harbor seals are scheduled to arrive at the ASLC during April 1998. During the initial acclimation period the animals' body condition, health and blood chemistry biomarkers will be monitored. Groups of seals will begin exposure to experimental diets in September, 1998.

Summary of measurement schedule:

Every two days:	Mass
Additionally, every week:	Blood samples, length, girth
Additionally, every two weeks:	Blubber depth
Additionally, every month:	Whole body impedance
Additionally, every six months:	Plasma volume, water space

Food maintenance trials

The basic premise of the feeding protocol will be to maintain mass or growth rate. There are several considerations which must be addressed:

- In any captive situation, the behavior of the pinniped may influence feeding patterns, especially if the diet changes in palatability (11). Fortunately for this study, all of the fish species are part of the natural diet of harbor seals. In addition, feeding trials will extend for months and trainers will work with the animals continually on feeding behavior. In the event that an animal initially rejects a species during feeding trials, we will work with the trainers and handlers on whatever

feeding modifications would be necessary to ensure that the long-term experiments are successful. In addition, the effect of air and water temperature on feeding rates (10, 11) will be monitored.

In a captive situation, the feeding frequency during any given day impacts issues such as satiation, over-feeding, etc. We well feed the animals 4–6 times per day to avoid the problems of over-feeding at any single meal. True *ad lib* feeding is a difficult behavioral and mechanistic issue with captive pinnipeds and most husbandry protocols simply rely on feeding twice per day. Without knowledge of the passage rate and assimilation of specific prey, we cannot be sure that two feeding bouts per day would be adequate. Frequency of feeding versus assimilation and metabolizable intake will be assessed during the early phases of each feeding trial. We will work with the trainers and husbandry personnel to maintain a regular and adequate food intake and make sure that the animals are fed at the same time each day (13).

An additional consideration is the number of animals per feeding trial. As noted below, we will stagger animals through these long-term feeding schedules, however, three to six animals per trial are commonly used (13) and considered adequate for determinations of digestive efficiency.

Long-term alterations in the basic metabolic needs of the animals will occur as a result of annual cycles (e.g., molting) and even longer-term growth (some of the seals in this study will be sub-adults). The metabolic demand of phocids varies throughout the year (14). We assume that the absolute number of maintenance calories per unit time will change seasonally or over several years. Therefore, we must be able to factor that change into any nutritional limitations of the food itself. It is known that the growth of an individual over time can be described as a sigmoid curve in which most of the growth occurs during a relatively linear intermediate phase, whereas the caloric content of the gain during growth increases curvilinearly as body weight increases. This is especially true for young seals (15). We must measure these long-term changes to accurately interpret the biochemical profiles obtained in the field data. To offset these problems we will implement a staggered feeding regime. We will separate the seals into two or three groups, one feeding on a different food item than the other. Each group will feed on a given food item for at least three months, then alternate with another group at the end of each three-month trial. These feeding trials will continue for up to two years, exposing each animal to various seasonal or yearly cycles with each prey species. This will provide standard deviations in assimilation efficiency, digestive efficiency and metabolizable energy while minimizing potential errors associated with temporal fluctuations (season or year) in growth or metabolism (e.g., molting) and confounding errors associated with each prey item during a particular feeding trial. Although staggered feeding methods have been utilized in captive bird studies (16) few data exist on long-term assimilation studies for captive marine mammals.

The final issue is the application of laboratory data to the field environment. *We are not proposing to model the metabolic demands of harbor seals in the wild.* The stresses and food requirements of wild populations are very different from captive animals. Instead, we are investigating the metabolic response to differing diets and the effect of these diets on blood chemistry, blubber physiology and body condition of these animals. That is, we do not seek to model how may calories an animal may consume per month and apply that to field estimates of mass of fish consumed at sea. *We will quantify how blood chemistry biomarkers change when an animal is fed several different kinds of fish and compare those chemical changes to observed*

patterns already collected from wild populations. For example, we know different populations of sea lions exhibit circulating red cell hemoglobin concentrations (MCHC) that vary significantly from one another. This study is designed to investigate whether fish diets and seasonal alterations in food demand impact these chemical levels.

Given these considerations, the staggered feeding protocol described above will be implemented approximately six months after stable diets have been established by the attending husbandry personnel and will continue for 24 months.

Body condition, health and blood chemistry alterations

As soon as the seals have been established on their initial diets, we will commence the collection of samples for condition and health.

BODY CONDITION

Seals will be weighed every two days. Some of the harbor seals are already trained to walk onto load scales to obtain mass measurements. The trainers will work with the additional seals to establish the same behaviors. Every week, additional measurements of length and girth will be collected and blubber depth measurements will be taken every two weeks. Blubber thickness is measured using portable ultrasound techniques. Every month, whole body bio-impedance (BIA) will be used as a proxy for water content and every six months this technique will be calibrated with labeled water. In this technique, deuterated water (D_2O) is injected into the seal, allowed to equilibrate with the total body water and then blood samples are drawn to measure D_2O dilution. This is a routine procedure for body water determination and we have used it on both Steller sea lions and harbor seals. There are conflicting views of whether BIA accurately reflects total body water in pinnipeds (17), but our current research with Steller sea lions suggests it is reliable over the changes that would occur seasonally or with development. At the same time the D_2O experiments are conducted, total plasma volume will be determined using Evan's Blue dilution techniques. In order to facilitate the field/laboratory comparisons, these morphological indices are the same as those we developed for use on wild populations of pinnipeds. Models of the most sensitive indicators for the field animals exist for harbor seals (1, 8, 18).

BLOOD CHEMISTRY

To date, we have a database of blood indices from over 400 adult harbor seals and 50 harbor seal pups as well as 300 Weddell seals, 400 Steller sea lion pups, 20 Steller sea lion juveniles and over 80 Steller sea lion adults collected under field conditions. These indices include not only clinical veterinary panels of blood chemistry and hematology, but also additional indicators we have developed for specialized use on pinnipeds.

Blood samples will be collected every week from each animal throughout the duration of the study. The blood sample is taken from the extradural sinus directly into the appropriate vacuum collection tube. We routinely take blood into both EDTA (for hematology) and heparin tubes (for chemistry). The blood will be analyzed on site for most of the metabolites and hematological parameters of interest.

One of the implications of the junk food hypothesis is that the impacted animals are nutritionally stressed. Therefore, we have developed a series of blood indicators for fieldwork that provides a profile of the fasting and starvation status of pinnipeds. These markers include *ketone bodies*

(metabolites produced to support neural function in the face of decreasing food intake), *blood urea nitrogen* (marker for increased muscle tissue degradation during starvation), *differential fatty acid utilization* (selective utilization of fat from lipid stores in the blubber during fasting), *water balance* in the plasma (particularly sensitive as pups gain nutritional independence) and red cell characteristics including *hemoglobin content/cell* and *mean cell volume*. We have found these markers to be useful in determining whether or not pinnipeds are feeding, fasting, or entering starvation in the wild (19, 20, 21). However, we need to verify with controlled studies that different feeding regimes can alter these metabolites. Recent work with wild harbor seals in Scotland suggests that switching from a herring to cod-based diet is correlated with several of these markers (22). The captive studies are critical to test whether differing diet alters blood chemistry for these markers.

Nutritional assimilation

Estimating prey or nutritional requirements of a predator using an energy model necessitates that assimilation efficiency be quantified (23). Assimilation efficiency (AE), which is defined as the proportion of dry matter assimilated from a prey source, is influenced by food quality, meal size, feeding frequency and digestive passage rate (24, 25). Recent studies have suggested that assimilation efficiency is low when food quality is low (16, 26). For example, harp seals (*Phoca groenlandica*) fed Atlantic herring or capelin had a higher AE, and consumed less food, than those fed invertebrates of lower energy density (26). However, conflicting results have been reported for harbor seals (14) and northern fur seals (11), while studies of California sea lions fed pollock did not show a significant decrease in AE with lower energy density food, such as pollock (27).

During the feeding experiments to quantify assimilation efficiency and metabolizable energy (ME), captive seals will be fed a diet of one primary prey item, keeping other variables such as meal size and feeding frequency constant. The design and interpretation of feeding experiments will take into account the potential effects of seasonal variation in AE and ME and this is discussed above in the feeding trial design using staggered schedules. Each group of animals will be moved from wet to dry holding areas at the ASLC so that fecal samples can be collected as necessary.

For all animals, dietary prey and fecal samples will be freeze-dried and analyzed for energy (cal/g), nitrogen, total lipid, and ash. Routine bomb calorimetry will be used for energy density, nitrogen (protein) concentration will be determined using a carbon–nitrogen auto-analyzer, total lipid by Soxhlet extraction and ash by muffle furnace combustion. All these methods are routinely used at the UAF facilities and will be available at the SeaLife Center.

To determine digestibility of food absorbed in the digestive tract of seals, manganese (Mn^{2+}) concentrations will be measured using subsamples of prey items fed to individual animals and from their fecal samples. Mn^{2+} is used as a naturally occurring, inassimilable dietary marker. Its use has been applied to pinniped AE studies (27, 28). Differences in the Mn^{2+} concentrations between diet and feces will be used to calculate AE. Mn^{2+} concentrations will be determined using atomic absorption spectrophotometry (28). The tissue samples will be extracted in our own laboratory and then sent to commercial facilities for elemental analysis.

In order to determine the passage of digesta (mean retention time), feces will be collected during the feeding experiment. Rate of passage of digesta is one of the important factors that determines the efficiency of utilization of food (29). It has been documented in birds that the retention time of food in the gut is a function of food quality (30). In pinnipeds, such as the harbor seal, data indicate both high caloric prey items with soft parts and low caloric prey species have the fastest transit times through the digestive tract (31). However, the assimilation efficiency of the prey items fed to these seals was not known. Miller (11) reported that the passage rate of digesta in sub-adult female northern fur seals was rapid, although the AE appeared to be consistently high for the different prey items. Mean retention time will be calculated in order to examine its relationship with AE. If prey size and feeding frequency are equal in all trials, prey items with higher energy value should have shorter retention times and pass through the digestive tract more quickly. Methods that will be used will include inert prey/feces markers such as carmine red or stable isotopes to estimate emptying time of the stomach.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The Marine Mammal Protection Act permit and internal UAF Institutional Animal Care and Use Committee application required for this project have been approved. The internal ASLC Institutional Animal Care and Use Committee application is currently being reviewed.

SCHEDULE

A. Measurable Project Tasks for FY 99 (October 1, 1998 – September 30, 1999)

We predict that each feeding trial will take several months and work with sick animals may occur at any time of the year. We anticipate that newly arrived harbor seals will be fully acclimated to their new environment and available for experimental feeding trials in September of 1998.

October–November:	Continue Trial 1 of staggered feeding protocol, monitoring condition and health of seals. Assimilation efficiency experiments.
December–February:	Trial 2 of staggered feeding protocol, monitoring condition and health of seals. Assimilation efficiency experiments.
March–May:	Trial 3 of staggered feeding protocol, monitoring condition and health of seals. Assimilation efficiency experiments.
June–August:	Trial 4 of staggered feeding protocol, monitoring condition and health of seals. Assimilation efficiency experiments. Health surveys of stranded and rehabilitation harbor seal pups.
September:	Begin Trial 5 of staggered feeding protocol, monitoring condition and health of seals. Assimilation efficiency experiments.

B. Project Milestones and Endpoints

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

FY 99: First full year of feeding trials on several species of fish; second year of stranded pups and/or rehabilitation animals.

FY 00: Full year of feeding trials on remaining species of fish or re-trials of previous runs; third year of pups and/or rehabilitation animals.

FY 01: Wrap-up of protocols, close out project, final reports.

C. Completion Date

This project will finish on September 30, 2001.

PUBLICATIONS AND REPORTS

During FY 98 we anticipate publishing short papers on how several of the health biomarkers change through seasons, in healthy vs sick animals, etc., with more comprehensive articles appearing in later years, once feeding trials have been completed.

PROFESSIONAL CONFERENCES

The PI requests funds to attend a major medical conference each year to work with colleagues who follow such biomarkers in human health studies. Dr. Castellini has a long history of participating in these meetings (Experimental Biology) and they occur each April. Work on this project will be presented at these meetings as well as at the 10th anniversary EVOS meeting in March 1999 and the Alaska Native Harbor Seal Commission meeting in March 1999.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

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

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This proposal is a continuation of Project 98341 with no changes proposed from the original plan. While FY 98 focused on preparation for arrival, acclimation and initial monitoring of research animals at the ASLC, the FY 99 DPD focuses on initiation of feeding trials with these

animals. This follows the initially proposed time-line in the FY 98 DPD. Experimental protocols for measuring AE are currently being validated and no changes to the protocols are anticipated although additional information about methodology has been provided.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

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

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

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OTHER KEY PERSONNEL

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

Steve Trumble received his M.S. degree in 1995 from California State University Fresno (Moss Landing Marine Laboratory) where he worked on the feeding pattern and lactation habits of harbor seals. He has completed work on the first year of a UAF Rasmuson Fisheries Research Fellowship for his proposed Ph.D. thesis on feeding patterns and health issues for harbor seals in Alaska. This proposal deals with the laboratory component of his thesis and support from ADF&G covers the field component. He has completed two field seasons investigating health and development of harbor seal pups at Tugidak Island, Alaska. No salary is requested as it is covered by the Rasmuson Fellowship.

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

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1999 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 – September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel	$67.5	$73.3
Travel	$15.0	$8.7
Contractual	$11.1	$11.8
Commodities	$5.0	$6.0
Equipment		
Subtotal	$98.6	$99.8
Indirect	$24.8	$24.9
Project Total	$123.4	$124.7
Full-time Equivalents (FTE)	2.4	2.5
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Dollar amounts are shown in thousands of dollars.

Estimated FY 2000	Estimated FY 2001	Estimated FY 2002
$124.1	$85.4	

Comments:

The indirect rate is 25% TDC, as negotiated by the *Exxon Valdez* Oil Spill Trustee Council with the University of Alaska.

Student personnel costs include resident tuition of $2,916 per year each.

Travel to Anchorage for EVOS activities is by shuttle bus.

FY 99

Project Number: 99341
Project Title: Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet
Name: University of Alaska Fairbanks

FORM 4A
Non-Trustee
SUMMARY

Prepared: 4/9/98

1999 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 – September 30, 1999

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1999
	Castellini, M.	Principal Investigator/Assoc. Professor	3.0	8.4		25.2
	Castellini, J. M.	Research Associate	3.0	4.3		12.9
	TBN	Ph.D. Student	12.0	1.6		19.2
	TBN	M.S. Student	12.0	1.3		15.6
		Adjustment to recognize rounding				0.4
		Subtotal	30.0	15.6	0.0	
					Personnel Total	$73.3

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1999
	Seward to Anchorage for annual EVOS meeting	0.1	2	10	0.1	1.2
	Seward to Anchorage for EVOS workshop	0.1	1	5	0.1	0.6
	Seward to Fairbanks to oversee and carry out chemical analyses	0.3	6	24	0.1	4.2
	Anchorage to Sitka for Alaska Native Harbor Seal Commission Meeting in March (to share findings with Native communities)	0.5	1	3	0.1	0.8
	Seward to Washington DC to be a presenter at the annual Experimental Biology Meeting in April	0.9	1	5	0.2	1.9
					Travel Total	$8.7

FY 99

Project Number: 99341
Project Title: Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet
Name: University of Alaska Fairbanks

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 4/9/98

1999 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET

October 1, 1998 – September 30, 1999

Contractual Costs:	Proposed
Description	FY 1999
Publication/dissemination costs	1.0
Communications	0.8
Postage, shipping, freight	1.0
Contractual services (blood – veterinary analysis)	6.0
Contractual services (additional animal services)	3.0
Contractual Total	$11.8

Commodities Costs:	Proposed
Description	FY 1999
Laboratory expendables for collection of blood samples	3.0
Laboratory expendables for analysis of blood samples	3.0
Commodities Total	$6.0

FY 99

Project Number: 99341
Project Title: Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet
Name: University of Alaska Fairbanks

FORM 4B
Contractual & Commodities DETAIL

Prepared: 4/9/98

1999 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1998 – September 30, 1999

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 1999
Those purchases associated with replacement equipment should be indicated by placement with an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	
Description	of Units	
		[redacted]

FY 99

Project Number: 99341
Project Title: Harbor Seal Recovery. Phase II: Controlled Studies of Health and Diet
Name: University of Alaska Fairbanks

FORM 4B
Equipment
DETAIL

Prepared: 4/9/98

Project Title: **Publication of a Indexed Bibliography of the Genus *Ammodytes* (Sand Lance)**

Project Number: 99346

Cooperating Agencies: U.S. Forest Service, U.S.G.S.

Cost FY 98: $5,400

Cost FY 99: $9,600

This is a request for additional funding to cover the cost of publication because the bibliography is much larger than our original estimate (about 3 times larger). We have now completed the literature search and all references and available abstracts have been entered into a word processing document. Key wording and initial clean-up has been completed for about 25% of the manuscript. This manuscript includes about 2,000 references and will total about 440 pages, single space. The final publication will include two additional chapters, in addition to the bibliography -- a review of sand lance biology and sand lance as a cornerstone species. Both of these review chapters should enhance the value of the bibliography considerably. The chapter on sand lance as a cornerstone species is nearly complete and the chapter on sand lance biology is being written.

The manuscript will be published as a General Technical Report by the U.S. Forest Service, Pacific Northwest Research Station. We have attached an estimate of publication cost from the Communications Group of the Pacific Northwest Research Station. Our request includes an additional $1,000 to cover the cost of secretarial help.

Completion Date

Final report will be submitted to the Senior Scientist for review in October 98. Publication date will depend on reviews and printer schedule--we estimate in spring of 1999.

Publications and Reports

Overall publication as a U.S. Forest Service, Pacific Northwest Research Station, General Technical Report will include three chapters.

Chapter 1: Robards, M.D. et. al. A Review of Sand Lance Biology.

Chapter 2: Willson, M.F., Armstrong, R.H., Robards, M.D. and J.F. Piatt. Sand Lance as 'Cornerstone Species' for Predator Populations.

Chapter 3: Armstrong, R.H.; Robards, M.D.; and M.F. Willson. Indexed Bibliography of the Genus *Ammodytes* (Sand Lance).

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FROM: Karen Esterholdt

Number of pages, including this FAX cover sheet: 1

If you do not receive all pages, please call: _____ at: _____

Description, comments, special instructions:

The bid for the bibliography was $13,900 or $11.58 per copy. Both Cheryl and I feel this is high. I think $10 will be plenty or $12,000 for 1200 copies. If we need more than the minimum number, go from there. KE

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99347

FATTY ACID PROFILE AND LIPID CLASS ANALYSIS FOR ESTIMATING DIET COMPOSITION AND QUALITY AT DIFFERENT TROPHIC LEVELS

Project Number:	99347
Restoration Category:	Research Monitoring
Proposer:	Ron A. Heintz, M. Larsen NMFS, Auke Bay Laboratory ABL Project Manager: Dr. Stan Rice NOAA Program Manager: Bruce Wright
Lead Trustee Agency:	NOAA
Alaska Sea Life Center:	No
Duration:	2nd year, of 3-year project
Cost FY 99:	$105.4
Cost FY 00:	$35.8
Geographic Area:	Prince William Sound, Lower Cook Inlet
Injured Resource/Service:	Various

ABSTRACT

This project begins the systematic development of fatty acid profiles and lipid class analysis to identify diet differences and quality in forage fish and their prey. Specifically we propose to examine the spatial and temporal variability of fatty acid profiles in herring, sandlance, and zooplankton, and relate this to the nutritional condition of these important forage fish. In FY98 we began the spatial comparisons which will provide insight into the energetic differences in forage fish in disparate parts of PWS. These comparisons are based on samples collected by APEX study 193A. In FY99 we propose making temporal comparisons which will provide information on the energetic changes that inevitably occur with seasonal, ontogenetic, and reproductive changes. Again, these comparisons will be made with samples collected by APEX investigators. Results of these studies will benefit APEX investigators by demonstrating the utility of fatty acid analysis for establishing dietary and energetic differences between aggregates of forage fish.

INTRODUCTION

This project seeks to extend the utility of fatty acid (FA) analysis for estimating diet composition, by relating FA compositions in forage fish to their prey and examining the nutritional condition of these animals through lipid class analysis. Iverson et al (in press) have indicated that FA profiles in seals in Prince William Sound (PWS) reflect the profiles found in their prey. In view of its promise, the utility of FA analysis for estimating diet composition warrants investigation in other predators.

Before FA analysis for estimating diet composition can be extended, the basic assumption that a predator's FA composition resembles its prey requires demonstration and the sources of variation underlying the FA composition need to be described. The basic assumption has been investigated under laboratory conditions, but not tested in the field. This assumption indicates the sources of variation in the FA profiles of their prey must be quantified because a predator's FA profile will be influenced by the FA available in its foraging range. In fact, Iverson et al. (In press) reported spatial and ontogenetic variation in herring FA profiles, but the spatial and temporal scales of this variability have not been defined. Last year this project began analyzing the spatial scale of variation in herring and sandlance, this year we propose examining the temporal scale of variation in sandlance. An new unsolicited project has been proposed to demonstrate the basic assumption underlying this analysis.

FA can be viewed as the energetic currency that is exchanged when predators consume prey. After consumption, some fraction of the consumed FA are used to provide energy for the Krebs cycle, and surplus FA are distributed via the blood stream to fat depots located throughout the organism. Examination of the FA composition of the surplus FA affords an integrated view of the FA derived from a predator's prey. Iverson (in press) has concluded that changes in a predator's FA composition occur within a short time. Thus, while examination of the FA composition may provide insight into diet composition, it is important to know how sensitive this tool is to the temporal variations in diet.

Examination of the relative abundance of lipid classes in organisms provides a measure of their nutritional condition. Lipids can be classified by their structure into several classes. Each class represents lipids used for either membranes, energy reserves, structural elements or hormones. Comparing the relative abundance of the energy reserve class, triacylglycerides (TAG) in fishes and wax esters in zooplankton, to the total amount of lipid provides a measure of the relative amount of energy reserve, thus the nutritional condition of the specimen. Combining observations of dietary differences with evaluations of nutritional condition can lead to extremely powerful interpretations of efficiencies in predator prey relationships. This power is easily obtained since FA analysis for estimating prey composition is most sensitive when performed on the energy reserve portion of the total lipid composition, thus lipid class analysis is the first step to analyzing FA composition.

We propose two field surveys designed to demonstrate 1) the spatial and temporal scales of variation in the FA profiles of important forage fish in PWS and lower Cook Inlet, and 2) the analysis of FA profiles and lipid class analysis for examining the nutritional consequences for predators consuming different diets. These projects are the first steps in the systematic development of these techniques for examining broad scale trophic relationships. Specifically,

the studies provide detailed information on the spatial and temporal variability of FA profiles in sandlance as well as measuring the consequences of dietary differences by evaluating the availability of surplus energy. An objective of the first year of this study, FY98, proposed to examine the spatial variability of FA profiles of herring, sandlance, and zooplankton collected at different sites in PWS by APEX 163A investigators. These samples are currently being processed. In FY99, the temporal variability of FA will be examined by processing sandlance samples collected every 2 weeks from April through August, 1998, by APEX 163M investigators in Lower Cook Inlet. The investigation into the temporal variation will be supplemented with samples collected monthly from June through August by APEX 163E investigators working near Point Eleanor in Prince William Sound. The results of these studies will help define the spatial and temporal limits to discriminating fatty acid profiles in this important forage species.

NEED FOR THE PROJECT

A. Statement of the Problem

Trustee sponsored projects including APEX, SEA and NVP focus on understanding trophic relationships, but depend on diet information that do not adequately quantify energy transfer between predator and prey. Diet studies are typically underpowered, because parametric techniques for estimating sample sizes are not well understood (Ferry and Cailliet 1996). Even if analysis of stomach contents could provide precise estimates of diet over spatial and temporal scales, the data are biased by differences in prey digestibility and the assumption that stomach contents at collection represent diets averaged over time. Marine mammal diets are usually assessed by examining scats, which have many of the same biases as stomach contents. In addition, diet evaluation by stomach or fecal content analysis provides only an indirect method for estimating the amount of energy transferred between predator and prey, since measurements of energy density and digestibility estimate energy availability rather than energy acquisition.

FA analysis for estimating prey composition may have tremendous potential for avoiding the biases observed in stomach content or scat analysis, while lipid class analysis provides a more direct measure of energy acquisition in predators. The application of FA analysis in seals was reported in Restoration Project 95064 (Frost et al. 1996). In addition, the FA profiles in predators has been found to reflect the profiles in prey in a number of feeding studies involving herring (Gatten et al. 1983), cod (dos Santos et al. 1993), chinook salmon (Kennish et al. 1992) and pike (Schwalme 1992). However, these latter studies have been under laboratory conditions where developmental stages, diets and environments have been tightly controlled, and field application remains to be examined. Similarly, lipid class analysis coupled with FA analysis has been used to study trophic relationships in closed systems (Fraser 1987). Lipid class analysis measures nutritional condition by expressing the TAG content as a proportion of total lipid, with high proportions of TAG indicating increased amounts of storage lipid (Fraser 1987).

The success of FA analysis for estimating prey composition depends on understanding the nutritional requirements of the predator, its foraging behavior, and the FA composition of its prey. Iverson et al. (In press) demonstrated that herring in PWS have FA profiles that vary both

spatially and morphometrically. These differences are thought to arise from dietary differences in herring from different locations, and their consumption of different sized prey. Phocid seals and their prey may be a good model system for this technique since seal foraging ranges may be quite small with respect to the scale of spatial variability in their prey (Frost et al. 1996), while FA profiles of less selective predators, or predators that forage over broad spatial scales may be more difficult to match to prey. Also, establishing direct links between prey and predator is contingent on tracing the route of essential FA from prey to predator.

Systematic development of a trophic relation that can be examined by FA and lipid class analysis requires identification of essential FA in the predator, and examination of the sources of variability in the FA profiles of its prey. Essential FA are best identified in controlled feeding trials where the FA composition of the predator can be evaluated over time and related to known changes in the FA composition of its prey. Ideally, feeding trials will survey several developmental stages in the predator since, FA profiles will change in response to ontogenetic demands (Leger 1985). This examination is being proposed for sandlance under a separate title. After validating the assumption that a predators FA composition reflects its diet, the analysis of FA profiles to examine trophic relationships needs to be extended by understanding how variation in FA composition is structured spatially and temporally. It is important to know if the variation if FA composition within a local aggregate is greater or less than variation between distant aggregates because these sorts of differences provide a basis for statistically identifying aggregates. Similarly, it is important to know if the variation in FA composition of a fish aggregation sampled at a particular time is greater or less than the variation observed between two times. Also, how does the magnitude of this variation compare with variation in other species. The answers to these questions will demonstrate the utility of FA analysis for examining trophic relationships.

The structure of variation between groups identified *a priori* can be examined with existing multi variate techniques. Once the structure to variation in the FA composition has been described then the plausibility of specific models aimed at hindcasting predator diets from the FA composition of its depot fats will be known. Ideally, predator FA profiles would be compared to a library of prey profiles described for the predator's foraging range, and the relative abundance of each prey item in the predator diet would be predicted with some measure of statistical confidence. Currently Tree Structures (CHART) are used to specify prey compositions in predator diets, but no statistical confidence is associated with the compositions identified by this technique, nor are the relative contributions of the prey predicted. Development of a parametric model for hindcasting diet composition must wait until the sources of variation in prey FA profiles are better understood and essential FA identified.

B. Rationale/Link to Restoration

We propose to continue the investigation into the variability of FA profiles and nutritional condition of forage fish by expanding the scope of the project to examine temporal scales of variation. This supplements the investigation of the spatial variability of FA profiles proposed in the first year of this study. The allocation of consumed and stored energy of forage fish is dependent on the requirements of the organism as dictated by its particular life stage as

well as a number of physical environmental factors. Juvenile fish are primarily allocating their energy to growth while mature fish might be allocating energy to gonad production and fish preparing for winter dormancy are building fuel reserves. These allocations might also be influenced water temperature, physical activity, and prey availability. We propose to analyze sandlance over a time period that encompasses the period of lipid buildup, energetic allocations, and preparation for reproduction. We will investigate how these temporal changes influence the FA profile and the nutritional condition of sandlance.

APEX project 163M and 163E propose to characterize the relationships between seabird populations and forage fish densities. They will provide sandlance samples collected as part of their routine monitoring and collection cruises and will benefit from the specific energetic data proposed in this project. Also, analysis of these samples will provide APEX investigators with valuable information regarding the nutritional value of sandlance in Lower Cook Inlet and PWS. Field collections of sandlance will also address questions about the variability of FA profiles posed by Restoration Study 064 (Harbor Seals), and further complement plans made by Restoration Study 064 by providing those investigators with increased power to resolve harbor seal diets. Using the sampling design proposed by APEX we can provide investigators cost-effective analysis of energetic content and nutritional condition. Thus, the studies proposed here have direct links to a number of ongoing and proposed projects, and will also provide information that is of interest to other Trustee programs.

A stated objective of the Trustee funded APEX project is to examine the differences in forage fish diets and determine the consequences of the differences at the individual and population level. We propose to supplement the cruder evaluations of energetic content (calorimetry) in herring and sandlance proposed under the APEX studies with analysis of lipid class composition and FA profiles, since lipid class composition provides a direct measure of the energetic consequences of different diets (Fraser 1987). In this two year project examination of the FA profiles of herring, sandlance and their prey from PWS and Cook Inlet will quantify the temporal (FY99) and spatial (FY98) range of diet variability because dietary differences are thought to be reflected in FA profiles. Sampling designs by APEX investigators include fine scale sampling of sandlance, herring and their prey in PWS and Cook Inlet.

C. Location

This project depends on forage fish samples collected from lower Cook Inlet and central PWS. All the samples will be shipped to and processed in Auke Bay, Alaska.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Scientists involved in this study will regularly present progress reports and results in scientific and public forums, including the annual workshop. They will be available to talk with interested public and will provide information for Trustee Council newsletters and annual reports as appropriate. The project uses existing agency labor to process and analyze the samples.

PROJECT DESIGN

A. Objectives

The main objectives are to examine of the spatial and temporal ranges of variability in sandlance FA profiles and relate these differences to nutritional condition.

In FY98 we began the examination of spatial using samples collected in July, 1997 by APEX investigators. Young of the year herring and sandlance were collected at several locations near Naked Island in central Prince William Sound and at locations near Bainbridge Island in SW Prince William Sound. In addition, the lipid quality and composition of prey fields sampled in these two locations will also be characterized. The FA profiles and lipid class composition of the major zooplankton taxa will be evaluated. These values will be weighted by the relative abundance of these taxa (as estimated by APEX investigators) to model the FA availability in local prey fields. The hypotheses we plan to test with data acquired in FY98 are:

1. FA profiles of herring and sandlance are the same.
2. FA profiles of herring are the same regardless of the presence of sandlance.
3. FA profiles of herring are the same between the central and southern parts of PWS.
4. FA profiles of herring are the same between bays within southern PWS.

Similarly, the zooplankton tows will be analyzed and the following hypotheses tested:

5. Energy is the same between bays within a region
6. Energy is the same between the central and southern regions of PWS

In FY99 we propose to complete statistical analysis of data collected in FY98 and examine the temporal scales of variability in the FA profiles of sandlance using samples collected by APEX 163M investigators in lower Cook Inlet and APEX 163E investigators in PWS. We plan to relate these temporal changes to the developmental stage of the organism. A timed series of FA profiles from 2 separate locations provides investigators valuable information into how energy allocation is affected by ontogenetic and reproductive changes and if differences are dictated by location as well as ontogeny. Specific FY99 objectives are listed below.

1. Determine how FA profiles change in one location over time and relate those changes to the life stages of adult and juvenile sandlance.

2. Determine of temporal changes are unique to a specific area of if the changes are similar between lower Cook Inlet and PWS.

Herring have not been included in this plan because their broader foraging ranges suggest the probability of consistently sampling a herring aggregate through time is minimal. Sandlance present a low cost solution to this problem.

B. Methods

Temporal Scale of Variability in Sandlance FA Profiles

From May through September APEX 163M investigators make biweekly collections of sandlance in lower Cook Inlet near Kachemak Bay. We propose to determine the FA profiles of juvenile and adult sandlance during these 10 collection opportunities. Seven juvenile and adult sandlance will be processed as whole body samples. In total this results in 140 samples.

To supplement the time scale of FA profiles of sandlance in lower Cook Inlet we propose to collect supplemental sample within PWS in conjunction with APEX 163E. Sandlance will be collected monthly, June to August, at 2 locations in PWS. Adult and juvenile sandlance will be sampled as in Kachemak Bay, providing a total of 84 samples.

APEX 163M investigators will be responsible for the lower Cook Inlet sample collection, storage and shipment to Auke Bay. APEX 163E will augment sampling in PWS. Fish will be stored in airtight containers and labeled with unique sample numbers and codes reflecting the collection location and date. Sampling design and analytical priorities will be contingent on fish availability. All samples will be collected by APEX investigators during FY98 as part of their existing study plans.

Lipid Class/FA Analysis

Samples will be extracted by methods developed by Folch (1957) and modified by Iverson (1988). Lipid classification will employ high performance liquid chromatography (HPLC) and evaporative light scattering detection (ELSD) equipped with a stream splitter and an automated integration system. The lipid classes will be separated on a silica based HPLC column; as they elute from the column, each lipid class will be split with one portion being directed to the detector and the other portion being collected for FA analysis. The portion going to the detector will be integrated and the chromatographic data for each lipid class will be quantified by standard calibration curves established by analyzing standards with lipid compositions similar to the sample.

After separation the lipid class of interest will undergo acid catalyzed transesterification as outlined in Christie (1982). The resulting FA methyl esters (FAME) will be determined using a gas chromatograph coupled with a mass selective detector (MSD). The FAME will be identified by comparison of the chromatographic peaks with those of known laboratory standards. Peaks not identified by direct comparison to standards will be identified from the fragmentation pattern resolved by the MSD. FA will be reported as a percentage of the total amount of FA and named according to IUPAC nomenclature.

These methods will give results directly comparable to that of the conventional methods using TLC/Iatroscan for lipid class determination and gas chromatography-flame ionization detection (GC-FID) for FAME analysis. The ELSD will allow for simultaneous detection and separation of lipid classes without developing rods or TLC plates and without extracting lipids from the TLC media for FA analysis. Likewise, analysis of FAME mixtures by MSD will forego the need for silver nitrate augmentation to identify of peaks that are not components of standard

mixtures. Since each compound has a unique fragmentation pattern the identity of unknown peaks can be determined from the mass spectral data.

Statistical analysis

Statistical analysis of the proposed fish collections will use multi variate techniques to measure the similarity between groups classified *a priori.* Groups will classed by age, location and sampling period and their FA compositions will be summarized by discriminant analysis and the distance between group centroids will be measured and tested to determine if they are different from 0. Rejection of a null hypothesis that the distance is 0 indicates significant differences exist between the groups, therefore variation in FA composition within the group is less than variation between the groups. In addition, differences among FA profiles can be related to APEX-generated data on diet diversity, as well as species diversity and energy density of concurrently sampled prey fields.

Differences in nutritional condition between the logically associated groups identified by ordination will be examined by ANOVA. The existence of different logical groups based on differences in FA profiles of the TAG component suggests dietary differences, this analysis will examine the nutritional consequences of these dietary differences. Nutritional condition will be calculated as the proportion of total lipid comprised of TAG. A one way ANOVA will be used to examine differences in the mean nutritional condition between logical groups.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The experiments described in this proposal are designed to initiate development of techniques for examining broad scale trophic relationships and supplement other Trustee Projects. In this project we begin by examining the structure of variation in FA composition. In a separate unsolicited project we propose to demonstrate in the field the underlying assumption that a predator's FA composition is similar to their prey. The combination of these projects may provide empirical validation for the theory of FA composition analysis. Afterwards, application to higher level predators can proceed. We have chosen to examine a forage fish model because of their central value to the PWS ecosystem. Our proposed studies depend on the sampling protocol of APEX study 163M and 163E. APEX investigators will be responsible for collecting, labeling and storing samples until they return to Auke Bay. APEX 163M and APEX 163E will benefit from our analysis by relating our measures of dietary differences and their energetic consequences to their coarser indices of nutritional condition.

SCHEDULE

A. Measurable Project Tasks for FY 99 (October 1, 1998 - September 30, 1999)

October 1: Complete sample processing for spatial variability of FA.

	Begin analysis of temporal variability samples.
December :	Complete statistical analysis of data from spatial variability samples.
March:	Attend 10th Anniversary Symposium
April:	Submit annual report
Sept. 30:	Complete sample processing for temporal variability of FA.

B. Project Milestones and Endpoints

FY99

Oct. 1998	Complete lab processing of herring, sandlance, and zooplankton collected for spatial comparisons. Begin lab processing herring and sandlance collected for temporal comparisons.
Dec. 1998	Complete statistical analysis of spatial variation data.
March 1999	Report on spatial scales of variability in forage fish FA profiles.
June 1999	Complete manuscript on spatial scales of variation of herring and sandlance in PWS.
Sept. 1999	Complete processing of herring, sandlance, and zooplankton collected for temporal comparisons.

FY00

Dec. 1999	Complete statistical analysis of temporal variation data.
Jan 2000	Report on temporal scales of variability in forage fish FA profiles.
Jul 2000	Final Report submitted

C. Completion Date

This project will began in FY98, and will continue through FY00. Synthesis of herring, sandlance, and zooplankton spatial data will be complete in the middle of FY99. Synthesis of the temporal data will be complete in the first quarter of FY00, and the final report will be submitted in the middle of FY00.

PUBLICATIONS AND REPORTS

April 1998: Annual Report containing update on sample processing for the forage fish experiment.

Jan 1999 Submit scientific manuscript to journal:

Heintz, R , M. Larsen, S. D. Rice, and APEX investigator. 1999. Spatial

Variation of FA Profiles and Lipid Class Compositions in Herring, Sandlance and Their Prey in Prince William Sound, Alaska. Journal uncertain.

April 1999: Annual Report containing data on the forage fish studies

Jan. 2000: Submit scientific manuscript to journal:
Heintz, R , M. Larsen, S. D. Rice, and APEX investigator. 1999. Temporal Variation of FA Profiles and Lipid Class Compositions in Sandlance in Lower Cook Inlet and Prince William Sound, Alaska. Journal uncertain.

April 2000: Final Report .

PROFESSIONAL CONFERENCES

Report on forage fish results at National Meeting of the American Fisheries Society in September 1999.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

NOAA/ NMFS has statutory stewardship for most living marine resources; however, if the oil spill had not occurred NOAA would not be conducting this project. NOAA/ NMFS proposes to make a significant contribution (as stated in the proposed budget) to the operation of this project, making it truly cooperative.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

The original proposal included temporal sampling by APEX 163A investigators in PWS in FY99 which is no longer possible because cruises have been eliminated. Sampling for temporal variations will therefore be conducted in lower Cook Inlet by investigators from APEX 163M and supplemented by sampling in PWS with the aide of APEX 163E.

PROPOSED PRINCIPAL INVESTIGATOR

Ron Heintz
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PRINCIPAL INVESTIGATOR

Ron Heintz obtained his BS in Ecology, Ethology & Evolution from the University of Illinois in 1979 and his MS Fisheries Science from the University of Alaska in 1986. He has worked for the National Marine Fisheries Service, Auke Bay Laboratory since 1985 and been actively involved with Trustee sponsored research since 1992. He is a co-investigator in two pink salmon studies, the first examines the effects of incubating in oiled gravel on reproductive capacity, and the other examines the effects on homing fidelity. The first of these projects established the plausibility of effects on pink salmon fry observed in the Sound after the EVOS, including the existence of long-term effects on growth, marine survival and reproductive ability. He was also a co-author of the final report for Subtidal 8, which examined all of the Trustee Hydrocarbon data for the presence of EVO. This work is of substantial importance to the trustees, by providing evidence for the presence of oil on the beaches of PWS. His efforts in this project led to a detailed understanding of the utility of multi variate methods for analyzing GC/MS data.

OTHER PERSONNEL

Stanley D. Rice, GM-14 Physiologist
Education:
BA in biology (1966) from Chico State University
MA in biology (1968) from Chico State University
Ph.D. in comparative physiology (1971) from Kent State University

Experience:
1986 - present: Habitat Program Manager. Managed NOAA/NMFS/Auke Bay Laboratory's *Exxon Valdez* damage assessment and restoration studies. Conducted and managed cooperative projects interactive with other agencies, provided critical reviews and input in agency decisions.
1971 - 1986: Research Physiologist/Task Leader. Researched and managed studies investigating oil effects encompassing a wide variety of organisms and conditions.

Marie Larsen, GS-11 Research Chemist
Education:
BA in chemistry (1983) from The College of St. Benedict

Experience:
1990 - present: Research Chemist. Managed daily activities and schedules in the hydrocarbon analysis lab at the Auke Bay Laboratory. Primary operator of mass spectrometer.
1983- 1990: Contracted chemist services to the U.S. EPA Environmental Research Laboratory-Duluth as part of the National Dioxin Study. Responsibilities included sample processing and

operation/maintenance of mass spectrometry systems.

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1999 EXXON VALDEZ TRU[illegible] COUNCIL PROJECT BUDGET
October 1, 1998 - September 30, 1999

Budget Category:	Authorized FFY 1998	Proposed FFY 1999	LONG RANGE FUNDING REQUIREMENTS					
Personnel	$61.3	$68.2						
Travel	$4.1	$6.6						
Contractual	$0.0	$5.0						
Commodities	$20.0	$15.0						
Equipment	$16.0	$0.0						
Subtotal	$101.4	$94.8	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2003	Estimated FFY 2004	Estimated FFY 2005	
General Administration	$9.2	$10.6						
Project Total	$110.6	$105.4	$35.8	$0.0	$0.0	$0.0	$0.0	
Full-time Equivalents (FTE)		1.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources		$38.5						

NOAA Contribution:

Habitat Investigation Program Manager, S. Rice,0.5 mo = $5.5K, Principle Investigator, R. Heintz 1.5 mo @9.7K, Senior Analytical Chemist, M. Larsen 1.5 mo @ 9.4K, Senior Research Chemist, J. Short 1 mo. @ 8.3K for a total NOAA contribution of 38.5K.

1999

Project Number: 99347
Project Title: Fatty Acid Profile and Lipid Class Analysis for Estimating Diet Compostion and Quality at Different Trophic Levels
Agency: National Oceanic & Atmospheric Administration

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:4/10/98

1999 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET
October 1, 1998 - September 30, 1999

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1999
J. Lunasin	Research Chemist	9/6	5.0	5.0		25.0
R Heintz	Co-PI: Fishery Research Biologist	12/3	2.0	6.6		13.2
M. Larsen	Co -PI: Analytical Chemist	11/6	3.0	6.0		18.0
L. Holland	Research Chemist	11/6	2.0	6.0		12.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		12.0	23.6	0.0	
					Personnel Total	$68.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1999
Anchorage , 10th Anniversary Symposium, 2	0.5	2	8	0.2	2.6
Miscellaneous (Car rental, telephone chgs, POV mileage, etc.)					0.4
					0.0
National American Fisheries Society Meeting, 1	1.5	1	4	0.2	2.3
Miscellaneous (Car rental, telephone chgs, POV mileage, etc.)					0.2
					0.0
APEX Technical Review Session, 1	0.5	1	2	0.2	0.9
Miscellaneous (Car rental, telephone chgs, POV mileage, etc.)					0.2
R Heintz PI					0.0
					0.0
					0.0
					0.0
				Travel Total	$6.6

1999

Project Number: 99347
Project Title: Fatty Acid Profile and Lipid Class Analysis for Estimating Diet Compostion and Quality at Different Trophic Levels
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Personnel
& Travel
DETAIL

Prepared:4/10/98

1999 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET
October 1, 1998 - September 30, 1999

Contractual Costs:	Proposed
Description	FFY 1999
Labor for sample processing (sample sorting, extractions, etc.)	5.0
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
	0.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$5.0

Commodities Costs:	Proposed
Description	FFY 1999
Sample Analysis: reagents, standards, laboratory expendables	15.0
Commodities Total	$15.0

1999

Project Number: 99347
Project Title: Fatty Acid Profile and Lipid Class Analysis for Estimating Diet Composition and Quality at Different Trophic Levels
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Contractual & Commodities DETAIL

Prepared:4/10/98

1999 EXXON VALDEZ TRU[illegible] COUNCIL PROJECT BUDGET
October 1, 1998 - September 30, 1999

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1999
			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
HPLC	1	NOAA
GC/MS	1	NOAA

1999

Project Number: 99347
Project Title: Fatty Acid Profile and Lipid Class Analysis for Estimating
Diet Compostion and Quality at Different Trophic Levels
Agency: National Oceanic & Atmospheric Administration

FORM 3B
Equipment
DETAIL

Prepared:4/10/98

99348

Responses of river otters to oil contamination: a controlled study of biological stress markers

Project Number:	98348
Restoration category:	Research
Lead Trustee Agency:	University of Alaska Fairbanks
Cooperating Agencies:	Alaska Department of Fish and Game; Purdue University, Indiana; Woodshole Oceanographic Institute.
Alaska SeaLife Center:	Yes
Duration:	2nd year. 2-year project.
Cost FY99:	$208,300
Cost FY00:	none
Geographic Area:	Prince William Sound and Seward, Alaska.
Injured Resource:	River otters - Recovery Unknown.

ABSTRACT

This project is designed to explore experimentally the effects of oil contamination on physiological responses in river otters (*Lutra canadensis*). Fifteen captive otters will be exposed to two levels of oil contamination under controlled conditions in captivity. Samples of blood, tissues and feces will be collected for analysis of biomarkers, and immunological examinations.

INTRODUCTION

This proposal originates from the need to better understand the effects of contamination by crude oil on biological stress markers in river otters (*Lutra canadensis*). Previous studies demonstrated elevated levels of biological stress markers (bioindicators) in river otters from oiled areas compared with those from nonoiled areas throughout Prince William Sound, Alaska, shortly following the *Exxon Valdez Oil Spill* (*EVOS*). In addition, elevated values of bioindicators have been documented in river otters as part of the *EVOS* - Nearshore Vertebrate Predator Project (NVP) 7 years after the spill.

Although the data collected to date strongly indicate a correlation between oil contamination and physiological stress in river otters, this circumstantial evidence requires verification through controlled experiments as identified by the *EVOS* Trustees Council review process (1997). Also, it is difficult to assess from the evidence collected to date whether the physiological stress is a direct result of oiling or a secondary response to food limitation (Fig. 1). The documented injury to the prey base of river otters, however, is not sufficient to explain the observed pattern of physiological stress.

In this study, we propose to investigate the effects of exposure to oil on physiology of river otters under controlled conditions and hypothesize that exposure to oil will result in elevated levels of bioindicators in river otters.

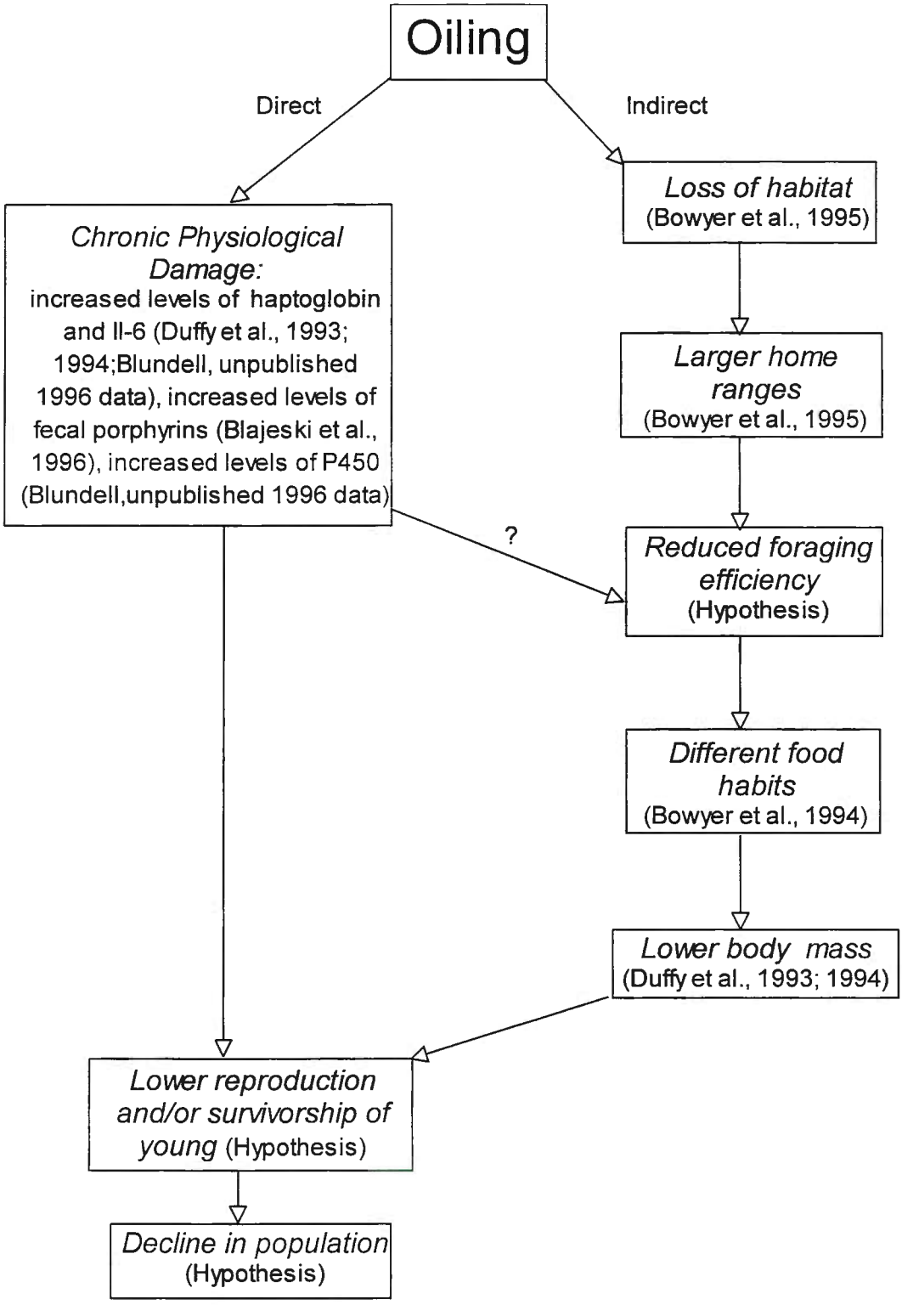

Fig. 1 - Possible pathways for the effect of oiling on river otters in Prince William Sound, Alaska

Background

General

Investigations in Prince William Sound following the *Exxon Valdez* oil spill revealed that river otters (*Lutra canadensis*) on oiled shores had lower body mass and elevated levels of bioindicators, than did otters living on nonoiled shores (Blajeski et al., 1996; Duffy et al. 1993; 1994a; 1994b; 1996). In addition, otters from oiled areas selected different habitat characters, had larger home ranges, and less diverse diets than those in nonoiled areas (Bowyer et al. 1994; Bowyer et al. 1995). These observed differences between river otters from oiled shores and those from nonoiled areas strongly suggest that oil contamination had an effect on physiological and behavioral processes in otters. Moreover, these effects have a potential to become chronic and may impede recovery of populations of river otter as hydrocarbon exposure continues. Between 8-16% of the 10.8 million gallons of crude oil spilled by the *T/V Exxon Valdez* remains buried in marine sediments (Wolfe et al., 1994). Such oil is not subject to degradation by marine organisms and remains in a form that is toxic to many vertebrates (Braddock et al., 1996). Moreover, microbial analyses indicates that oil in sediments along oiled shorelines is still several orders of magnitude more common than in unoiled areas (Braddock et al., 1996), suggesting that oil may still be available for biological transport from benthic invertebrates through the food chain.

Biomarkers

Studies initiated following the *EVOS* suggest that several mammalian and avian predators display physiological stress related to oil toxicity. Sea otters from oiled regions had greater antigenic stimulation than animals from unoiled areas (Rebar et al., 1994). Pigeon guillemots had elevated levels of haptoglobins and blood proteins in specific locations and years, although dosing experiments in the field failed to demonstrate the connection between oiling and those parameters (Prichard et al., in press). More specifically, river otters live-captured in oiled areas had higher haptoglobin, Interleukin - 6 (Il-6), and fecal porphyrin levels than otters from nonoiled regions post spill (Blajeski et al., 1996; Duffy et al., 1993; 1994). In addition, river otters showed elevated haptoglobin and P450 values in 1996 (G. M. Blundell, pers. comm.). Similar changes in plasma proteins, abnormalities in white blood cells (leukocytes), reduction in the number of red blood cells (erythrocytes), and electrolyte imbalance, were observed in mink (*Mustela vison*) and polar bears (*Ursus maritimus*) following exposure to hydrocarbons (Mohn and Nordstoga, 1975: Oristsland et al., 1981; J. Mazet, UC Davis, personal communication).

Cytochrome P450 are a group of enzymes that metabolize a wide variety of xenobiotic compounds. P450-1A is specifically induced by planar aromatic or chlorinated hydrocarbons, and thus its presence serves as a bioindicator of hydrocarbon exposure. Haptoglobin and Il-6 indicate increase liver activity in synthesizing acute-phase proteins in response to tissue injury (Duffy et al., 1993; 1994). Porphyrins are tetrapyrrolic pigments that are involved in biosynthesis of the heam molecule. Chemical-induced

changes in patterns of porphyrins have been observed in several avian species following an exposure to aromatic hydrocarbons (Miranda et al., 1987) Other physiological responses such as those of the immune system have been used recently in the *EVOS* - NVP project as assays to toxic damage of oil.

Although the data collected to date strongly indicate a relationship between oil contamination and physiological stress in river otters, this circumstantial evidence requires verification through controlled experiments. The *EVOS* Trustees Council review process (1997) identified the need for such controlled experiments: "....For river otters captive laboratory exposures to petroleum ...is needed to solidify the cause for P450-induced individuals in western PWS.....captive experiments that examine the relationship between oil dose and biochemical responses in the species where such responses appear to be related to spill effects should be done.....To obtain a better basis for interpretation of the field haptoglobin and fecal porphyrin data, controlled oil exposures of river otters are highly recommended."

NEED FOR THE PROJECT

A. Statement of Problem

The 1997 review process of the NVP Project funded by the *EVOS* Trustees Council identified the need to verify the effects of oil contamination on physiological stress responses in river otters. Data collected in summer 1996 revealed that coastal river otters in the western Prince William Sound are still exposed to oil contamination (P450) and show high levels of haptoglobins. These results may indicate that restoration of river otter populations may be impeded by the continued exposure to hydrocarbons. Nonetheless, as long as the connection between exposure to oil and bioindicators is not demonstrated under controlled conditions, the interpretation of the results is limited because of the correlational nature of these data. This study will investigate the effects of exposure to oil on bioindicator levels in river otter tissues.

B. Rationale/Link to Restoration

Effective implementation of the *EVOS* Trustee Council's policy that "Restoration should contribute to a healthy, productive and biologically diverse ecosystem...", is complicated by the diversity and trophic interdependence of the numerous injured resources within the nearshore system. The existing evidence of chronic physiological stress in a wide variety of nearshore vertebrate predators (see NVP project) requires verification under controlled experiments, before the mechanisms that constraint recovery can be understood.

C. Location

River otters will be captured in the western PWS and transported via air to the Alaska Sealife Center in Seward, where the controlled experiments will be conducted.

COMMUNITY INVOLVEMENT

This project will involve intensive data collection both in the Sealife Center as well as in the different laboratories. We will recruit high school and undergraduate students to assist in the data collection. Preference will be given to students from local communities. In addition, supply of live-fish prey will be crucial for maintaining the otters and assuring their re-introduction to the wild (Kruuk, 1995). It is our intention to contract local fishermen to provide us with these prey.
The captive river otters in the Sealife Center will be available for public viewing and education. We will participate in the development of the educational materials associated with the river otter display. We will also welcome opportunities to interact with local communities to present and discuss our findings.

PROJECT DESIGN

A. Objectives

The objective of this study is to document the effects of exposure to oil on physiology and behavior of river otters under controlled conditions.We will address the hypothesis that exposure to oil will result in elevated levels of bioindicators in river otters.

B. Methods

General

River otters will be live-captured from the wild in unoiled areas in western PWS (Esther Island, Unakwik Inlet, and Montegue Island) using No. 11 Sleepy Creek leg-hold traps (Blundell et al., in review) under permit from the Alaska Department of Fish and Game (ADFG 98-001) from April 19 to May 30, 1998. Of these trapped otters 15 subadult/young adult males will be transferred to the Alaska Sealife Center in Seward and held in captivity from May 1998 to March 1999. Traps will be placed on trails at latrine sites and monitored by means of trap transmitters (Telonics, Mesa, Arizona, USA) that signal when a trap has been sprung. Processing of otters will begin within 1 - 2 hours. Otters will be anesthetized with Telazol (9mg/kg; A. H. Robins, Richmond, Virginia, USA) administered using Telinject darts and a blowgun.

Once anesthetized, otters will be weighed (to the nearest 0.1 kg), and measured (to the nearest 1 mm). These measurements will include body length, tail length, and total length; total skull length and width of zygomatic arch; length from hock to toe of the right hind foot; canine length and diameter, and distance between canines. Age of otters will be determined by removing an upper premolar 1 for cementum annuli aging. We will insert

a PIT tag under the skin between the scapulae of each individual to allow for individual identification. In addition, fur bleaching in unique combinations will be done for each animal to allow for visual identification of individuals.

Collection of tissue samples at capture will follow the same operating protocol as used in the NVP project (see below). Data collected from all trapped otters (including the ones intended for this project) will be used for assessing recovery of river otters through the NVP project. In addition, the data collected from the 15 males at the time of capture will serve as baseline information to assess the effects of captivity on physiological responses of the otters. The assays performed on the tissue samples will include: haptoglobin, Il-6, P450-1A (in epithelial cells and WBC), CBC, RBC, WBC, and serum chemistry, lymphocyte blastogenesis, serum protein electrophoresis, immunoglobulin quantification, delayed type hypersensitivity reactions, DNA adduct analysis.

Serum obtained from the 15 river otters live-captured in PWS will be sent for screening of the following diseases:
1. Aleutian disease
2. canine distemper
3. phocid distemper
This initial screening will assist in determining whether the trapped animals have been previously exposed to these diseases prior to their placement in captivity. Although rarely observed in free-ranging mustelids, these three diseases are the most likely diseases to be contracted by these carnivores.

The fifteen wild-caught male river otters will be transferred under sedation via air to the Alaska Sealife Center in Seward, Alaska. The animals will be housed as one large group in an area of 90 m^2 surrounding 5 pools:

1. A large round salt-water pool (4.5 m diameter x 3 m depth).
2. 2 smaller salt-water pools (2 x 1.5 x 1.5 m).
3. 2 smaller fresh-water pools (2 x 1.5 x 1.5m).

The area surrounding the pools is divided into 9 smaller enclosures that can be sealed off in case a need will rise to isolate an animal from the rest of the group. An effort will be made to handle the animals as consistently as possible. In case that some animals will be particularly hard to handle, the data from these individuals will be treated with special caution. All otters will have unlimited access to the large pool at all times outside the experimental sessions. Each otter will be provided with an individual solid sleeping box. Otters will be fed live fish on a weekly basis in the large saltwater pool, and diet will be supplemented with prepared food mixture (mink chow), vitamins, and minerals (Robbins, 1993). Separating the otters will be done by sealing their sleeping boxes and transferring the boxes into one of the sealed areas. Alternatively, otters will be enticed into the designed area with favorable food.

Experiments will begin in July allowing the animals 1.5 months to acclimate to the enclosure, feeding regimes, and handling. During this period otters will be offered live

prey in the large pool and will be trained to forage in that pool. Animals will also be exposed to the closing and opening of different enclosures.

After the acclimation period and prior to the first sampling occasion, otters will be randomly assigned to 3 experimental groups of 5 individuals each:

Group 1 - control
Group 2 - exposure to low levels of oil (100 ppm)
Group 3 - exposure to high levels of oil (1000 ppm)

We will use a stratified random sampling approach to ensure that size and age of animals will be taken into account. Therefore, the 3 smallest individuals will be randomly assigned to the 3 different groups; the second size set of 3 individuals will be randomly assigned to the 3 groups; etc.

Sedating the animals prior to drawing blood will be done by feeding the animals with Versed® hidden in a fish. Alternatively, animals will be anesthetized with Telazol (9mg/kg; A. H. Robins, Richmond, Virginia, USA) administered using Telinject darts and a blowgun. During these times the large pool area will be closed off to the otters to prevent drowning.

Oil will be administered to otters mixed with prepared food (mink chow). Weathered (comparable to 2 weeks weathering) Prudhoe Bay Crude oil will be dissolved in salmon oil and than mixed with the food. Oil feeding will last 100 days from July 23 to October 30, 1998. Data collection will continue for 100 additional days.

Prior to the exposure to oil a series of tissue sampling will be conducted on each individual otter. The day of sampling prior to oil administration will be termed day 0 of the experiments for each otter. Table provides the planned date schedule of oil administration and sampling, although dates may change slightly.

Following completion of the experiments river otters will be released back into the wild at the site of their original capture. These animals will be implanted with radio transmitters following the surgical protocol described below and monitored using aerial telemetry for the next 6 months.

One week before release, serum samples will be collected from the animals. These samples will be screened for diseases as detailed above. Following this bleeding session animals will be placed under isolation from visitors and only the specific technician assigned to the otter project alone will be allowed access to their enclosure. This will ensure that no infection will occur between the time of disease screening and release. Only uninfected animals will be released.

Table 1. Schedule of experiments for captive river otters to examine the effects of crude oil, Seward Sealife Center.

Oil Administration	Blood sampling	Skin punches (P450)
July 23	July 21-22	July 21-22
"	Aug. 10-11	-
"	Aug. 30-31	-
"	Sept. 19-20	Sept. 19-20
"	Oct. 9-10	-
"	Oct. 29-30	Oct. 29-30
Oct. 30	Nov.19-20	-
-	Dec. 9-10	Dec. 9-10
-	Dec. 29-30	-
-	Jan. 18-19	Jan. 18-19

Otters will be anaesthetized to a surgical plane with a combination of Ketamine Hydrochloride (100 mg/ml, Ketaset, Aveco Co., Fort Dodge, Iowa, 50501, USA) at a dose of 10 mg/kg, and Midazolam Hydrochloride (5 mg/ml, Versed, Hoffman-LaRoche, Nutley, New Jersey 07110, USA) at a dose of 0.25 mg/kg mixed in the same syringe (Spelman et al., 1993). The surgery site will be shaved and surgically scrubbed with Nolvasan soap and a final iodine prep. Once the site is prepared and prior to making the incision, the otter will be checked to ascertain depth of anesthesia and proper analgesia. The surgeries will be performed by a veterinary technician with specialized training in the procedure, using methods outlined in Testa et al. (1994). All surgeries will be done adhering to sterile technique. We will use a side entry, posterior to the last rib to introduce a hermetically sealed radio transmitter (IMP/400/L; Telonics, Mesa, Arizona) into the peritoneal cavity. Each muscle layer will be closed separately with simple interrupted sutures, the skin will be closed with a continuous subcuticular suture line to prevent the otter from accessing any sutures. As a final precaution, the skin incision will be sealed with surgical glue. We have performed this surgery successfully many times on wild river otters.

Animals that will suffer minor but noticeable damage due to oil administration that will threaten their survival in the wild will be kept at the Sealife Center for public viewing and education. In instances where oil damage will cause pain and major suffering, animals will be humanely euthanized using inter vinous injection of beuthanasia (0.5cc/kg body mass). Any carcasses will be used for full pathological screening. All methods used in this research has been approved by an independent Animal Care and Use Committee at

the University of Alaska Fairbanks, Fairbanks, Alaska and an Independent Committee at the Alaska Sealife Center, Seward Alaska, in compliance with policies recommended by the National Institutes of Health (NIH), the National Science Foundation (NSF), and the Scientists Center for Animal Welfare (SCAW).

Tissue sampling

Collection of tissue samples will follow the same operating protocol as used in the NVP project to assure that results will be comparable. The assays performed on the tissue samples will include: haptoglobin, Il-6, P450-1A (in epithelial cells and WBC), CBC, WBC, RBC, and serum chemistry, lymphocyte blastogenesis, serum protein electrophoresis, immunoglobulin quantification, delayed type hypersensitivity reactions, DNA adduct analysis.

Collection of blood will be conducted every 20 days. Each session will last 2 days. At each session, the sequence of sampled animals within this 2 day period will be drawn at random, with no relation to group assignment. This approach will reduce the bias resulting from increased efficiency of handlers through time and the adjustment of the otters to the handling procedures. The short period of sampling (i.e., 2 days) will ensure that the time between sampling for each otter will be between 20 and 21 days at most. The first sampling session will precede the oil administration (July 21 - 22) and continue for 81 days past the end of oil administration (January 18, 1999). Therefore, a total number of 10 samples per individual otter will be obtained. One sample before oil administration, 5 samples during oil administration, and 4 samples following the end of oil administration. See Table 1 for estimated dates.

A total of 22 milliliters of blood will be drawn from the jugular vein of each otter, using a 20 gauge 1 inch needles, with care to keep samples sterile. Ten milliliters will be preserved with heparin (40u/ml or 0.4ml/10ml of blood) and stored in a red top vacutainer. An additional 2 ml will be preserved with EDTA (purple top vacutainer), and 10 ml of blood will be collected in a red top vacutainer and allowed to clot. Two blood smears will be made for each river otter on site, at the time of blood draw. A tissue sample from the skin of medial surface of the right or left front limb in the triceps area will be collected from each river otter using a 3mm disposable skin biopsy punch. The specimen will be preserved in 10% neutral buffered formalin immediately after collection for P450 analysis.

In the laboratory, red-top tubes will be centrifuged at low speed (800 x g,) for 20 minutes. Serum will be drawn from the clot of the centrifuged sample and frozen separately. All serum samples, and the clot, will be frozen within 12 hours of obtaining the samples. The plasma will be drawn off of the heparinized sample with care so as not to disturb the buffy-coat layer. One milliliter of the plasma will be mixed with 0.2 ml of DMSO (tissue culture grade) and placed on ice. The buffy-coat will be removed from the erythrocyte layer and placed in a snap top tube along with 1 ml of plasma. The plasma/DMSO will then be added slowly (one drop at a time) to the mixture. The mixture will be aliquoted

into two cryovials (approx. 1 ml each), placed into a prechilled Nalgene freezing unit and placed into the freezer for 12 hours. The buffy-coat samples will be transferred to a liquid nitrogen dewer for storage and eventual transport to the Purdue University laboratory. Any remaining plasma will be frozen. EDTA samples and one blood smear from each otter will be flown to a laboratory in Anchorage (Quest Lab c/o Laurie Rubin, 562-2551) for a complete blood count within 72 hours of the blood draw. All serum and plasma will stay frozen and sent, periodically, to Fairbanks for analysis. Serum samples will be sent to Quest Lab for Serum Chemistry Panels and other tests as needed.

Assays Biological Stress Markers and Immunology

Haptoglobins

Haptoglobins (Hp) are alpha$_2$ glycoproteins that stoichiometrically bind free hemoglobin (Hb) in a haptoglobin-hemoglobin complex. Excess hemoglobin will be added to the serum sample in a 1 part of a 10% hemoglobin suspension to 20 parts of undiluted serum, and allowed to mix for 5 min. Two microliters of the sample mixture will then be electrophoresed on agarose gels at 100 volts for 1 hr. After fixing the protein complex with 7.5% trichloroacetic acid, gels will be stained for hemoglobin using o-dianisidine, as described by the manufacturer. The Hp-Hb complex, which migrates in a different region from hemoglobin, is quantitated by densitometry and results are expressed as mg of hemoglobin binding capacity per 100 ml of serum as described by the manufacturer.

Interleukin - 6

Samples received from the captive otters will be analyzed for IL-6 levels using an immunochemical assay . Samples, run in duplicate, will be added to a microliter plate coated with a monoclonal antibody for IL-6. After washing away any unbound proteins, an enzyme-linked polyclonal antibody for IL-6 will be added to the wells and incubated to allow for any IL-6 binding. After a final wash, a substrate solution will be added to the wells. After color develops, sample concentrations will be determined from a standard curve. IL-1ß will be measured similarly.

Cytochrome P450 assays

Two approaches will be taken to evaluate cytochrome P450 levels:

1) Immunohistochemistry: The induction of cytochrome P4501A (CYP1A) in tissues of the river otters will be evaluated by immunohistochemistry. Candidate tissues to be used include skin punches. Tissue samples will be preserved in 10% neutral buffered formalin immediately after collection and shipped to Woods Hole Oceanographic Institute for analysis (by Dr. J. Stegeman).

Analytical SDS-PAGE will be done using a modified procedure of Laemmli[31]. The test and control media will be removed from the 12 well plate, and each well will be

rinsed twice with 2 ml cold wash buffer (62.5 mM Tris-HCI, pH 6.8). Sample buffer (2.35% [w/v] SDS. 10% [v/v] glycerol, 5% [v/v] ß-mercaptoethanol, and 62.5 mM Tris-HCI: pH 6.8) will be added to each well (200 μl per well) to solubilize the cells. Cell lysates will be collected from individual wells and stored at -20°C. Test samples will be heated to 90°C for several minutes and equal volumes loaded in 9 or 10% (w/v) acrylamide: 0.27% (w/v) bis-acrylamide slab gels (approximately 12 x 16 cm, 0.75 mm thick) and run at 20 mA constant current per gel for approximately 4 h to resolve individual bands.

The gels will be fixed and stained using a Sigma Chemical Co. AG-25 silver staining kit procedure. Analytical gels will be prepared as above and electrobloted onto nitrocellulose membranes using 25mM Trisma base, 192 mM glycine, and 20% (v/v) methanol for 3 h at 100 V. The membranes will be then blocked in 5% nonfat dried milk in CMF-PBS, washed four times in CMF-PBS, and incubated with antibody to hsp 70 and 141 which recognizes a conserved epitope present in most members of these families. The blots will be washed as before and incubated with an HRP-conjugated goat antirat IgG antibody (Sigma, A-9037) as the secondary antibody. For the color development, the blot will be washed as before and stained using 3,3'-diaminobenzidine tetrahydrochloride (DAB) as the HRP substrate (Sigma Fast® DABkit D-4418).

2) Quantitative RT-PCR to measure cytochrome P450: The purpose of this approach is to use an alternate method (quantitative polymerase chain reaction) to measure cytochrome P450 expression in peripheral blood lymphocytes. The lymphocytes will be isolated from blood samples drawn from thecaptive animals. The method to be used will be adapted from Vanden Heuvel et al. (1993). Total RNA will be extracted from isolated peripheral blood lymphocytes and a reverse transcriptase-polymerase chain reaction (RT-PCR) assay will be used to quantify cytochrome P450 levels. Advantages of this technique are: (1) the use of peripheral blood samples for analysis; (2) the small sample size required for detection and (3) potentially increased sensitivity as compared to other methods (by Dr. P. Snyder).

Hematology and serum chemistry

For CBC (complete blood cell counts), WBC (white blood cell counts), and serum chemistry samples will be submitted to commercial clinical laboratories. The serum samples from the captive river otters will be batch tested at Purdue University for serum electrophoresis (SEP) and immunoglobulin quantitation using standard methodologies. Serum protein electrophoresis offers information on relative protein distribution and allows for the calculation of absolute values (Melvin 1987). Many disease states may alter the electrophoretic pattern (Turnwald and Barta 1989). Acute phase, complement, immunoglobulin and coagulation proteins can all be assayed using SEP.

Immune function assays

A total of 10 ml of blood collected with 40u of preservative-free heparin/ml as the

anticoagulant will be used to isolate buffy coat leukocytes. Blood samples will be processed using a technique modified from Truax et. al. (1993) on cryopreservation of buffy coat cells, stored in liquid nitrogen, and shipped to Purdue University. For analysis, frozen cells will be thawed rapidly in a 37°C water bath and immediately placed on ice. The sample will then be transferred to a 15 ml centrifuge tube and diluted to 10 ml with Hank's balanced salt solution (HBSS) containing 40u of heparin/ml. The sample will then be layered over 4 ml of a ficoll gradient and centrifuged at 1600 x g for 30 minutes. The cells at the interface will be collected and washed 3 times in HBSS. Following the final wash the cells will be resuspended in RPMI 1640 medium supplemented with 10% (v/v) fetal clone, 2 mM L-glutamine, 25 mM 2-mercaptoethanol and antibiotics. Enumeration and viability will be assessed using trypan blue dye-exclusion. Lymphocyte proliferation assays will be performed using the mitogens PHA, Con A and PWM in 5 day cultures. All assays will be done in triplicate. Proliferation will be assayed by adding tritiated thymidine to the cultures at 16 hours prior to harvesting. Results will be recorded as counts per minute (cpm). Control wells will contain medium only.

Assays of Fecal Porphyrins

Fecal samples will be collected continuously throughout the experiment, at each occasion when the identity of the animal depositing the scat will be ascertained. Special effort will be made to collect feces in conjunction with bleeding sessions (Table 1).

Oil Measurement in Feces

A sample of 2.5 ml or g of feces will be placed into an extraction tube containing 4 mL isopropyl alcohol. The extraction tube will then be shaken for 1 minute to extract the PAH components. The extract will be filtered using a piston filter and then diluted 10-fold. This first dilution allows detection of 0.7 to 15 ppm PAH from the gauze saturated with isopropyl alcohol. If necessary a second dilution will be made to increase the detectable range to 140 ppm. The alkaline phosphatase hapten-enzyme conjuate will be added to the diluted sample and to a negative reference solution. The analyte detector used has a discrete sample reaction zone (sample zone) as well as a negative control reference reaction zone (reference zone), each of which contain latex particles that are coated with affinity-purified antibody. Five drops of prepared test sample will be added to the sample zone, and 5 drops of negative reference solution will be added to the reference zone of the detector. After 3 minutes, each solution will pass through the immobilized antibody and will be absorbed into the detector by capillary action. PAH in the sample will compete with the hapten-enzyme conjugate for sites on the immobilized antibodies. To remove any unbound hapten conjugate, 2 drops of rinse solution will be added to each reaction zone. To produce a color endpoint for the immunoassay, 2 drops of alkaline phosphatase color forming substrate will be added to each reaction zone which then reacted with the antibody bound hapten conjugate. As the concentration of PAH in the sample increases, the color endpoint decreases in intensity. A hand-held dual-beam reflectometer will be used to compare color intensity of the sample zone to the reference

zone. The concentration of PAH in the isopropyl alcohol saturated gauze will be calculated from a preprogrammed standard curve and displayed by the reflectometer. The sensitivity, specificity, and predictive values of the test will be calculated by standard methods.

Fecal Extraction

The protocol used for extraction of fecal porphyrins is a modification of that developed by Lockwood et al. (1995). Five milliliters of 12N HCL will be added to approximately 1.0 g of dry (lyophilized) feces. This mixture will be vortexed, allowed to sit for 5 minutes, and vortexed again. Fifteen milliliters of both diethyl ether and distilled H_2O will be added, and the mixture will be vortexed after each addition. To ensure that the porphyrins will be not denatured, the time elapsed between the addition of HC1 and H_2O will not exceed 10 minutes. This mixture will be then centrifuged at 3,000 RPM for 10 minutes. The aqueous phase will be centrifuged again at 4,000 RPM for 5 minutes, and the supernatant refrigerated in the dark until time of analysis. The aqueous phase, which contains all porphyrins, will be approximately 20 ml, and exact volumes will be recorded.

Diode-array Spectrophotometry

One milliliter of each fecal extraction will be measured spectrophotometrically using Perkins-Elmer diode-array spectrophotometer. Porphyrins have a characteristic absorbency in the Soret banc, between 390-440 nm. The high noise created by the dark color of aqueous phases complicates the spectra so the second derivative spectra (350-450 nm) will be obtained for all samples and standards. The relative concentration of total porphyrins will be obtained by relating the trough depth (as measured from the baseline) of a standard porphyrin kit (Porphyrin Products, Logan, UT) to the trough depth of each sample. Porphyrin could be detected in every sample with 0.76 nmoles being the lowest level detected in the 201 samples analyzed. The concentration of total porphyrins in each sample will be calculated from the equation:
Total Porphyrins (nmole/g dry feces) = TD*(6/stdTD)*20ml/(DW*VU)
where: TD=trough depth of sample, measured from baselines; 6/std TD=trough depth of standard kit (6nmole); DW=dry weight of sample initially used for extraction; VU=volume of sample used for diode array analysis.

HPLC Analysis

Two milliliters of the initial aqueous phase will be concentrated to approximately 1 ml using a SpeedVac concentrator. One-hundred fifty micorliters (μl) of each sample, which will be selected arbitrarily from the 201 extracted samples, will be injected into a Waters HPLC system to determine porphyrin profiles. A Waters 441 UV detector with a 405 nm filter will be used for sample analysis. A silica-C1 column with 5 μm packing will be obtained from Phenomenex, Inc. (Torrance, CA). The gradient solvent system for the HPLC used will be a modification of the procedure outlined by Lim and Peters (1984). Solvents for gradient elution will be 10% (v/v) acetonitrile in 1 M ammonium acetate

(Solvent A) and 10% (v/v) acetonitrile in methanol (Solvent B). All solvents will be HPLC grade (Fischer Scientific, Inc.). Porphyrins will be separated for 40 minutes with a linear gradient elution from 100% A to 100% B, followed by isocratic elution at 100% B for 20 minutes, then returning to 100% A over a 5 minute period. The flow rate will be 1 ml/minute at room temperature.

Statistical Analysis

After examination of blood profiles and immunological assays of otters (by Dr. A. Rebar), animals will be classified to their appropriate clinical state (effected, uncertain, not effected). We will use a Chi-Square analysis for tests of homogeneity of proportions among groups (Guenther 1973). For bioindicators we will produce response curves. We will use a repeated measures approach to fit the response curves and test for differences between the three treatment groups through time for haptoglobin, IL-6, P450, and total fecal porphyrins by examining a full model with dosage as a main effect and potential interaction terms between dosage and time (Johnson and Wichern, 1992). In addition, univariate ANOVA will be conducted for comparison of the three treatment groups at any point in time during the study. In addition to statistical analyses, we will follow the groups of 5 otters (Table 1) as a case-study for signs of clinical effects from oiling.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

This project is a collaborative research project of scientists from a variety of State (ADFG), university, and private research centers. University of Alaska Fairbanks will be responsible for the research work order, and contracts to Purdue University and Woods Hole Oceanographic Institute to assess health and oil exposure parameters.
Various transport aircraft and vessels will be chartered from the private sector. Local fishermen will be contracted to provide live prey.

Professional services contracts and Research Work Order mechanisms will be used to transfer funds from Trustee Agencies to university and private cooperators on this project. These will include contracts to Purdue University, Western Ecosystems Technology, Woods Hole Oceanographic Institute and others.

Oil Wildlife Care Network, University of California, Davis, has provided the PIs funding to conduct measurements on diving physiology (dive duration, oxygen consumption, and recovery times) and foraging behavior (capture success of different prey types) on the experimental animals. These measurements will be conducted in collaboration with Dr. Michael Castellini, Institute of Marine Sciences, UAF, and Dr. Terrie Williams, UC Santa Cruz and will maximize data collection from the experimental animals. These measurements will provide a link between the elevation of bioindicators in oiled otters and possible reduction in diving ability and foraging success.

SCHEDULE

A. Measurable tasks for FY98 and FY99

This project will begin in FY98 and will be completed in 1999.

Apr - May 1998:	Live - trapping of otters (PWS) and transport to Sealife Center
Jun 1998 - Feb 1999:	Conduct experiments at Sealife Center (Seward)
March 1999:	1. Release animals to the wild
	2. Attend Annual Restoration Workshop (Anchorage)
Jan - Sep 1999:	Data entry, analysis, and write up (Fairbanks and Seward)

B. Project milestones and endpoints

FY 98: Data collection
FY 99: Data collection and report submission

C. Completion Date

The work will be completed by Sept. 1999.

PUBLICATIONS AND REPORTS

All reports will be published in FY 99. We anticipate publishing at least 3 manuscripts from this project, related to effects of captivity, and oiling on bioindicators, and post rehabilitation success of release. At this point, prior to data collection, we are unable to provide titles. We predict that manuscripts will be appropriate for submission to the Journal of Wildlife Diseases, Environmental Toxicology, and the Journal of Animal Ecology.

PROFESSIONAL CONFERENCES

The senior scientists on this project will likely present project results at various forums in 1999. However, other than the annual *EVOS* meeting in March in Anchorage, presentations at professional conferences have not been identified or scheduled at this point. We propose to notify the Trustees of presentations and forums as they are scheduled.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The project is closely linked with the river otter section of the NVP project and with the

Sealife Center in Seward. The field component of this project will be fully integrated with the NVP project. The NVP project is providing additional funding for chartering the vessel that will be used to capture the otters. Also NVP personnel will join us in the capture work and assist with developing the new protocol for preparing samples for the P450 analysis. The costs of analyzing the blood samples from the field captures will be incurred by the NVP project. In the Sealife Center close contacts and working relationships have been established and lead-PI is joining the educational team of the Sealife Center and will mentor 3 local high school students in 3 science projects.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

We have changed the pattern of oil administration (see Table 1) following discussions with experts at the 5th International Conference on Effects of Oil on Wildlife, discussions with Dr. Jeff Short from the Auk Bay lab, discussions with Dr. Paul Snyder and D. Brenda Ballachy and discussions with Dr. John Blake from UAF. Deliberations with Dr. Jonna Mazet. OWCN; Dr. Julie Schwartz, and Dr. Chuck Mohr, UC Davis; Dr. David Jessup, OSPR; and Dr. John Blake. UAF, indicated that single or triple exposures of oil will be unlikely to produce the chronic responses we wish to investigate in this project. These individuals have previously conducted captive experiments on mink (unpublished), and although most of these projects tested for different bioindicators then we propose in this study, physiological responses at low doses were obtained only when oil was administered continuously for about 100 days. Therefore, we have changed the protocol of oil administration to last 100 days from mid July to the end of October 1998. At the same time following advice from Dr. Jeff Short, we have lowered the doses of oil to better reflect the potential exposure in the wild. These changes required changes to the tissue sampling protocols. Discussions with Dr. Paul Snyder and Dr. Brenda Ballachy assisted in the decision to increase the number of sampling sessions to include a longer period at the end of the oiling period. This was supported by discussions with Dr. Lyman McDonald on the optimal sampling schedule from the perspective of statistical analysis. Using the new protocol we will be able to produce response curves which will be extremely valuable for interpretation of field data. Therefore, the duration of sampling has increased by 3 months, the number of samples per otter increased to 10 samples of blood, and 5 samples of skin punches. The increase in number of samples will result in an increase the costs of lab analyses and technician time (see details in budget).
This increase in sampling duration should not affect the duration of captivity. Otters were scheduled stay in captivity until March 1999 to reduce the stress of release in mid-winter. One additional analysis has been requested by the permitting agency (ADFG). We are required under the permit (ADFG 98-001) to test the otters for three diseases that although rare in mustelids, can potentially be found in these animals. These test are required upon capture and prior to release, in fear that they may be introduced into the wild populations upon release of the captive animals. This analysis will add to the cost of the project (see details in budget).

PRINCIPAL INVESTIGATORS

Dr. Merav Ben-David
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Merav Ben-David, Ph.D. is a research associate with the Institute of Arctic Biology University of Alaska Fairbanks. She has extensive experience in studying behavior of mammals and birds under captive conditions. Her research concentrates on mustelids and predatory behavior. She is currently funded for three projects one of which involves developing new DNA techniques to estimate population levels of river otters (ASTF). She is an active member of the IUCN/SSC otter specialist group. Her responsibilities in this project include project coordination, trapping, and supervising all stages of work in captivity. She will be responsible for data analysis and report writing.

Dr. R. Terry Bowyer
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Dr. R. Terry Bowyer, Professor of Wildlife Ecology, University of Alaska Fairbanks. Dr. Bowyer has an extensive publication record (70). He has conducted extensive research on river otters and impacts of *EVOS* on this species (10 publications).His responsibilities will include data analysis and assistance in report writing.

Dr. Lawrence K. Duffy
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Dr. Lawrence Duffy, Professor of Chemistry and Biochemistry at the University of Alaska Fairbanks has been working in the area of toxicology for 15 years and is a member of the International Society of Toxicology. He has studied various bacterial and mammalian toxins. Since the *Exxon Valdez* oil spill, he has published six papers related to developing biomonitors. He is currently funded for two major environmental studies in Alaska. At the University, he teaches "Environmental Biochemistry and Biotechnology" and is a member of the Environmental Chemistry Program and Mammal Group. His

responsibilities in this project will be to conduct the biomarkers analysis.

OTHER KEY PERSONNEL

Dr. Lyman McDonald
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Dr. Lyman MacDonald, B.S., M.S. Oklahoma State University, PhD. Colorado State University, is a biometrician with 25 years of comprehensive experience in the application of statistical methods to design, conduct, and analyze environmental and laboratory studies. He has designed and managed both large and small environmental impact assessment and monitoring programs. His responsibilities will include providing advice on project design and statistical analysis.

Dr. Alan Rebar
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Dr. Alan Rebar is Dean of the School of Veterinary Medicine and Professor of Veterinary Clinical Pathology at Purdue University. He is internationally recognized as an expert in the field of clinical pathology and toxicology. He has been involved in EVOS studies of sea and river otters since 1991. His responsibilities will include conducting the physiological, pathological and immunological investigations.

Dr. Paul W. Snyder
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Dr. Paul W. Snyder is an Assistant Professor of Pathology and Immunotoxicology and Director of the Clinical Immunology laboratory of the Department of Veterinary Pathobiology, Purdue University. He is also a Diplomate of the American College of Veterinary Pathologists. His research interests are in the area of mechanism based studies

on the pathology and immunology of xenobiotics on biological systems. He has an NIH-funded project related to the immunobiology of environmental contaminants. His responsibilities will include conducting the physiological, pathological and immunological investigations.

Dr. Hans Kruuk
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Dr. Hans Kruuk is a leading researcher in carnivore ecology with international reputation. In recent years he has conducted extensive research on the European river otter as well as on other otter species worldwide. His publication record on river otters is the most extensive to date. He has successfully maintained river otters in captivity and conducted experiments on diving physiology of captive river otters. He will serve as an advisor to the project to assure the suceessful aclimation of the wildcaught animals to captive conditions.

Dr. Michael Castellini
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Dr. Michael castellini is an associate professor in the Institute of Marine Sciences University of Alaska Fairbanks. He is the coordinator of the Sealife Center Facility in Seward Alaska. He will be assisting with acclimating the river otters to the captive conditions and conducting the captive experiments.

Mr. Howard Golden
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Mr. Howard Golden is a researcher with the Alaska Dept. of Fish and Game, Division of Wildlife Conservation. His specialty is studying furbearers including river otters. He has extensive experience in live-trapping river otters as well as other furbearers. He will be involved in the trapping, transporting and release of the river otters.

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FY 99 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel	$63.9	$76.1
Travel	$15.1	$12.2
Contractual	$62.8	$73.3
Commodities	$8.7	$11.3
Equipment	$0.0	$0.0
Subtotal	$150.5	$172.9
Indirect	$37.6	$35.4
Project Total	$188.1	$208.3
Full-time Equivalents (FTE)	16.5	17.0
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

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

Dollar amounts are shown in thousands of dollars.

Comments:
1. Indirect costs at 25% as agreed with the University of Alaska Fairbanks. For contractual work with another institution at cost between 25,000 and 250,000 (Purdue University) indirect cost at 5%.
2. 3% of direct cost will be spent on community involvement.
3. 3% of direct cost will be spent on attending workshops and professional meetings.
4. Bench fees for housing otters in the Sealife Center will be negotiated directly between Trustees council and Sealife cooredinator.
5. Travel from lower 48 for Dr. Lyman McDonald to attend restoration meeting and discuss data analysis. Travel from Europe for Dr. Hans Kruuk for consultation on release of animals.
6. Three additional transmitters are available from NVP.

FY 99

Prepared: 3/25/98

Project Number: 98348
Project Title: Responses of river otters ot oil contamination: a controlled study of biological stress markers
Name: Institute of Arctic Biology - UAF

FORM 4A
Non-Trustee
SUMMARY

MPK 12/6/98

FY 99 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET
October 1, 1998 - September 30, 1999

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1999
	M. Ben-David	Principle Investigator - coordinator	9.0	4.5		40.5
	R. T. Bowyer	Principle Investigator - analysis and reprot	0.0	10.5		0.0
	L. K. Duffy	Principle Investigator - lab analyses	1.0	11.2		11.2
	O. Ormseth	Technician - data collection and animal ca	5.0	2.2		11.0
	A. Porchet	Technician - lab analyses	2.0	6.7		13.4
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	17.0	35.1	0.0	
					Personnel Total	$76.1

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1999
	Travel to Fairbanks from lower 48	0.8	1	4	0.1	1.2
	Travel to fairbanks from Europe	2.0	1	4	0.1	2.4
	Travel to Seward	0.2	6	20	0.1	3.2
	Travel to Anchorage	0.3	2	6	0.2	1.8
	Travel to professional meetings	0.8	2	10	0.2	3.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$12.2

FY 99

Prepared: 3/25/98

Project Number: 98348
Project Title: Responses of river otters ot oil contamination: a controlled study of biological stress markers
Name: Institute of Arctic Biology - UAF

FORM 4B
Personnel
& Travel
DETAIL

mpH 3/26/98

FY 99 EXXON VALDEZ TRUS COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Contractual Costs:	Proposed
Description	FY 1999
Statistical consultation	4.8
P450 - Woodshole @ 110.0 per sample 75 samples	8.3
Purdue (RT-PCR for P450, serum protein electrophorysis, lymphocyte transformation, Ig quant.) @ 260.0 per sample x 150 samples	39.0
Quest lab (CBC and full blood panel) @ 38.0 per sample x 150 samples	5.7
Disease screening (admission to ASLC, Aleutien, phocid and canine distemper) @ 55.0 per sample x 30 samples	1.7
Charter plane for release @ 600.0 x 6 flights	3.6
Telemetry flights after release @ 300.0 x 6 flights	1.8
Duplication and computer fees	5.0
Publication costs	2.4
Telephone	1.0
Contractual Total	$73.3

Commodities Costs:	Proposed
Description	FY 1999
Haptoglobin 8 kits (150 samples) @ 165.0 per kit	1.3
Interleukin-6 8 kits (150 samples) @ 550.0 per kit	4.4
Lab supplies for fecal porphyrins	2.0
Radiotransmitters @ 300.0 x 12 units	3.6
Commodities Total	$11.3

FY 99

Prepared: 3/25/98

Project Number: 98348
Project Title: Responses of river otters ot oil contamination: a controlled study of biological stress markers
Name: Institute of Arctic Biology - UAF

FORM 4B
Contractual & Commodities DETAIL

FY 99 EXXON VALDEZ TRU. COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1999
			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 analyzer	1	
Telonics receivers	2	
GPS unit	2	
Computer	2	
Radiotransmitters	3	

FY 99

Prepared: 3/25/98

Project Number: 98348
Project Title: Responses of river otters ot oil contamination: a controlled study of biological stress markers
Name: Institute of Arctic Biology - UAF

FORM 4B
Equipment
DETAIL

Development of Habitat-Based Population Assessment for Nearshore Rockfish along the Northern Gulf of Alaska

Project Number:	99354
Restoration Category:	Research and Monitoring
Proposer:	Alaska Department of Fish and Game
Lead Trustee Agency:	Alaska Department of Fish and Game
Cooperating Agencies:	None
Alaska SeaLife Center:	This project will provide specimens to project 99252
Duration:	1st year, 3- year project
Cost FY 99:	$236.5K
Cost FY 00:	$223.7K
Cost FY 01:	$223.7K
Cost FY 02:	$100.0K (close-out)
Geographic Area:	Outer Kenai Peninsula, Prince William Sound
Injured Resource/Service:	Nearshore Rockfishes

ABSTRACT

This project will develop habitat-based population assessment techniques for nearshore rockfish assemblages along the northern Gulf of Alaska coastline. Nearshore rockfishes (genus *Sebastes*) were the only fishes documented to have suffered direct mortalities immediately following the 1989 *Exxon Valdez* oil spill. Lost fishing opportunities for salmon and herring as a result of the EVOS, coupled with greater recreational effort, has increased exploitation of nearshore rockfish resources in recent years. Project 99354 will coalesce a variety of complimentary habitat-specific population assessment methods (transect dive survey, multiple mark-resighting, hydroacoustics and underwater video stations) for application to nearshore rockfish assemblages. The project will also collect rockfish tissue samples and live specimens for genetic analyses under SeaLife Center project 99252. Project results will be used to identify essential habitat for nearshore rockfishes.

INTRODUCTION

Nearshore rockfishes (genus *Sebastes*) were the only fish documented to have suffered direct mortalities immediately following the 1989 *Exxon Valdez* oil spill (Hoffman et al. 1991). Histopathological analyses of liver tissues indicated that moribund rockfishes were exposed to toxins (Hoffman et al. 1991).

Rockfish are an important ecosystem link, serving as food for a variety of species of marine fishes and mammals, as well as for humans. Lost fishing opportunities for salmon and herring as a result of the *Exxon Valdez* oil spill (EVOS), coupled with greater recreational effort, has produced increasingly intensive fishing pressure on nearshore rockfish resources in recent years. Some localized depletions have occurred in readily accessible areas, but population structures are poorly known, so the significance of these depletions is unclear. This project will develop and implement a habitat based method (O'Connell and Carlile 1993, North Pacific Fisheries Management Council 1997) for assessing nearshore rockfish populations in the northern Gulf of Alaska region impacted by the EVOS. The first year of the project will focus on technique development and the second and third years on assessment of rockfish populations along the northern Gulf of Alaska coastline. This project will collect tissue samples and live specimens for determination of rockfish population structure as part of SeaLife Center project 99252 (Investigations of Genetically Important Conservation Units of Species Inhabiting the EVOS Area). The project will also collect tissue samples for later energetic analyses at the SeaLife Center. Projects 99252 and 99354, will provide information needed to identify population units for management of the human use of nearshore rockfish, as well as the identification of potential rockfish marine refugia (National Marine Fisheries Service 1998).

NEED FOR THE PROJECT

A. Statement of the Problem

In the Gulf of Alaska, rockfish (*Sebastes spp.*) are managed as assemblages of pelagic shelf, demersal shelf, and slope species (Trowbridge 1996; North Pacific Fisheries Management Council 1997). Nearshore fisheries in the EVOS impacted area target the pelagic shelf species, particularly black, *S. melanops*; dusky, *S. ciliatus*; and Yellowtail, *S. flavidus* rockfishes, and demersal shelf species, particularly canary, *S. pinniger*; China, *S. nebulosus*; copper, *S. caurinus*, quillback, *S. maliger*, redbanded; *S. babcocki*; rosethorn, *S. helvomaculatus*; tiger *S. nigrocinctus*; and yelloweye; *S. rubberimus* rockfishes (Bechtol 1992). The pelagic shelf assemblage has generally been assessed through groundfish trawl surveys in offshore areas of the Gulf of Alaska (Clausen and Heifetz 1997). This technique does not accurately assess nearshore populations, and it is known to underestimate abundance, because (1) the gear can only be fished on relatively smooth bottoms, (2) rockfish tend to be associated with rocky substrates, and (3) some unknown portion of the population is in the water column and unavailable to the gear. More recently, line-transect submersible surveys have been used to assess demersal shelf rockfish, primarily yelloweye, in the eastern Gulf of Alaska (O'Connell and Carlile 1994; O'Connell et al. 1997), but this technique is very expensive and has only been applied to limited areas (O'Connell, personal communication).

Exploitation rates on nearshore rockfish have increased in recent years as commercial fisheries in the EVOS impact area were restricted after the spill due to contamination of fishing areas and failure of salmon and herring runs. Herring fisheries in PWS were closed in 1993, 1994, 1995 and 1996. In 1997, the herring harvest in the sound was only a fraction of pre-spill harvests. Since the spill, pink salmon harvests have also declined. In 1991, 1992 and 1994, pink salmon runs failed causing severe economic hardships in communities around the sound. The fishermen dependent on these resources are now looking for alternative economic opportunities. Recreational exploitation of nearshore rockfish along the outer Kenai Peninsula coast has also increased in recent years with development of the tourism industry. Construction of the Whittier road is expected to substantially increase recreational exploitation of rockfish in the EVOS impacted area.

Due to life history characteristics, rockfish are very vulnerable to overharvest. In the Gulf of Alaska, pelagic shelf species live over 50 years (Clausen and Heifetz 1997); demersal species in the Gulf of Alaska live over 100 years and may not begin to reproduce until age 20 or greater (Westrheim 1975, National Marine Fisheries Service 1997). Most species are ovoviviparous with internal fertilization and incubation of eggs (Boehlert et al. 1986). Parturition (larval release) occurs in spring or summer for most species (Westrheim 1975; Kendall and Lenarz 1986), but little is known about the distribution, feeding or in some species the duration of larval and juvenile stages (National Marine Fisheries Service 1997). Although rockfish often exhibit localized distributions (Archibald et al.1981), the population structure is generally unknown, so the significance of local depletions in areas of high exploitation is not clear.

In recent years, resource managers have begun to recognize the value of marine refugia for sustaining rockfish populations. Rockfish may benefit particularly from refugia, because they often exhibit localized distributions (Carlson and Haight 1972; Archibald et al.1981; Pearcy 1992) and reproductive potential is invested in relatively few old, large individuals (Leaman and Beamish 1984). In such cases, fishery alterations that affect the size structure and abundance of a population may threaten long-term stock survival (Dugan and Davis 1993). In a recent workshop, marine refugia were identified as one of the few constructive ways to address protection and conservation of essential rockfish habitat (National Marine Fisheries Service 1998). Dugan and Davis (1993) identified several potential effects of refugia on target species: (1) increased abundance, (2) increased mean individual size and age, (3) increased reproductive output, (4) enhanced recruitment inside and outside refugia, (5) maintenance of genetic diversity, and (6) enhanced fishery yields in adjacent areas. Refugia may further provide a means to deal with infrequent interdecadal recruitment events by allowing researchers to separate environmental from fishery effects. Refugia may also allow for incorporation of ecosystem principles into fisheries assemblage management, as well as, provide baseline data for more accurate stock assessment (National Marine Fisheries Service 1998). Energetic analyses of rockfish may provide a useful tool for identifying localized habitats that provide for greater individual growth rates and, thus, greater reproductive output (Archibald et al.1981, Smith et al 1988, Pearcy 1992, Paul et al. 1993).

Traditional assessment techniques that rely solely on trawl gear cannot be applied to rockfish in nearshore habitats, because survey gear tends to become entangled in the rocky substrate. Jigging machines have been used to determine relative abundance but have limited application for absolute abundance (Alaska Fisheries Development Foundation 1981). Transect methods using SCUBA have been used to provide population estimates for nearshore rockfish (Rosenthal et al. 1982a, Rosenthal et al. 1983), but only in

relatively shallow habitats due to limitations of depth and underwater time. Mark-recapture techniques may be used to evaluate the bias associated with other assessment methods (Davis and Anderson 1989), but more information is needed regarding tagging methods (Wallace and Tagart 1994), rockfish movements (Seber 1986, Davis and Anderson 1989), and detectability functions for tagged and untagged rockfish (Burnham et al. 1980; Buckland et al. 1993). Jig gear has been used in waters shallower than 20 m to support tagging studies (Rosenthal et al. 1982a; unpublished data), but rockfish retrieved from depths greater than 20 m depth exhibit nearly 100 percent mortality due to embolism (Gotshall 1964). A diver operated electroshocking system may provide an alternative to surface tagging with minimal mortality (Davis and Anderson 1989). Hydroacoustics may provide accurate abundance estimates for pelagic species (Starr et al. 1995), but the effect of light level on vertical distribution is unknown (Spyker and Van den Berghe 1995), and the most effective method for obtaining species\size composition of targets needs to be determined (Richards et al. 1991, Farron Wallace, Washington Dept. of Fish and Wildlife, Montesano, WA, personal communication). Underwater cameras operated from Remote Operated Vehicles (ROV) or towed sleds may be useful for assessing rockfish populations in low-relief habitats, but relatively poor vehicle control may limit applications in high-relief habitats (O'Connell and Carlile 1993, 1994). Sampling at underwater video stations has been used successfully to estimate nearshore rockfish abundance (Pacunski and Palsson 1998), but information regarding effects of time of day and habitat type on abundance estimates is lacking (Spyker and Van den Berghe 1995).

Several investigators have concluded that no single assessment method can accurately estimate rockfish abundance in all habitats and recommended a combination of habitat-specific methods. Adams et al. (1995) found that ROV surveys performed better than trawl surveys for demersal rockfish species associated with relatively flat bottom substrates, but the reverse was true for species that tended to swim off the bottom. In a comparison of trawl and dive surveys, Kulbicki and Wantiez (1990) concluded that both techniques provided biased estimates dependent on habitat use by different species. Uzmann et al. (1977) and Starr et al.(1995) also concluded that a combination of survey methods is probably needed to adequately estimate rockfish abundance. Project 99354 is designed to identify, develop, and combine a variety of habitat-specific assessment methods to provide the basis for management of nearshore rockfish in a sustainable manner.

Four assessment techniques will be evaluated for use in assessment of nearshore rockfish assemblages: (1) transect SCUBA dive surveys, (2) multiple mark-sightings, (3) hydroacoustics, and (4) underwater video stations. Transect dive surveys will be evaluated for application to demersal and pelagic species in shallow habitats. Underwater video stations and hydroacoustics will be evaluated for application to demersal and pelagic species, respectively, in both shallow and deep habitats. Multiple mark-sightings obtained from SCUBA surveys and video stations will be evaluated as a method for determining biases in other techniques.

B. Rationale/Link to Restoration

Nearshore rockfish suffered direct mortality and long-term sublethal effects from the 1989 EVOS. Lost fishing opportunities for salmon and herring as a result of the EVOS, coupled with greater recreational effort, has produced increasingly intensive fishing pressure on nearshore rockfish resources in recent years. Rockfish are very vulnerable to overharvest, because reproductive potential is invested in relatively few old, large individuals. Although some localized depletions have occurred in readily

accessible areas, population dynamics is poorly known, and long-term significance of depletions is unclear. Project 99354 will develop habitat-based assessment techniques for use by managers in setting appropriate harvest strategies to sustain rockfish populations in the spill impacted area. The project will also provide habitat and distribution information needed to identify sites for establishment of marine refugia, and will provide samples for determination of rockfish population structure as part of SeaLife Center project 99252.

C. Location

Field studies of rockfish habitat, abundance, and population structure will be conducted along coastal areas along the northern Gulf of Alaska coast from Prince William Sound to Cape Elizabeth during 1999-2001. Depending on results obtained from the first year of studies, field sites may also be established along the coast of Kodiak Island and the Alaska Peninsula.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Local residents and commercial, recreational, and subsistence fishermen will be solicited for information on the distribution of rockfish species and historical changes in those distributions. This information will be incorporated into a GIS database to aid researchers in identifying and classifying rockfish habitat. Laboratory analyses and reporting are technical pursuits that will be conducted or supervised by professional scientists. Wherever possible, local-hire will be used to fill field positions required for sampling or routine laboratory positions. People from communities in the EVOS-affected area will have an opportunity to participate in this project as employees of the ADF&G which gives local residents priority in hiring for state employment.

PROJECT DESIGN

A. Objectives

The overall goal of this project is to develop habitat-based assessment techniques for nearshore rockfish along the northern Gulf of Alaska to ensure this resource is managed in a sustainable manner. To accomplish this goal, four assessment techniques will be evaluated: (1) transect SCUBA dive surveys, (2) multiple mark-sightings, (3) hydroacoustics, and (4) underwater video stations. Specific objectives of this project are:

FY1999:

1. Utilize side-scan sonar to map rockfish habitat at six study sites.
2. Determine effective techniques for marking rockfish.
3. Determine feasibility of using SCUBA dive transects to assess nearshore rockfish abundance with emphasis on developing detectability functions.
4. Determine feasibility of using underwater video stations to assess nearshore rockfish abundance with emphasis on examining effects of habitat type and time of day on estimates.
5. Determine feasibility of conducting hydroacoustic surveys to assess nearshore

rockfish abundance with emphasis on examining effects of time of day on estimates and developing methods for estimating species or size composition of acoustic targets.

6. Document the extent of pelagic rockfish movements through sightings and recovery of marked rockfish.
7. Examine potential biases in assessing rockfish abundance among the four techniques investigated using multiple mark-sightings from SCUBA surveys and video stations, as well as any other information collected during this study.
8. Collect tissue samples and live specimens for genetic analyses under SeaLife Center project 99252, and store tissue samples for energetic analyses under a SeaLife Center project to be started in FY2000.

FY2000 & 2001:

9. Assemble existing bathymetric, geological, and biological data into a Geographical Information System database, and identify essential habitats for rockfish along the northern Gulf of Alaska coastline.
10. Implement a habitat-based assessment of rockfish populations along the northern Gulf of Alaska.
11. Collect tissue samples and live specimens for genetic analyses under SeaLife Center project 99252, and store tissue samples for energetic analyses under a SeaLife Center project to be started in FY2000.

B. Methods

Objective 1:

Digitized geo-referenced bathymetric and sediment type data available from the National Ocean Services (NOS) and National Geophysical Data Center (NGDC) will be used to identify six sites for FY1999 field studies. Additional bathymetric, sediment type, macrophyte, and fish resource data will also be compiled from previous studies to aid in site identification (Blackburn et al. 1983, Rosenthal et al. 1982a, Rosenthal 1983). Each study site will consist of an approximately 3000 m segment of shoreline. During early June the *R\V Montague* will conduct reconnaissance surveys of each site to map essential rockfish habitats. A side-scan sonar will be used in conjunction with commercially available seabed classification software (e.g. RoxAnn ™, Marine Micro Systems, Inc.) and a Differential Global Positioning System (DGPS) for data geo-referencing (Able et al. 1995, Auster et al. 1995, Zehner 1995, Yoklavich et al. 1995, Greenstreet et al. 1997). An underwater video system designed after Pacunski and Palsson (1998) will be used to develop a data set for interpretation of side-scan sonar data. The video camera will be mounted on a platform consisting of a tripod, 1.5 m in height, constructed from 2 cm diameter steel reinforcing rods. Weights will be attached to the bottom of the platform to improve stability in high currents. An underwater black-and-white video camera and light will be attached to a pan and tilt motor suspended from the apex of the tripod. A Kevlar line attached to the platform will be used to raise and lower the cage from a support vessel. A multistrand underwater electrical cable will be attached to the camera, light, and motor and extended to the vessel from where the pan and tilt of the camera will be controlled. The camera system will be deployed at selected sites and panned 360° to determine substrate type, vertical relief, habitat complexity and dominant biological cover. Habitats will be classified as (1) "rocky reef" comprised of bedrock, boulder, or hardpan, (2) "coarse bottom"

comprised of cobble or gravel, and (3) "fine bottom" comprised of sand or mud (Pacunski and Palsson 1998). Vertical relief will be determined from the relative elevation of the surrounding habitat to the camera. Habitat complexity will be subjectively estimated from the amount of crevice space 10 cm or greater within the survey plot. The prevalence of biotic cover (e.g. marine vegetation, colonial invertebrates) will be classified as either dominant (>50% of sample volume) or subdominant (<50% of sample volume).

Objective 2:

In FY1999, the application of tags to rockfish either brought to the surface or marked at depth by divers will be evaluated to determine the most effective technique for marking rockfish. These studies will be conducted in a rocky reef habitat where rockfish are relatively abundant. Rockfish will be captured for surface tagging by jigging at depths < 20 m. Hooked rockfish will be retrieved at a speed of < 0.3 m s^{-1} to minimize embolism (Morrison 1981, 1982), and will then be anesthetized in an immersion bath containing MS-222. Spaghetti anchor tags will be applied, and species, length, tag number, and condition will be recorded. Marked rockfish will be transferred to a floating net pen and held for 1 hour to evaluate short term tag retention and mortality. Rockfish will be captured at depth for marking using a diver-controlled electrofishing unit similar to the design of Phillips and Scolaro (1980). This apparatus consists of two stainless-steel electrodes placed 2 m apart on the bottom and connected to a surface vessel by lengths of copper welding cable. Rockfish will be attracted into the stunning field using bait. When a rockfish enters the field, a diver will signal an operator on the surface vessel to activate the apparatus. Stunned rockfish will be collected, measured for total length, and marked with spaghetti anchor tags. Marked rockfish will be held in nylon mesh bags for about 1 hour to evaluate short term tag retention and mortality. Date, time, depth, species, length, tag number, and condition upon release will be recorded for each rockfish. Initially, we will attempt to tag approximately 300 rockfish at each site (Davis and Anderson 1989). We will attempt to differentiate rockfish marked at the surface and at depth during SCUBA surveys and at video stations through the use of different tag colors, sizes, or shapes, and application of two tags to each rockfish marked at depth. Evaluation of marking effectiveness will be based on various factors, including marking rate, capture mortality, short term handling and marking mortality, as well as tag visibilty and retention (based on sighting during SCUBA surveys and at video stations).

Objective 3:

Beginning the day after tag application, systematic line-transect dive surveys will be conducted along eight equally spaced radial transects running out 500 m away from the tagging site (Seber 1982, Davis and Anderson 1989). A single four-person dive team will conduct each survey. Divers will work in pairs and alternate between diving and tendering. This approach will allow the crew to survey eight transects a day with adequate time for decompression between dives. Each transect will be divided into several 50 m segments. Each diver will swim along the transect line using a compass and count rockfish passing through an imaginary plane running perpendicular to the transect ahead of them. The distance at which rockfish can be counted will vary with depth and light level. Angle of the rockfish off the transect line, whether it is tagged or untagged, and species will be recorded. For each 50 m segment, the distance at which rockfish are counted ahead of divers will be recorded, as well as mean depth, substrate type (e.g., rock, boulder, cobble, gravel, sand), and biotic cover. Beginning and ending coordinates of

each transect will be recorded by the tendering crew using GPS equipment.

Detectability functions for tagged and untagged rockfish will be estimated from measurements of the distance of each rockfish observed by divers from the transect line. Distances of each rockfish from the transect line will be calculated later from each rockfish's estimated distance along the transect ahead of the diver and its angle off the transect line. Distances off the transect line will be placed into classes: 0-2 m, 2-4 m, 4-6 m, 6-8 m, etc. A frequency histogram for rockfish distance x from the transect may be viewed as approximating a probability density function *g(x)* describing the probability of detection by distance. It is assumed that detection on the transect line is certain, so rockfish occurring on the transect will have a detectability function $g(0) = 1$. Using least squares regression to estimate *g(x)*, a simple quadratic equation will be fit to the midpoints of each histogram class to obtain an estimate of the number of rockfish not detected. The quadratic equation will be scaled so the intercept representing *g(0)* is one.

The proportion of rockfish detected (P) is thus

$$E_x = \int_{t_1}^{t_2} |v(t)|^2 \, d$$

where, w = distance from the line (Burnham et al. 1980, Buckland et al. 1993). Different detectability functions will be estimated for different environmental conditions (e.g. water clarity, light level, etc.).

Objective 4:

Underwater video sampling will be conducted by the *R/V Montague* following methods described by Pacunski and Pallson (1998). The camera system was described under *Objective 1*. A DGPS will be used to geo-reference each sampling station. Habitat type, depth and time of day will be investigated to determine their effect on the abundance of demersal rockfish. A 3x2x3 factorial treatment design will be used to evaluate demersal rockfish abundance at all possible combinations of these factors. At each site, underwater video sampling will be conducted at shallow (<20 m) and deep stations (>20 m) within each of three habitat types: (1) "rocky reef" (2) "coarse bottom", and (3) "fine bottom". Surveys of each habitat-depth combination with be conducted during three time periods each day: 0800-1200, 1200-1600, and 1600-2000. Three sites containing each habitat-depth combination will be chosen for underwater video sampling during each two-week sampling period. One day will be required to complete video sampling at all habitat-depth-time combinations within each site. Each site will be surveyed four times during the two-week period. A minimum of two 360° sweeps of the viewing plane will be conducted during each camera deployment. During each sweep, the camera will be tilted up and down to screen the entire field surrounding the platform within 2 m of the bottom. A scaling system will be used to estimate the visible range of the camera for each deployment and measure selected fish targets. Visibility estimates will be validated from SCUBA observations and measurements of distance, camera angle, and water clarity. All activities including deployment, platform positioning, camera sweeps, and retrieval will be recorded on Hi-8mm video tape with a video cassette recorder. Videotapes will be labeled and archived for later laboratory analysis.

In the laboratory, video tapes will be reviewed and all fish observed within 2 m of the bottom during each camera sweep identified and enumerated. Habitat information will also be collected from the videotape including dominant and sub-dominant substrate, vertical relief, habitat complexity, and dominant and sub-dominant biological cover. Density estimates (no./m^2) for each species will be made by dividing the number of individuals (C) observed for each species during the camera sweep by the area viewed during the deployment. Image enhancement software will be used to aid in identifying fish species and measuring fish length. The viewing area (a) of the deployment will be determined by using the estimated visibility (V) as the radius in the area of a circle. For each species, density (f) will be estimated after Pacunski and Pallson (1998):

$$f = \frac{C}{a} = \frac{C}{(\pi V^2)}.$$

Split-plot analyses of variance will be used to test for effects of habitat (h), depth (d) and time of day (t) on the abundance of demersal rockfish at each site. Day will be treated as a random block. Two separate errors will be required for this analysis. Because the experimental units defined by unique habitat-depth stations will be independent, the first error is an estimation of the variation between these stations. Repeated surveys on the same experimental unit over time will tend to be less variable than measurements on different experimental units thus the second error will be an estimation of the variation within the times of day at each station. The general Anova table for the analysis is:

Source of Variation	DF
Block (day)	(b-1)
Habitat	(h-1)
Depth	(d-1)
Habitat x Depth	(h-1)(d-1)
Error(1)	((h)(d)-1)(b-1)
Time	(t-1)
Time x Habitat	(t-1)(h-1)
Time x Depth	(t-1)(d-1)
Time x Habitat x Depth	(t-1)(h-1)(d-1)
Error(2)	(h)(d)(t-1)(b-1)

Tukey's multiple comparisons tests will be used to test for differences between sites (Kuehl 1994).

Objective 5:

Hydroacoustic surveys will be conducted from the ADF&G research vessel *Montague* using a 70 kHz Biosonics DT4000 single-beam digital echosounder with a transducer mounted on a 1.2 m tow body in a down-looking configuration. The tow body will be operated at a depth of about 2 m approximately 5 m off the side of the vessel. Habitat type and time of day will be investigated to determine their effect on the abundance of pelagic rockfish. A 3x3 factorial treatment design will be used to evaluate pelagic rockfish abundance at all possible combinations of these factors. At each site, acoustic sampling will be conducted within each of three habitat types: (1) "rocky reef" comprised of bedrock, boulder, or

hardpan, (2) "coarse bottom" comprised of cobble or gravel, and (3) "fine bottom" comprised of sand or mud. Surveys of each habitat with be conducted during three time periods each day: 0800-1200, 1200-1600, and 1600-2000. Three sites containing each habitat will be chosen for acoustic sampling during each two-week sampling period. One day will be required to complete acoustic sampling at all habitat-time combinations within each site. Each site will be surveyed four times during a two-week period. Approximately, five transects perpendicular to shore will be sampled within each habitat type during each time period. Each transect will extend from the 10 m isobath to approximately the 100 m isobath or 0.5 km from shore which ever is less. The vessel will run at approximately 3 kt will sampling each transect.

Echo integration will be used to determine the density of acoustic targets within each depth interval. The echo integral (E_k) for depth interval *k* is given by

$$E_k = \int_{t_1}^{t_2} |v(t)|^2 \, dt$$

where v(t) is the voltage produced by the echosounder at time t. The time gate t_1 to t_2 is chosen to correspond to a specifc depth interval to be sampled (Ehrenberg and Lytle 1972). Each sample transect will be divided into *j* elementary distance sampling units (EDSU). The length of the EDSU's will be chosen to minimize serial correlation without unnecessarily eliminating information on rockfish distribution. The mean echo integral (E_{jk}) will then be calculated for each depth interval-EDSU cell (MacLennan and Simmonds 1992).

The biomass of rockfish per unit area in each cell (β_{jk}) is given by

$$E_{jk} = \int_{t_1}^{t_2} |v(t)|^2 \, dt$$

where C is a calibration factor, $\bar{g}$ is the mean TVG correction factor, ψ is the equivalent beam angle (a measure of beam width), $\langle \sigma \rangle$ is the mean acoustic cross section per unit weight of the target, and E_{jk} is the mean echo integral (MacLennan and Simmonds 1992). The target strength of fishes will be estimated from measured fish lengths (Love 1971, 1977). We will evaluate the use of jigging as well as underwater video focused on aggregations of fish as methods for estimating the length and species composition of acoustic targets. When possible, diver observations will be used to evaluate any bias associated with each method. The mean biomass of rockfish along the *i*th transect (β_i, kg m^{-2}) is given by

$$E_k = \int_{t_1}^{t_2} |v(t)|^2 \, dt$$

where n_{jk} is the number of depth interval-EDSU cells in the *i*th transect (MacLennan and Simmonds 1992).

Split-plot analyses of variance will be used to test for effects of habitat (h) and time of day (t) on biomass of pelagic rockfish at each site. Day will be treated as a random block. As in the underwater camera study, two separate errors will be required for the analysis:

Source of Variation	DF
Block (day)	(b-1)
Habitat	(h-1)
Error(1)	(h-1)(b-1)
Time	(t-1)
Time x Habitat	(t-1)(h-1)
Error(2)	(h)(t-1)(b-1)
Subsample	(h)(t)(b)(s-1)

Tukey's multiple comparisons tests will be used to test for differences between sites (Kuehl 1994).

Objective 6:

The extent of pelagic rockfish movements will be documented in through sightings of marked rockfish during SCUBA surveys and at video stations, and recoveries of marked rockfish during collection activities. The proportion of tagged to untagged rockfish relative to distance from the marking site during SCUBA surveys is one statistic that will be used to estimate rockfish dispersal within one to several days after marking. Information on tagged individuals obtained from video tapes as well as recoveries during collection activities in the same and subsequent years will help document movements over longer time periods.

Objective 7:

Biases in assessing rockfish abundance for the four techniques used will be examined. One way to do this is through use of multiple mark-sightings obtained from SCUBA surveys and at video stations. The ratio of tagged to untagged rockfish should remain constant if marked rockfish 1) retain their tags, 2) do not suffer greater mortality than unmarked rockfish, and 3) do not behave differently than unmarked rockfish, and if recruitment of unmarked rockfish into the population at the study site is small. A decline or increase in the ratio of tagged to untagged rockfish would indicate that one or more of these conditions is not being met. While this information is most helpful in determining the feasibility of doing mark-recapture experiments, it may also indicate the occurrence of large movements of rockfish into and out of study sites. Information collected in conjunction with *Objectives 5 and 6* may also help identify potential sources of bias within the various techniques used, including availability and accessibility of rockfish to the various types of sampling gear. A thorough comparison of results from the various techniques should allow us to determine the most appropriate technique, or suite of techniques, to use in assessing nearshore rockfish abundance.

Objective 8:

This project will also collect muscle plug and fin clip samples (n=50) from selected rockfish species at each study site for later genetic analyses at the SeaLife Center under project 99252. Specimens will be collected by jigging and electroshocking as described under objective 2. A sample (n=50) of fish from selected species will be collected while jigging for either tag application or identification of species\size composition of acoustic targets. Rockfish will be sacrificed for collection of genetic samples as well as otoliths for age determination. Length, weight, sex, and gonad maturity will also be measured for each of these rockfish. Additional genetic samples will be collected by diver-controlled electroshocking. This technique will allow genetic samples (fin clips) to be collected without sacrificing the specimen. For these rockfish, only length and species will be recorded. Muscle plug samples (n=50) will also be collected at each site for later energetic analysis at the SeaLife Center. It is anticipated that the University of Alaska will submit a project proposal for energetic analyses of rockfish in FY00.

FY00 & 01:

Objective 9:

Existing bathymetric, geological, and biological data will be assembled into a Geographical Information System (GIS) database. Digitized geo-referenced bathymetric and sediment type data are available from the National Ocean Services (NOS) and National Geophysical Data Center (NGDC) as well as through private vendors. Shoreline sediment data will also be obtained from aerial photographs, digitized and entered into the GIS database. Shoreline sediment types will be categorized as rock, boulder, cobble, gravel, sand, or mud. Additional bathymetric, sediment type, macrophyte, and fish resource data will be compiled from previous studies and entered into the GIS database when practical (Blackburn et al. 1983, Rosenthal et al. 1982, Rosenthal 1983). Local residents and commercial, recreational, and subsistence fishermen will be solicited for additional information on the distribution of rockfish species. This information will also be incorporated into the GIS database. The database will be used to identify 10 primary and 5 alternate study sites in each of three habitat types to be surveyed each year. Potential rockfish habitats will be classified on the basis of expected habitat quality and thus probable rockfish densities. High rockfish habitats will be identified by the presence of rocky reefs or known rockfish aggregations. Medium rockfish habitats will be identified by the presence of steep slopes, kelp beds, cobble bottoms or other potential habitats. Low rockfish habitats will include areas where the habitat type is unknown but appears to offer some possible rockfish habitat. Shoreline segments with sand or mud beach substrates and adjacent shallow sloping bottoms will not be included in the survey due to the low probability of occurrence of rockfish in these areas.

Objective 10:

The data obtained during FY99 will be used to identify the most appropriate method for application in specific habitats based upon general feasibility, precision, accuracy, daily cost, and daily area surveyed. The data collected in FY99 will further be used to determine appropriate sampling designs and sample sizes for those methods selected for implementation. As data continues to be collected in

FY00, sampling designs may be further modified to increase the accuracy and precision of the estimates.

Objective 11:

In FY00 & 01, this project will continue to collect muscle plug and fin clip samples from selected rockfish species at each study site for later genetic analyses at the SeaLife Center under project 99252. The methods employed will be the same as described under objective 5. It is further anticipated this project will collect samples for a University of Alaska rockfish energetics project beginning in FY00 at the SeaLife Center.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The Alaska Department of Fish and Game will complete all work on this project. University of Alaska researchers are expected to develop a complementary proposal in FY00 for energetic studies of rockfish at the SeaLife Center.

SCHEDULE

A. Measurable Project Tasks for FY 99 (October 1,1998 - September 30, 1999)

October – May:	Assemble bathymetric, geological, and biological data needed to identify FY99 study sites, purchase and/or assemble equipment and field test, certify divers.
Early June:	Map essential rockfish habitats at six study sites.
Late June:	Conduct first two-week field sampling trip.
Mid July:	Conduct second two-week field sampling trip.
August-Sept:	Analyze field data and begin evaluation of various sampling techniques.

B. Project Milestones and Endpoints

Field sampling needed to address objectives 1-5 will be completed in FY99 and these objectives will be achieved in early FY00 after a period of data analysis. Objectives 6 will completed prior to the FY00 field season, and the field work for objectives 7-8 will be achieved during the summer in FY00 and FY01. Two years of implementation of the assessment program will be needed to obtain habitat-specific abundance data from a sufficient number of sites within each habitat type to develop a habitat-based population estimate.

C. Completion Date

This project will be completed in FY02 under close out funding. A final report describing the results of the three years of the project will be submitted in April 2003.

PUBLICATIONS AND REPORTS

An annual report will be submitted to the EVOS Trustee Council by April 15 of each year. In addition, we plan to submit manuscripts to Fishery Bulletin describing (1) development of a habitat-based population assessment for nearshore rockfish in FY00, and (2) identification of potential nearshore rockfish refugia through habitat-based population assessments in FY02.

PROFESSIONAL CONFERENCES

Travel funds have been requested for this project to attend meetings with personnel in Anchorage and Juneau. Participation in two technical conferences are also planned: an American Fisheries Society meeting and the West Coast Groundfish Conference. The place and time for these latter meetings have not been set at this time.

NORMAL AGENCY MANAGEMENT

This project will develop a habitat-based assessment program for rockfish populations injured by the EVOS. The project will implement and refine the assessment techniques developed during the first year through surveys conducted in the spill impacted area. These studies will allow managers to set appropriate harvest levels needed to maintain rockfish populations in the spill impacted area, as well as to identify potential sites for establishment of marine refugia. The research and development work conducted through this project could not be supported through normal agency funding. The tools developed through this project will likely be applied in other spill impacted areas along the coast of Kodiak Island and the Alaska Peninsula in future years.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will collect fin clip and muscle plug samples of rockfish for genetic analyses under project 99252. The demographic data (distribution, age composition, migration) obtained from this project will further aid with interpretation of results from genetic analyses. We will also collect and archive rockfish muscle plug samples for later energetic analyses under a planned SeaLife Center study of rockfish energetics and developmental biology.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

This is a new project.

PRINCIPAL INVESTIGATOR

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Education: 1985 Master of Science, Fisheries Oceanography, University of Alaska Fairbanks. 1983 Bachelor of Science, Fisheries Science, University of Alaska Fairbanks.

Professional Experience: March 1991 - present: Research Biologist with the Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division in Cordova, Alaska. Supervised by Dr. Stephen Fried. Conduct various fisheries enhancement and evaluation projects in PWS including juvenile salmon growth studies, lake stocking, limnological investigations of sockeye salmon producing lakes, and quality control of coded-wire tagging at private hatcheries. Conduct fisheries oceanographic studies in PWS in cooperation with private hatcheries and University of Alaska investigators. Chairman of PWS Regional Planning Team. March 1986 - February 1991: Fisheries Instructor/ Assistant Research Professor, University of Alaska Fairbanks, School of Fisheries & Ocean Sciences, Supervised by Dr. Don Kramer. Conduct research on the effects of oceanographic conditions on the growth and survival of juvenile salmon in PWS, fish bioenergetics in an arctic lagoon ecosystem, age and growth of juvenile fish in the Chukchi and Bering Seas, ocean temperature variability in the North Pacific Ocean and effects on pink salmon production, salmon feeding on the high seas. Design and implement a program of education, research, and public service to promote fisheries development in northwest Alaska. Teach college level course in oceanography. Teach a marine safety and vocational training courses in fisheries.

Research Projects: Principal Investigator, Herring Natal Habitats, 1996-1998, Principal Investigator, Pink Salmon Embryo Mortality, 1996-1998, Principal Investigator, Otolith Thermal Mass Marking of Hatchery Pink Salmon in Prince William Sound, 1995-1997; Principal Investigator, SEA: Salmon Growth and Mortality, 1994-1995; Principal Investigator SEA: Salmon Predation, 1994-1998; Principal Investigator, Coghill Lake Sockeye Salmon Restoration, 1994-1995; Principal Investigator, Forage Fish Influence on Recovery of Injured Species - Fish Diet Overlap, 1994; Principal Investigator, Fish\Shellfish Study No. 4A, Early Marine Salmon Injury Assessment in Prince William Sound, 1991-1993; Co-investigator, Conceptual Model of the Ecosystem of Kasegaluk Lagoon, Alaska, 1989-1990; Co-investigator, Distribution, Abundance, Age and Growth of Fishes in the Southeast Chukchi Sea and Kotzebue Sound, 1987-1988.

Selected Publications:

Willette, T.M., R.T. Cooney, K. Hyer. 1998. *An evaluation of some factors affecting piscivory during the spring bloom in a subarctic embayment*, Can. J. Fish. Aquat. Sci. (in review).

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Willette, T.M., G. Carpenter, P. Sheilds, S. Carlson. 1994. Early marine injury assessment in Prince William Sound, Final Report the *Exxon Valdez* Trustee Council, Anchorage, Alaska, 78 p.

Willette, T.M., G. Carpenter, S. Carlson, G. Kyle. 1994. Restoration of Coghill Lake sockeye salmon. 1993 Annual Report to the *Exxon Valdez* Trustee Council, Anchorage, Alaska.

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Member: American Fisheries Society, Alaska Chapter.

OTHER KEY PERSONNEL

Bechtol, William R.

Education: University of Alaska, Fisheries, 1990 M.S.,University of Washington, Wildlife,1979 B.S.

Employment: Fisheries Biologist III, ADF&G, Homer, 1995-present; Fisheries Biologist II, ADF&G, Homer, 1992-1995; Fisheries Biologist I, ADF&G, Homer, 1986-92; Fisheries Technician III, ADF&G, Homer, 1981-86; Fisheries Technician III, ADF&G, Cordova, 1980; Commercial longline and pot shrimp fisherman in Prince William Sound, 1979-81; Fisheries Technician, Fisheries Research Institute, Seattle, 1979; Field Technician, N. Mex. Div. For., 1978.

Professional Experience: ADF&G, Commercial Fisheries, Research Project Leader, 1995-present, Primary responsibilities include research of commercial groundfish and shellfish fisheries in Cook Inlet, Prince William Sound, and state waters of the Central Gulf of Alaska; design and implementation of port and onboard observer sampling programs; herring egg deposition surveys in Prince William Sound using SCUBA; SCUBA surveys of log transfer facilities; development of fisheries regulations and management plans; surveys involving bottom and midwater trawls, longlines, scallop dredges, and clam shovels; principally involved in design and implementation of jig, line transect, and mark-recapture surveys, including use of SCUBA, to assess pelagic and demersal rockfish resources along the outer Kenai Peninsula. Currently a member of the Gulf of Alaska Groundfish Plan Team for the North Pacific

Fisheries Management Council, and also serving as Alaska Chapter vice president of the American Fisheries Society.

ADF&G, Fisheries Rehabilitation Enhancement and Development (FRED) Div., 1980-1989: Primary responsibilities included design and implementation of limnology surveys, particularly concerning juvenile sockeye rearing in barrier lake systems of lower Cook Inlet and the outer Kenai Peninsula; mark-recapture surveys to assess survival from different juvenile salmon rearing strategies; and aerial surveys to assess salmon escapements.

University of Washington, Fisheries Research Institute, 1979: Field technician in studies of side-scanning and upward-scanning hydroacoustic estimation of sockeye salmon escapement to the Kvichak River, Alaska.

Selected Publications:

Otis, E.O., **W.R. Bechtol,** and W.A. Bucher. *under review.* Maximizing the utility of run-age composition and auxiliary information to assess and manage the Pacific herring *Clupea pallasi* sac-roe fishery in Kamishak Bay, Alaska. In: Proceedings of the International Symposium on Fishery Stock Assessment Models for the 21st Century: combining multiple information sources. Alaska Sea Grant Report.

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Education: Master of Science, Statistics, Oregon State University, 1995. Bachelor of Science, Marine Biology, Humboldt State University, 1987.

Professional Experience: April 1996 - present: Biometrician, Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Cordova, Alaska. Supervised by Brian Bue. Collaborate with biologist to develop analytic techniques for various fisheries evaluation projects in PWS. September 1993 - December 1995: Graduate Research Assistant, Oregon State University, Department of Statistics, Corvallis, Oregon. Supervised by Dr. Scott Urquhart. Design and perform statistical research and analysis for environmental and fisheries management programs. June 1995 - August 1995: Research Statistician, Oregon Health Sciences University, Center for Research on Occupational and Environmental Toxicology, Portland, Oregon. Supervised by Dr. Kent Anger. Collaborate with scientists to develop analytic techniques for identifying neurotoxic disorders associated with chemical exposure. May 1988 - September 1993: Fishery Biologist I / Fishery Biologist II, Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Anchorage, Alaska. Supervised by Dave Mesiar. Project leader for the Kuskokwim River sonar project. Design and implement experiments to evaluate the feasibility of using sonar to count migrating salmon. Develop a test-net sampling program for purpose of species apportionment. Research Projects: EMAP: Techniques for estimating river miles in the Midappalachian Highlands 1994-1995; Oregon State University: Predictors of Mercury Levels in Fish 1994; Oregon Health Science University: Socioeconomic factors affecting performance on behavioral tests 1995.

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FY 99 EXXON VALDEZ TRU[illegible] COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$134.6
Travel		$2.8
Contractual		$27.5
Commodities		$8.4
Equipment		$41.1
Subtotal	$0.0	$214.4
General Administration		$22.1
Project Total	$0.0	$236.5
Full-time Equivalents (FTE)		1.5
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
	$223.7	$223.7	$100.0		

Dollar amounts are shown in thousands of dollars.

Comments:

One trip to Seattle is budgeted to meet with Washington Dept. of Fish and Wildlife staff regarding methods used for rockfish assessment in the Puget Sound area.

Overtime is actually Sea Duty during field sampling season.

FY 99

Prepared:

Project Number: 99354
Project Title: Development of Habitat-Based Population Assessment for Nearshore Rockfish along the Northern Gulf of Alaska
Agency: ADF&G

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 99 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1999
Mark Willette	Fishery Biologist III	18F	3.0	6.6	11.3	31.1
Karen Hyer	Bimetrician I	17C	4.0	5.6	2.0	24.4
Vacant	Fishery Biologist II	16E	4.0	5.6	10.4	32.8
Sandy Nehl	Field Office Assistant	11C	1.5	3.7		5.6
Vacant	Fish & Wildlife Technician III	11C	3.0	3.7	7.4	18.5
Vacant	Fish & Wildlife Technician III	11C	1.0	3.7	7.4	11.1
Vacant	Fish & Wildlife Technician III	11C	1.0	3.7	7.4	11.1
Note: Overtime column is sea duty pay.						
	Subtotal		17.5	32.6	45.9	
					Personnel Total	$134.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1999
Attend annual EVOS workshop	0.2	1	5	0.1	0.7
Two round trips between Homer and Cordova	0.4	2	2	0.1	1.0
One round trip between Anchorage and Seattle	0.6	1	5	0.1	1.1
				Travel Total	$2.8

FY 99

Prepared:

Project Number: 99354
Project Title: Development of Habitat-Based Population Assessment for Nearshore Rockfish along the Northern Gulf of Alaska
Agency: ADF&G

FORM 3B
Personnel
& Travel
DETAIL

FY 99 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Contractual Costs:	Proposed
Description	FY 1999
Air charter (7 hours x $275 per hour)	1.9
Vessel charter (24 days x $1000 days)	24.0
Diver certification training (4 classes x $400)	1.6
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$27.5

Commodities Costs:	Proposed
Description	FY 1999
Office & computer supplies (paper, toner, diskettes, etc.)	0.5
Field sampling supplies (boots, raingear, outboard parts, misc. parts, outboard fuel)	2.0
SCUBA tank hydrostat tests (15 tanks x 20 tanks each)	0.3
Bouyancy control devices (2 @ $400)	0.8
Dive gear replacement parts	1.2
Vessel fuel (3600 gals x $1 per gal.)	3.6
Commodities Total	$8.4

FY 99

Prepared:

Project Number: 99354
Project Title: Development of Habitat-Based Population Assessment for Nearshore Rockfish along the Northern Gulf of Alaska
Agency: ADF&G

FORM 3B
Contractual & Commodities DETAIL

FY 99 EXXON VALDEZ TRU[illegible] COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1999
Jigging machine	1	3.9	3.9
Underwater video camera w/ 150 m cable	2	1.8	3.6
Remote operated pan and tilt system	1	5.6	5.6
Underwater laser scaling system	1	5.0	5.0
Saltwater electroshocker system	1	2.0	2.0
Sidescan sonar bottom classification system	1	21.0	21.0
Those purchases associated with replacement equipment should be indicated by placement of an R.	**New Equipment Total**		$41.1

Existing Equipment Usage: Description	Number of Units	Inventory Agency
20' aluminum skiff w/ 90 hp outboard motor	1	ADFG
Recording light meter	1	ADFG
Profiling light meter	1	ADFG
Underwater video cameras with cable	2	ADFG
70kHz hydroacoustic system	1	ADFG
Dive regulators	29	ADFG
Dive depth/pressure gauges	14	ADFG
Dive backpacks	9	ADFG
Dive jumpsuits (various sizes)	12	ADFG
Dry suits (various sizes)	14	ADFG
Dive tanks	21	ADFG
58' Steel hull research vessel with scanning sonar equipment (Complete inventory on file at ADFG)	1	ADFG

FY 99

Project Number: 99354
Project Title: Development of Habitat-Based Population Assessment for Nearshore Rockfish along the Northern Gulf of Alaska
Agency: ADF&G

FORM 3B Equipment DETAIL

Prepared:

99360

The Exxon Valdez Oil Spill: Guidance for Future Research Activities "Submitted Under the BAA"

Project Number:	99360-BAA
Restoration Category:	
Proposer:	Chris Elfring, Polar Research Board, National Research Council
Lead Trustee Agency:	
Cooperating Agencies:	
Alaska SeaLife Center:	No
Duration:	1st year, 3-year project (24-month total)
Cost FY 99:	$181,700
Cost FY 00:	$185,260
Cost FY 01:	$35,580
Cost FY 02:	
Geographic Area:	
Injured Resource/Service:	potentially all, to varying degrees

ABSTRACT

The Polar Research Board (PRB) proposes to critique the scope, content, and structure of the draft science plan the *Exxon Valdez* Oil Spill Trust Council is preparing to guide long-term research and monitoring in the northern Gulf of Alaska. The committee formed to accomplish that task will also review the damage assessment and restoration research and monitoring activities sponsored by the Trustee Council to determine if they were of appropriate scope and carried out effectively, as well as consider the extensive literature produced to identify data gaps and conflicting conclusions. The lessons learned from the retrospective review will give guidance on the nature and scope of future activities.

INTRODUCTION

The Polar Research Board (PRB), a unit of the National Research Council (NRC), proposes to critique the scope, content, and structure of the draft science plan the *Exxon Valdez* Oil Spill Trust Council is preparing to guide long-term research and monitoring in the northern Gulf of Alaska. The study will also review the damage assessment and restoration research and monitoring activities sponsored by the Trustee Council to determine if they were of appropriate scope and carried out effectively, as well as consider the extensive literature produced to identify gaps and conflicting conclusions. The lessons learned from the retrospective review will give guidance on the nature and scope of future activities.

This study will be conducted by a special committee of volunteer experts, supported by a small staff and following standard NRC procedures regarding committee selection, committee operation, and report review. The committee will be composed of approximately 12 participants selected to have appropriate expertise and experience for this task. The committee will meet six times over a period of 24 months to gather information, deliberate, and produce a final report with conclusions and recommendations. This proposal seeks support for this activity in the amount of $402,540.

The NRC is the operating arm of the National Academy of Sciences and the National Academy of Engineering. It is a private, nonprofit organization operating under the authority of a charter granted by the Congress in 1863. The NRC is charged to be an independent advisor to the federal government and the nation on scientific and technical issues. The mission of the PRB is to promote excellence in polar science, including studies to address important issues in natural and social sciences, technology, environment, and natural resources. The PRB will receive input from the NRC's Board on Environmental Sciences and Toxicology (BEST), which has related experience.

NEED FOR THE PROJECT

A. Statement of the Problem

In 1989, the *T/V Exxon Valdez* spilled 11 million gallons of crude oil into Prince William Sound in Alaska. In 1991, the U.S. District Court approved a civil settlement that required Exxon Corporation to pay the United States and the State of Alaska $900 million over 10 years to restore the resources injured by the spill and compensate for the reduced or lost services (human uses) the resources provide. Under the court-approved terms of the settlement, a Trustee Council of three federal and three state members was formed to administer the funds. The mission of the Council is to return the environment to a "healthy, productive, world-renowned ecosystem" by restoring, replacing, enhancing, or acquiring the equivalent of natural resources injured by the spill and the services provided by those resources.

Funds from the *Exxon Valdez* Oil Spill Trust (EVOS) have been disbursed for almost 10 years, at first for damage assessment activities (approximately 1989-1991) and then in relation to identified important "resource clusters," or communities/resources affected by the oil spill (1992 to present). These include: (1) pink salmon; (2) Pacific herring; (3) Prince William Sound ecosystem assessment; (4) sockeye salmon; (5) cutthroat trout, Dolly Varden trout, rockfish, and pollock; (6) marine mammals; (7) nearshore ecosystem communities; (8) seabird/forage fish and related resources; (9) archaeological resources; (10) subsistence resources; (11) reduction of marine pollution; (12) habitat improvement; and (13) ecosystem synthesis. Extensive research has been conducted in each of these areas over the decade, both under the auspices of the Trust and the Exxon Corporation and by others, making this the most studied cold water marine oil spill in history.

The final payment from the Exxon Corporation will arrive in 2002, after which activities will be funded solely out of the Restoration Reserve, which was created from portions of the Exxon Corporation payments saved over the previous 10 years. A plan to guide future science activities is being developed, and the purpose of this study is to provide an independent scientific review of the draft plan for long-term monitoring and research to help ensure that plan is complete and scientifically sound. The study will review the plan's scope, content, and structure.

To plan for future science activities requires an understanding of the activities conducted to date. Thus this study will also examine the research conducted over the past 10 years and consider whether the program was of appropriate scope and carried out effectively. This retrospective review will provide an important framework for development of continued long-term restoration, research, monitoring, and management plans and it will help the Council plan for the wise and sustainable use of funds contained in the Restoration Reserve.

This study would be a part of the Trustee Council's increasing emphasis on the

integration and synthesis of what has been and is being learned from the various projects conducted to date, including the initial damage assessment phase, monitoring, research, and restoration. The integration and synthesis would enable the Council, the scientific community, and the public to better understand the effects of the oil spill and our capabilities to restore damaged resources.

B. Rationale/Link to Restoration

An independent assessment of the science program is important not only to determine whether the program has been comprehensive and effective but, more importantly, to integrate that information into future decision-making as decision-makers plan continued, long-term research and monitoring. While monitoring recovery, understanding the spill's effects, and undertaking needed restoration are tasks that will extend into the future, the scope and nature of such activities remain to be determined. The lessons learned would be broadly valuable to the nation in increasing our capability for responding effectively to other cold water oil spills.

C. Location

This project is a critique of the science plan and review of past efforts, and thus stands to deal with many locales.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

The committee charged to conduct this study will establish contact with the communities involved in or affected by science projects to inform them of this assessment, most likely through the Public Advisory Group or the community liaisons. The study itself will have no direct impacts on the communities. When the final report is available, a summary will be made widely available, full copies will be available on request, and the report will be posted on the National Academy of Sciences website.

PROJECT DESIGN

A. Objectives

This study will provide an independent scientific critique of the Trustee Council's draft plan for a long-term, interdisciplinary research and monitoring program in the Gulf of Alaska and will review the damage assessment and restoration research and monitoring activities conducted under the auspices of the *Exxon Valdez* Oil Spill Trust Council. To begin, the committee will attend the planned March 24-27, 1999 public overview symposium, "Legacy of an Oil Spill 10 Years After the *Exxon Valdez*," as an information-gathering orientation to the issues and research and otherwise become familiar with the nature and scope of the full portfolio of projects conducted to date.

The committee appointed to conduct this study will:

- Examine the research conducted within the resource clusters and consider whether the content of the research program was of appropriate scope and carried out effectively, and whether there were any significant gaps in the program. Because of the large volume and wide range of the research, it will be necessary to limit in-depth review to selected clusters, such as pink salmon and pacific herring, and key issues, such as

background hydrocarbon levels in the oil-spill area. The Trustee Council will request two such topics in advance of committee formation, while others will be selected by the committee at its first meeting.

- Examine the peer-reviewed literature related to those same selected resource clusters and key issues to identify instances of data gaps and conflicting conclusions about the effects of the oil spill (both short and longer-term).
- Critique in detail the scope, content, and structure of the *Exxon Valdez* Oil Spill Trust's draft plan for long-term research and monitoring.

The retrospective elements of the study should be of an overview nature, with the goal of identifying lessons that can be learned to ensure that the future science program is well planned. As part of assessing the program's effectiveness, the committee would conduct a general review of the projects funded overall, the amounts awarded, and the research publications that resulted, followed by more detailed examination of the selected resource clusters. The committee will not limit itself to research conducted using *Exxon Valdez* Oil Spill Trust funds, but look at the totality of activities as available in the peer-reviewed, published literature, with special attention to areas where the research presents conflicting conclusions and to identifying gaps in the knowledge base. The committee will not examine land acquisition or habitat protection efforts, except where related to the science program or in general as needed to understand the full scope of the Trust's activities.

B. Methods

This study will be conducted by a multidisciplinary committee of 12 members that includes experts in northern latitudes ecology, biological oceanography, fisheries biology, intertidal and subtidal communities, marine mammal biology, ornithology, population dynamics, environmental assessment, cold water oil spill chemistry and impacts, environmental restoration, and administration/planning of long-term research and monitoring. Committee members serve as volunteers, receiving reimbursement for travel and direct expenses only. They will be selected to bring the best expertise available as well as a diversity of perspectives; no members will have direct ties to parties involved in relevant litigation. Nominations for committee members will be sought from the involved boards, the National Academy of Sciences and the National Academy of Engineering, the Trust Council, and the research community. All members will be subject to standard NRC procedures regarding bias and conflict of interest. The Polar Research Board will be the primary oversight unit for this study, responsible for study design, the committee nomination process, day-to-day management, and report production; the Board on Environmental Studies will provide input into study design, committee nomination, and report review and provide back-up staffing if necessary.

The committee will meet 6 times over a 24 month period, first to become familiar with the science program to date, then look in depth at selected cluster areas, and then to carefully critique the draft plan for continued research and monitoring. The committee's first meeting will coincide with the March 1999 10th anniversary symposium. The committee may organize itself into subcommittees to give more focused attention to the cluster areas selected for in-depth review. The committee and its subcommittees may seek assistance from experts not on the committee to help the committee locate the most important of the extensive literature available. Close coordination with the Trust Council staff will be necessary to locate materials for the committee and otherwise support the review and critique.

From its information-gathering activities and deliberations, the committee will develop a final report with conclusions and recommendations. The committee's report will include

the principle findings from its retrospective examination of the *Exxon Valdez* Oil Spill Trust science program and details of its critique of the draft plan for future long-term monitoring and research in the Gulf of Alaska. The report development process will conform fully with the review procedures of the NRC.

Public Information About the Project: The NRC will post on its web site (http://www.nas.edu) a brief description of the project, as well as committee appointments with short biographies of the members, meeting notices, and other pertinent information, to afford the public greater knowledge of our activities, and an opportunity to make comments. The web site will also include an ongoing record of compliance to the requirements of Section 15 of the Federal Advisory Committee Act of 1997, and a certification of compliance will be provided when the study is completed.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Not applicable.

SCHEDULE

A. Measurable Project Tasks

FY 99 (October 1, 1998 - September 30, 1999)

January 30:	Committee nomination process complete; members appointed.
March 22	First day, first committee meeting; orientation to study goals
March 23-27	Members attend 10th anniversary symposium
March 28	Final day, first meeting; plan committee strategy and assign tasks
June	Second meeting, information-gathering activities
September	Third meeting, information-gathering activities and deliberations

FY 00 (October 1, 1999 - September 30, 2000)

January	Forth meeting, transition from retrospective review to critique of draft science plan
April	Fifth meeting, deliberations on draft science plan, draft report
July	Sixth meeting, report writing workshop
September	Report submitted for outside review

FY 01 (October 1, 2000 - December 30, 2000)

October	Response to review
November	Final revisions; Academy approvals
December	Report production and delivery

B. Project Milestones and Endpoints

In the three meetings scheduled for the project's first year, the committee will examine the research conducted within the "resource clusters" and consider whether the content of the research program was of appropriate scope and carried out effectively, and whether there were any significant gaps in the program. Because of the large volume and wide range of the research, it will be necessary to limit in-depth review to selected clusters, such as pink salmon and pacific herring, and key issues, such as background hydrocarbon levels in the oil-spill area. The Trustee Council will request two such topics in advance of committee formation, while others will be selected by the committee at its first meeting.

By the third meeting, the committee should be familiar enough with the program and the peer-reviewed literature related to the selected resource clusters and key issues to identify instances of data gaps and conflicting conclusions about the effects of the oil spill (both short and longer-term). Writing assignments and committee research activities will occur between meetings. As the committee moves into its second year, its focus will shift to its most important task: critiquing in detail the scope, content, and structure of the *Exxon Valdez* Oil Spill Trust's draft plan for long-term research and monitoring. The committee's final three meetings will be devoted to assessing the scope, content, and structure of the draft plan for long-term research. This will include whether the plan adequately addresses gaps in the knowledge base and existing uncertainties or conflicting information, as identified in the earlier phase of the study, as well as broader issues related to the plan's overall effectiveness for guiding continued efforts to return the Gulf of Alaska to a "healthy, productive, and world-renowned ecosystem."

C. Completion Date

The committee's final report will be delivered to the Trust Council and released to the public in December 2000. This product will be in final, albeit prepublication form with a published volume to follow from the National Academy Press within three months.

PUBLICATIONS AND REPORTS

The committee will provide periodic progress reports, noting the committee's activities and process. According to standard Academy operating procedures, no drafts or reports containing conclusions and recommendations will be available until the project is complete in December 2000.

PROFESSIONAL CONFERENCES

This proposal contains a request for travel funds for the committee and staff to attend the March 1998 10th anniversary symposium. The committee will hold its first meeting in conjunction with the symposium, meeting a day in advance to be oriented to its task and staying a day after the sessions to plan its study strategy.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will help the Trust Council in its efforts to synthesize and integrate the extensive research efforts conducted so far, and apply those lessons to the draft science plan. The committee will likely be briefed by Trust Council staff and sample principal investigators, visit field sites, and take other actions to gain a solid overview of the program and more detailed understanding of specific cluster areas (to be identified by the Council and the committee).

PROPOSED PRINCIPAL INVESTIGATOR

This study will be conducted by a volunteer committee composed of carefully selected scientists with expertise in northern latitudes ecology, biological oceanography, fisheries biology, intertidal and subtidal communities, marine mammal biology, ornithology, population dynamics, environmental assessment, cold water oil spill chemistry and

impacts, environmental restoration, and administration/planning of long-term research and monitoring. The committee will be selected via standard NRC procedures, including wide polling of the scientific community to identify candidates; final selection of members remains the responsibility of the Executive Office of the National Research Council.

The responsible staff officer for the activity will be:

Chris Elfring, Director
Polar Research Board (HA 454)
National Research Council
National Academy of Sciences, National Academy of Engineering
2101 Constitution Avenue NW
Washington, DC 20418
202-334-3426
202-3341477
celfring@nas.edu

PRINCIPAL INVESTIGATOR

CHRIS ELFRING is Director of the National Research Council's Polar Research Board (PRB). Since joining the NRC/NAS in 1988, she served first as a senior study director for the Water Science and Technology Board where she directed studies ranging from *Flood Risk Management and the American River Basin* (1995) to *Water Transfers in the West: Efficiency, Equity, and the Environment* (1992). Other projects have focused on soil and water research priorities for developing countries, climate change and water management, irrigation, and science in the national parks. She continues to conduct some work under the auspices of the WSTB, currently *New Strategies for America's Watersheds*. Since joining the PRB in late 1995, Ms. Elfring has been responsible for completing: *NOAA's Arctic Research Initiative: A Proceedings* (1997), *The United States In Antarctica: Comments from the PRB* (1997), *The Arctic Aeromedical Laboratory's Thyroid Function Study: A Radiological Risk and Ethical Analysis* (1996) and *The Bering Sea Ecosystem* (1996) Current projects address contamination in the Arctic, research priorities in the natural sciences in the Arctic, and a variety of other topics.

Before coming to the NRC, Ms. Elfring was a policy analyst at Congress's Office of Technology Assessment, where she focused on natural resource management. She first came to Washington in 1979 as a AAAS Congressional Fellow from the University of Wisconsin-Madison. She has a long-standing interest in topics with relevance to polar and northern climates, having worked on issues related to watershed management, sustainable development, public lands management, the environmental impacts of resource development, and alternative dispute resolution. In addition, in the spring of 1995 she was a resident fellow for The Island Institute in Sitka, Alaska, and enjoyed a unique opportunity to gain insights into Alaska's people, issues, and current scientific needs.

OTHER KEY PERSONNEL

The committee's membership will be determined upon receipt of funds, and after interaction with the Trust Council to identify the resource clusters it prefers to have assessed. The nature of the committee's membership will be tailored to address those areas. Selection of the committee is the responsibility of the NRC. Oversight for the study will be provided by the Polar Research Board. Its membership includes:

David Clark, University of Wisconsin-Madison (chairman)
Richard Alley, Pennsylvania State University
John B. Anderson, Rice University
Anthony Gow, CRREL, New Hampshire
Bernard Hallet, University of Washington
David Hofmann, NOAA, Boulder, CO
Donal Manahan, University of Southern California
James Morison, University of Washington
Walter Oechel, San Diego State University
Carole Seyfrit, Old Dominion University
Glenn Shaw, University of Alaska-Fairbanks
Thomas Taylor, University of Kansas
Robert Walker, Washington University

OTHER RELEVANT INFORMATION

FEDERAL ADVISORY COMMITTEE ACT

The Academy has developed interim policies and procedures to implement the Federal Advisory Committee Act, 5 U.S.C. § 1 et seq. (FACA), as amended by the Federal Advisory Committee Amendments Act of 1997, H.R. 2977, signed into law on December 17, 1997 (FACA Amendments). The FACA Amendments exempted the Academy from most of the requirements of FACA, but added a new Section 15 that includes certain requirements regarding public access and conflicts of interest that are applicable to agreements under which the Academy, using a committee, provides advice or recommendations to a Federal agency. In accordance with Section 15 of FACA, the Academy shall deliver along with its final report to NOAA a certification by the Responsible Staff Officer that the policies and procedures of the National Academy of Sciences that implement Section 15 of FACA have been complied with in connection with the performance of the contract /grant/cooperative agreement.

FY 99 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$31,516.0
Travel		$82,376.0
Contractual		$19,234.0
Commodities		$450.0
Equipment		$0.0
Subtotal	$0.0	$133,576.0
Indirect		$48,124.0
Project Total	$0.0	$181,700.0
Full-time Equivalents (FTE)		0.8
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2000	Estimated FY 2001	Estimated FY 2002
$185,260.0	$35,580.0	

Dollar amounts are shown in thousands of dollars.

Comments:

Workshop attendance for the committee and staff is approximately 16% of the FY1999 budget. Under contractual please note that we have included copying, technology and phone charges, meeting expenses. These are NOT necessarily contracted out.
Office supplies have been included under commodities.

INDIRECT COSTS: Attached is a copy of the current Negotiation Agreement between the National Academy of Sciences and the Office of Naval Research.

FY 99

Prepared: 4/10/98

Project Number: 99360
Project Title: Exxon Valdez Oil Spill Study
Name: National Academy of Sciences/Polar Research Board

FORM 4A
Non-Trustee
SUMMARY

FY 99 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1999
	Chris Elfring	Director, PRB	9.0	2306	0.0	20,751.0
	David Policansky	Sr. Staff Officer, BEST	9.0	531	0.0	4,779.0
	Carol Weber	Project Assistant	9.0	665	0.0	5,986.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	27.0	3502.0	0.0	
					Personnel Total	$31,516.0

Travel Costs:			Ticket	Round	Total	Daily	Proposed
	Description		Price	Trips	Days	Per Diem	FY 1999
	Anchorage	Workshop in Spring of 1999/Meeting	1200.0	14	84	142.0	28,728.0
	Anchorage	(or other Alaska City TBD) (2 separate meetings)	1200.0	28	112	179.0	53,648.0
		These estimates are based on current airfares,					0.0
		assuming reasonable restrictions on the travelers.					0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
							0.0
					Travel Total		$82,376.0

FY 99

Prepared: 4/10/98

Project Number:
Project Title: Exxon Valdez Oil Spill Study
Name: National Academy of Sciences/Polar Research Board

FORM 4B
Personnel
& Travel
DETAIL

FY 99 EXXON VALDEZ TRU[illegible]L COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Contractual Costs:	Proposed
Description	FY 1999
Photocopies	2,270.0
Postage/Delivery	900.0
Technology/Communications	2,574.0
Meeting Expenses (Room rental, breaks, transportation, site visits.)	12,800.0
Publications/Computer Research/Searches	690.0
Contractual Total	$19,234.0

Commodities Costs:	Proposed
Description	FY 1999
Office Supplies	450.0
Commodities Total	$450.0

FY 99

Prepared: 4/10/98

Project Number:
Project Title: Exxon Valdez Oil Spill Study
Name: National Academy of Sciences/Polar Research Board

FORM 4B
Contractual & Commodities DETAIL

FY 99 EXXON VALDEZ TRU[illegible] COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1999
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	

FY 99

Project Number:
Project Title: Exxon Valdez Oil Spill Study
Name: National Academy of Sciences/Polar Research Board

FORM 4B
Equipment
DETAIL

Prepared: 4/10/98

Dynamic Graphical Techniques for Ecosystem Synthesis, Communication and Product Delivery

(Submitted Under the BAA)

Project Number:	99361
Restoration Category:	Research and Monitoring (Ecosystem Synthesis)
Proposers:	Jennifer R. Allen and Robert T. Cooney
Lead Trustee Agency:	NOAA
Duration:	3 years
Cost FY 99:	$88.8 K
Cost FY 00:	$100K
Cost FY 01:	$60K
Geographic Area:	Spill-Affected Area

ABSTRACT

As the tenth anniversary of the *Exxon Valdez* Oil Spill (EVOS) approaches, there is an increasing need for information synthesis, translation and communication. Transfer of ecosystem-level research results to the public, resource managers, policy makers and the wider scientific community remains a critical challenge. A number of techniques developed within the Sound Ecosystem Assessment (SEA) program have proven useful in this context. Project 99361 will extend selected SEA technologies to support the broader synthesis tasks of the EVOS Trustee Council's research program. The proposed work will complement existing synthesis efforts by focusing on graphical approaches, including advanced computer imaging and presentation technology.

INTRODUCTION

In the seven years since the civil settlement following the *Exxon Valdez* oil spill (EVOS), the EVOS Trustee Council has overseen a wide-ranging and comprehensive scientific program. Over $98 million has been invested to date in research, monitoring and general restoration projects. Numerous single species projects have helped define the status of injured resources and track their recovery. In addition, the Trustee Council recognized the need for multidisciplinary ecosystem-level investigations (EVOSTC, 1994) to increase understanding of system processes and factors that may be constraining recovery. Prominent among these are the Sound Ecosystem Assessment (SEA), Nearshore Vertebrate Predator (NVP) and Alaska Predator Ecosystem Experiment (APEX) programs.

As the tenth anniversary of the oil spill approaches and the restoration phase research efforts are drawing to a close, several pressing needs are apparent.

- ☐ Firstly, information synthesis is needed within and between projects. Synthesis is the process of reducing large volumes of data into more summarized findings, and then integrating the findings of different projects, in order to draw conclusions about the state of the ecosystem or its key resources from a broad perspective. Strong efforts already underway in this area include Projects 300 and 330.
- ☐ Secondly, there is a need for translation and communication of results to non-specialists. It is important that the new knowledge and its implications be disseminated to the public, managers, decision makers and the scientific community in order for the goals and value of EVOSTC-funded research to be fully realized. This knowledge transfer is a critical step in providing a more informed basis for restoration activities, management, and design of future long-term monitoring plans.
- ☐ Thirdly, scientists from the EVOSTC-funded projects need to deliver products (applications, tools, working models or their output), in formats that are useful to managers and others who will use them. This applied technology transfer is key in the difficult process of assuring utility of the products for non-specialist end users.

The three tasks described above are interrelated. Good synthesis both *requires* successful translation/communication *and* contributes to it. The two activities thus necessarily occur in parallel, each process informing and enhancing the other as the results move toward maturity. Successful technology transfer is likewise dependent on underlying knowledge transfer. All three tasks were recognized by the Interagency Ecosystem Management Task Force as critical to implementation of ecosystem approaches in resource management (IEMTF, 1995). The 3-volume report of that task force included recommendations to: (a) direct funding into overview and translation activities, including comprehensive syntheses; and (b) establish and recognize as important the position/function of information specialist or scientific translator, to provide a key bridge between scientists, managers and the public (IEMTF, 1995).

Graphical display techniques provide a powerful communication tool which takes advantage of the potent information processing and comprehension abilities of the human visual system (Gershon, 1994). Graphically oriented communications can be highly effective at facilitating understanding through dynamic illustration of concepts and complex relationships. For example,

this approach can be used to create a compelling, comprehensible presentation that transmits an overall concept of "the big picture" and leaves the viewer with a frame of reference into which future information can be placed. Another example is the use of specialized data visualizations by scientists for "data interrogation" (investigation of dynamics and relationships); or to communicate observations to colleagues across disciplinary boundaries. A third application is development of intuitive graphical interfaces for delivery of modeling products which mathematically describe and simulate highly complex systems, yet need to be operationally understood and applied by a variety of end users. The common denominator in these examples is use of graphics technology to enable "high bandwidth" information transfer and to enhance comprehension. In the last several years, exponentially increasing computer processing speed and video handling capabilities, plus increasingly sophisticated mid-range software for graphics and video editing, have brought to the desktop power that was previously accessible only at great expense in professional production studios. This processing capacity enables routine use of high impact 3- and 4-dimensional simulations and animations that can facilitate understanding and communication of complex processes for both lay and scientific viewers. Much of this technology has already been implemented and applied successfully to marine ecosystem problems by the SEA program.

A strong effort at synthesis and integration is already underway within the EVOSTC process. Accomplishments to date include organization of a modeling effort to construct a mass balance food web model for Prince William Sound (Project 330); as well as production of the first in a series of written narratives organized by species, designed for lay readers, and initiation of a series of technical manuscripts that will collate restoration project results according to selected themes (Project 300). In these projects, the emphasis is on products that take the forms primarily of a functional model or written materials, respectively. The intent of the work proposed here is to complement existing synthesis efforts by focusing on graphical approaches, including advanced computer imaging and presentation technology. In addition, recent and imminent advances in Internet communications and satellite technology will be exploited to develop graphically oriented delivery vehicles for modeling applications.

NEED FOR THE PROJECT

A. Statement of the Problem

What is the problem to be addressed? Which injured resource or service is it designed restore?

Prior to the EVOS, research in Prince William Sound was generally unconnected, limited in scope, and focused on single species rather than multiple interactions (IEMTF, 1995). Since 1994, EVOSTC requests for research proposals have emphasized system-wide understanding. A sizeable portion of the funded research has been coordinated by interdisciplinary groups focusing on: (1) the failure of the Pacific herring and pink salmon runs and factors constraining production of these species; (2) the long-term decline in marine mammals and seabirds, with emphasis on whether harvest of food resources limits recovery of damaged resources; and (3) recovery problems in nearshore ecosystems, including whether toxic effects still constrain recovery of some resources. The EVOSTC programs have led to an unprecedented wealth of data on these and

other ecosystem-level questions. However, to accomplish the full intent and potential of the programs, and to maximize the value of the work completed, it remains necessary to complete a successful synthesis within and between EVOSTC-funded projects. This is likely to prove the most difficult part of the endeavor to date, since it requires a *modus operandi* that is not yet the norm in scientific research. Successful synthesis will require that scientists find a common language for sharing, explaining and jointly interpreting results and concepts across disciplinary boundaries. A second communication problem is the disparity which often exists between the needs of managers and the practices and language of scientists (summarized by IEMTF, 1995). One example is that scientific results are often either not immediately relevant or not in a form that can be readily used by managers. The EVOSTC process has substantively addressed these problems by encouraging active participation of managers in the research process from an early stage, as occurred in the SEA program. Nonetheless, there remains a significant bilateral translation problem that must be solved in order to achieve useful knowledge and technology transfer to resource managers. Thirdly, communicating the new integrated ecosystem-level understanding to non-scientific audiences, including the general public and policy makers, remains a critical challenge.

B. Rationale/Link to Restoration

Why should the work be done? Discuss how the project will address the problem.

For reasons discussed above (Introduction), it is proposed that application of graphical communications technology will provide a common language that can help address each of the three needs mentioned in [A]. Successful completion of this work "will enable the Trustee Council, the scientific community, and the public to view the effects of the oil spill and the long-term restoration management of injured resources and services from broad, multi-project and ecosystem-level perspectives. Having the benefit of these perspectives will not only aid interpretation of past results in regard to injury and recovery, but will also provide an improved framework for development of long-term restoration, research, monitoring and management plans." (EVOSTC, 1998).

C. Location

Where will the work be done? Where will its benefits be realized?

The work will be performed at the Prince William Sound Science Center (PWSSC) in Cordova, AK, and at the University of Alaska, Fairbanks. Benefits will be realized throughout the spill-affected area.

COMMUNITY INVOLVEMENT

How will affected communities be informed of the project and provide their input?

Affected communities will be informed of the project and may provide input via a dedicated web site created and maintained by the principal investigator (PI). Presentations to the Prince William Sound community will be made from time to time as opportunity permits, using forums such as the *"Notes from the Field"* series organized by the PWSSC.

PROJECT DESIGN

A. Objectives

The objective of this project for FY 99 are:

1.	To produce a dynamic graphical presentation, to be delivered at the 10-year Anniversary Workshop, that communicates the synthesized results of the 5-year SEA program, and its connections to other EVOSTC-funded studies, to lay and general scientific audiences. An archived version of this presentation will also be delivered to EVOSTC in video and/or CDROM formats for wider distribution.*
2.	To develop graphical, interactive, web-based formats for delivery of ecosystem numerical modeling products to non-specialist end users. Two functional applications from the SEA program (involving the circulation model and nekton model, respectively) will be used as examples to demonstrate general applicability of these delivery formats.*
3.	To develop, in close cooperation with Project 99300, a plan for extension of SEA presentation and synthesis techniques to the broader synthesis/integration tasks facing the EVOSTC research program. The plan will lay out procedures and a timeline for synthesis activity that culminates in a dynamic integrated presentation, similar to #1 but broader in scope (encompassing at minimum the three ecosystem projects), in FY01.

* *It should be noted that objectives #1 and #2 go beyond the scope of the work that was originally proposed for the SEA program and these tasks are not covered in the SEA FY99 budget. The added work proposed here takes advantage of newly available presentation and information delivery technology to enhance the contributions made by SEA to the synthesis, communication, and information dissemination tasks facing the EVOSTC. Objective #3 builds on successes and prototypes established in #1 and #2.*

If approved, implementation of the plan (#3) would follow in FY 00-01. The time course and scope of activities beyond FY 99 are flexible, depending on the wishes of the EVOSTC.

B. Methods

Much of the proposed work will be performed using advanced computer graphics techniques and equipment. The three major tasks proposed (synthesis, presentation, and product delivery) share considerable overlap in their hardware and software requirements and partial overlap in methodology. The shared elements will be described first, followed by a brief discussion of specific techniques.

1. Shared Elements

(a) Hardware

The following existing equipment is available to the project and will be used extensively in this

work (equipment origin is indicated in parentheses):

Sun Sparc20-ZX/192MB workstation (EVOSTC)
Thinkpad 770 graphics notebook computer (OSRI)
DVD, video I/O, frame grabber, hardware MPEG-I and II (OSRI)
Proxima92 XGA 500 lumen computer projector (OSRI)
Sony CDU926S CDROM recorder, 2x6 speed (EVOSTC)
HP Scanjet II color scanner (PWSSC)
Codonics dye sublimation color printer (EVOSTC)

The following equipment is requested in this proposal:

Digital camera, Agfa ePhoto 1280 or similar

(b) Software

The project will take advantage of a base of currently installed software for image handling and graphic design, at no new cost to EVOSTC. On the Unix side this includes X11-R6 programs such as: ImageTool, Xfig, Xv, Snapshot, Imconvert, and the ppm-related command-line utilities, as well as Pageview, Ghostview, GMT and CDRoast. In the Windows 95/98 environment, the base includes LView-pro, PhotoVue, ACDSee, VideoWave, Vmpeg, and the Corel Suite 8 programs including Presentations, Capture, CorelDraw, CorelPhotoPaint, Dream3D, and OCRTrace. In addition, some support is sought in this proposal for AVS (maintenance license for partial year) and Adobe Premiere (purchase).

AVS (Advanced Visualization System) is a high end scientific visualization system that is modular and programmable, based on an advanced data-flow paradigm that permits recursion, animation and upstream flow. It is used to analyze, manipulate and display large volumes of complex data, including images and multi-dimensional numeric data. AVS includes a comprehensive suite of standard data tools (2D plots and graphs, image processing), as well as more advanced capabilities such as 3D interactive rendering and volume visualization, streamlines and particle advection, isosurfaces and slice planes, and finite element data visualization. Both AVS-5 and Express are available to the project. Together they constitute the heart of the proposed visualization environment. The AVS system's strength for the synthesis endeavor comes from its ability to display multiple datasets simultaneously in realistic georeferenced 3-dimensional context, and then animate them over time. This facilitates multi-variable comparisons at several spatial scales as well as interactive interrogation of data and assessment of the evolution of patterns or trends that vary over time. Most input to AVS is taken in the form of ASCII files, with pre-processing performed in customized FORTRAN or PERL routines. The project can receive data in ASCII or HDF, or in any of a range of common spreadsheet and database input formats.

The smaller graphics utilities listed above will be used mostly for basic image handling, manipulation, and format conversion. The ppm-related group is particularly useful for script-based batch processing of large volumes of data or large numbers of files. Two-dimensional mapping tasks will be handled using GMT via a library of routines written by the PI and others in the SEA group. On the PC, basic image utility tasks will be handled by LView-pro, while

PhotoVue and ACDSee will provide good image sorting, indexing, retrieval and thumbnail display capability. Creative tasks will be handled within the coordinated Corel Suite of applications. PhotoShop and PageMaker are also available, but are not expected to be the primary tools for this work. Adobe Premiere 5.0 will provide advanced digital video editing capabilities with abundant features that enable creation of detailed storyboards and incorporation of video clips into multimedia presentations (see Ozer, 1997, for a comparative review of video editing software). The GPL software XCDroast, in conjunction with the X11-R6 libraries, will be used for CDROM mastering.

(c) Web-related Procedures

Web-based information exchange will be part of both the synthesis and product delivery tasks. An NCSA HTTP server (v1.5) running on a Sun Sparc20 platform will be the engine for the system. This server is currently operational and administered by the PI. HTML coding will be in accord with V3.2 standards (Raggett, 1997). Basic interactivity including forms capability will be provided through CGI techniques, using PERL as the primary scripting language. More advanced web-page features will be coded in Javascript. Applications will be developed in the JAVA language. Sun's JAVA compiler JDK V.1.0.2 is currently selected for use because V.1.1 is regarded as not yet stable. It is likely that industry standards issues will continue to be resolved during the next year and the final choice on dialect and version will be made accordingly. A preliminary version of the first component of a JAVA-based application from SEA (a regional wind vector interpolator needed as input to the circulation model) is available for viewing on request.

2. Specific Procedures

Three groups of specific procedures will be addressed under the headings:

(a) Synthesis tasks;

(b) Presentations; and

(c) Product delivery.

(a) **Synthesis Tasks**

[i] *Synthesis Activities in FY 99*

No support is sought in this proposal for internal SEA synthesis in FY 99, since this is covered within SEA FY 99 closeout funds. However, the ongoing SEA synthesis will be leveraged to the advantage of the extended work proposed here, in two ways:

1- It will provide the content essential for the expanded multimedia presentation that is proposed here (see below); and

2- Technologies built to handle the SEA synthesis logistics are directly extensible to the larger synthesis needs beyond SEA.

The technologies envisioned as potentially useful to the larger synthesis effort include SEA's web-based communications, visualization tools, and presentation capabilities. An internal web area or Intranet incorporating file upload capabilities and internal discussion forums allows users to post files directly to the web and engage in online group dialog (Allen and Patrick, 1997). Further, an Intranet is the ideal medium for the actual work of developing a synthesis, i.e. collecting the pieces and building the story, since construction performed online is simultaneously accessible to all participants, and the evolving story can be subject to continual review and refinement through input from the owners of the data/results being integrated. Also useful to the synthesis process are flexible methods for translation of disparate data into common visual form, for communication and comparison of findings between groups.

[ii] *Plan Development in FY99*

As part of the FY 99 work for which funding is requested here, a plan will be developed for extending selected SEA technologies to support the larger EVOSTC synthesis effort, beginning in FY 00. Key parameters for the plan are:

Scope: The technologies offered are those related to graphic and visual communications support, including web site, imaging, and computerized techniques for visual presentation of results (see below).

Focus: It is anticipated that the plan will focus primarily on integration and presentation of results from the three ecosystem studies (SEA, NVP, APEX) although it need not be limited to these projects.

Coordination: It is anticipated that this plan will be developed in close coordination with the leader of Project 99300, and that Projects 99300 and 99361 will be cooperative and synergistic.

[iii] *Possible Synthesis Activities FY 00-01*

If the plan produced in FY 99 is acceptable to the projects concerned and continued funding is approved, expanded synthesis activities would begin in FY 00. It is expected that early steps might involve a joint meeting of representatives from the ecosystem and synthesis projects, appointment of designees from each project to a joint synthesis committee, and establishment of a shared internal web site to conduct the business of accumulating materials needed to build the integrated story and presentation.

(b) **Presentations**

Support is requested in this proposal for creation of one or more high impact graphical presentations illustrating EVOSTC achievements in ecosystem research. The first of these, to be delivered in the week of March 24-29, 1999, will cover the final synthesis of the SEA program and its relationship to other EVOSTC studies. The display will be of similar type to the one demonstrated at the January 98 Workshop. However it will build upon and extend the latter

significantly, due, on one hand, to the more complex and tightly developed integration of results that will exist one year from now, and, on the other, to continuing expansion of technological capabilities. Techniques used will draw heavily on images, video, targeted animations, and special effects. These will be balanced with textual elements according to basic graphic design principles (Williams,1994; Priester,1995; Hooper,1997). The aim is to build the story gradually, progressively adding detail one component at a time while maintaining sight of the larger picture, so that the audience is left with an appreciation not just of *what* was done but also of *why* it was done and what was learned. The presentation will be aimed at a level suitable for an informed lay audience but will contain sufficient depth to be of interest to the general scientific community. Live delivery will be performed by a human speaker supported by a computer-projected video/slide show. The show will subsequently be transferred to video tape and CD-ROM for wider distribution by EVOSTC.

The above scope of work was formulated largely on the basis of popular demand following SEA's first attempt at this type of presentation. However, this level of production goes beyond what was originally proposed or planned in SEA.. Additional support is therefore being requested at this time in order to allow the production to realize its potential.

Techniques developed and refined while preparing the FY 99 production will have direct application to larger-scale presentations created after FY 99. The expanded FY 01 slide/video show will likely encompass all the features described above. It is readily apparent, however, that the graphical generation of the FY 01 show, although technically challenging, is not the most difficult component of the task. The biggest hurdle is the prior step of formulating the content and message, which will require completion of a successful synthesis. This content-creation step will require an intensive cross-project effort at information sharing, distillation and integration. It will be facilitated by the visual display and summarization techniques described earlier, and by continual feedback and correction from individual projects as the conclusions begin to take shape. It is expected that in an effort of this scope there will be areas where it is difficult to reach consensus regarding "the answer" and that lively discussion will ensue. This is an essential step for maximizing the accuracy and quality of the final product. The quality of the final presentation is likely to be directly proportional to the degree of cooperation and involvement of individual projects in arriving at the synthesis conclusions. The logistics of coordinating such an attempt at an integrated cross-program presentation are formidable but not insurmountable. As outlined above, mechanisms for managing the logistics will be explored during development of the synthesis/presentation plan (2.a.ii), which is in turn able to draw upon the SEA experience and coordination tools. Clearly, there is much overlap and interdependence between this project and Project 99300. The anticipated close collaboration between the two groups is expected to benefit the efficiency of both projects as well as enhance the final outcome.

(c) **Prototypes for Application Delivery**

The third component of the proposed work is concerned with use of graphically oriented computer communications for delivery of modeling applications and products. The flexibility of the hypertext transfer protocol (HTTP), the growing ubiquity of Internet access, and the power of the JAVA language will be exploited to develop intuitive, interactive, highly accessible, web-

based application interfaces designed to serve the needs of the non-specialist end user. Two functioning prototypes will be delivered to demonstrate the possibilities of the technique. These prototypes applications will be two products arising from the SEA models:

[i] Circulation

Three components will be sequentially added to this application.

1- Wind vector interpolation. This work is being undertaken in conjunction with Dr. David Eslinger. The object is to provide an interpolated 2-dimensional field of horizontal wind vectors required as realtime input to the circulation model. Continuously updated hourly readings from six meteorological stations and buoys in Prince William Sound (PWS) will be obtained by automated FTP. These will be interpolated according to a spatial algorithm developed in conjunction with local pilots familiar with orographic patterns in PWS. The resultant wind fields will be displayed graphically in near realtime on a web site, together with user-selectable recent past patterns in animated form. The display will incorporate present meteorological conditions superimposed over the changing wind fields, and will provide access to a record of half-hourly sea state information for the preceding 12 hours from the NOAA buoys.

2- Interactive selection of circulation scenarios. In conjunction with Dr. Jia Wang, a set of circulation pattern simulations under a range of input weather conditions will be compiled. An interactive interface will be conducted to enable users to formulate what-if scenarios and then examine circulation pattern responses. Output will be in the form of animated current fields with start, stop, speed adjust, and interactive pan and zoom capabilities.

3- Prototype for near realtime display. This prototype will address data handling and storage formats and graphic display requirements for efficient near realtime display of output from a continuously running circulation model. The target is to have the product small enough to be viable for delivery to large and small vessels inside PWS.

[ii] Nekton

Components of this prototype follow a similar sequence to the above. They include:

1- Tracking of accessible input components to the SEA nekton model, such as a continuously running web page readout of relevant weather conditions, plankton watch data, and CFOS fluorescence readings as the spring plankton bloom approaches; and tracking of hatchery release dates and data as the salmon fry outmigration begins.

2- Interactive selection of scenarios. To be developed in conjunction with Dr. Vince Patrick and collaborating ADF&G resource managers, this segment will allow users to simulate what-if scenarios by selecting from a range of available input parameters and then viewing the graphical responses predicted by the fry survival model.

3- Prototype for "near realtime" display. Also in conjunction with Dr. Patrick and collaborating resource managers, this will be an extension of #2 which aims to

incorporate as far as possible the information known about the present season, as it develops, and explores the likely consequences for salmon fry survival.

This work leverages some early applied products from the concluding SEA effort. The functioning prototypes described here will add to the value of the modeling products by making the concepts and results more available, and possibly more understandable, to a wider audience. However, the emphasis of the proposed activity will be on developing interfaces suitable for delivery of a variety of different applications. The results of this work will include a set of generic routines in JAVA, PERL and HTML that can be re-used in modular fashion to deliver other model-related applications having interactivity and/or near realtime display as requirements.

SCHEDULE

A. Measurable Project Tasks for FY 99

DATE	TASK
	October 1, 1998: Funding period begins
October 30, 1998:	✓ Functioning online weather and wind interpolation generator
December 30, 1998:	✓ Functioning online circulation model products: access to pre-run simulation scenarios with interactive selection of input parameter combinations
March 24-29, 1999:	✓ Oral presentation of SEA graphical synthesis at 10 year Anniversary Workshop
April 15, 1999:	✓ Deliver preliminary draft of plan for extension of synthesis techniques to broader EVOSTC program (in conjunction with proposal for continuation of work in FY 00)
June 30, 1999:	✓ Functioning prototype for management of circulation model data output and realtime online delivery
June 30: 1999:	✓ Plan for nekton model product – jointly with ADF&G – online interactive interface to tools for preliminary run-strength prediction (model validation phase)
September 30, 1999:	✓ Functioning prototype for nekton model product – with ADF&G – online interactive interface to tools for preliminary run-strength prediction (model validation phase)
September 30, 1999:	✓ SEA CD/video completed
	September 30, 1998: Funding period ends
April 15, 2000:	✓ Deliver final report, FY 99

B. Project Milestones and Endpoints

MILESTONE / DELIVERABLE	DATE
FY 99	
1. Dynamic graphical presentation of SEA synthesis	
(a) Present at Anniversary Workshop	March 24-29, 1999
(b) CD/Video completed in final form	September 30, 1999
2. Graphical, interactive, web-based formats for delivery of ecosystem modeling products to non-specialist end users.	
(a) Circulation prototype functional	June 30, 1999
(b) Nekton prototype functional	September 30, 1999
3. Plan for extension of SEA techniques (web, graphical display and presentation) to assist with broader EVOSTC synthesis and integration.	
(a) Preliminary draft delivered with FY 00 proposal	April 15, 1999
(b) Final version completed	September 30, 1999
Potential FY 00-01	
1. Functioning internal web site and graphical support for ongoing synthesis across EVOSTC projects	start date to be determined
2. Dynamic graphical presentation of synthesis of ecosystem projects	
(a) Delivered for FY 01 Restoration Workshop	end of January, 2001
(b) CD/Video format final	September 30, 2001

C. Completion Date

The anticipated completion date is September 30, 2001. This schedule presumes that the last ecosystem project to finish (APEX) will be completed in FY00; hence the plan to deliver a synthesized presentation in the following year, FY01.

PUBLICATIONS AND REPORTS

What publications do you intend to submit in FY 99, if any?

1. Scientific visualization in model-based study of a marine ecosystem. Allen, J.R., Patrick, E.V. and Thomas, G.L. Proc. 127th Ann. Mtg Am. Fish. Soc., Monterey, CA.

2. The SEA Intranet: Scientific collaboration in a shared information space by a multidisciplinary, geographically distributed research team. Allen, J.R., Patrick, E.V. and Cooney, R.T. IJHCI.

COORDINATION AND INTEGRATION

Mechanisms to achieve and demonstrate large scale coordination and integration among restoration projects will be a product of this work. In addition there are several coordination tasks internal to the project in FY99. Coordination among SEA PI's in generating the FY99 presentation will be achieved through the SEA internal web site, augmented by teleconferences and one meeting. There will be regular communications with several colleagues from ADF&G during prototyping of fisheries related model applications, by means of regular face to face meeting and electronic correspondence. Thirdly, collaboration with Dr. Gunther will be critical during generation of the synthesis/presentation development plan in FY99. Regular communications are expected and travel funds are requested for one Cordova-Oakland round trip for planning purposes. Dialog with representatives of the other ecosystem projects will be initiated early in the process.

PRINCIPAL INVESTIGATORS

Jennifer R. Allen
Prince William Sound Science Center
P.O. Box 705,
Cordova, AK 99574
tel: 907-424-5800
jrallen@grizzly.pwssc.gen.ak.us

Robert T. Cooney
Institute of Marine Science
School of Fisheries and Ocean Sciences
University of Alaska
Fairbanks, AK 99775-7220
907-474-7407 cooney@murre.ims.uaf.edu

Qualifications

Jennifer Allen has a background in digital image processing, scientific visualization and computer communications. She has been active for several years in the synthesis and presentation arenas of the SEA program, including development of the SEA web site, oversight of web-based synthesis activities, and production of the 1997 SEA presentation at the January 98 Restoration Workshop. Ted Cooney is Chief Scientist of the SEA program. In addition to a distinguished research career in fisheries oceanography , Dr. Cooney has a successful track record in synthesis undertakings in cooperative multi-disciplinary research. (See biographical sketches below.)

OTHER KEY PERSONNEL

Ravi Kulkarni is a computer scientist and visualization specialist at the Advanced Visualization Laboratory, University of Maryland. He served as a consultant for the SEA program and is responsible for expert technological advice that led to much of the successful scientific visualization capability developed by that team. He will act as a consultant to this project.

Vince Patrick is a numerical modeler and Director of Information Systems at PWSSC. Through his modeling activities he is responsible for mathematical integration of datasets across projects in the SEA program and thus is a key figure in continuing synthesis of results from these projects. He is also responsible for delivering the models whose applications are the subject of the delivery formats described in this proposal. The PI will work closely with Dr. Patrick in delivery of these end-user applications.

Jennifer R. Allen

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907-424-5800 jrallen@grizzly.pwssc.gen.ak.us

EDUCATION

1983	Bachelor of Veterinary Science (First Class Honors) University of Sydney, Australia *[this degree equivalent to the DVM in the Unites States.]*
1985	Residency in Equine Medicine and Surgery, Washington State University, Pullman, WA, USA

EMPLOYMENT

1994-present	Technical Project Manager and Information Systems Specialist Prince William Sound Science Center, Cordova AK
1989-93	Research Assistant and Teaching Assistant Program in Statistics, Washington State University, Pullman WA
1985-89	Research Associate College of Veterinary Medicine, Washington State University
1984-85	Resident in Equine Medicine and Surgery College of Veterinary Medicine, Washington State University

SELECTED PUBLICATIONS

Allen, J.R. and Patrick E.V. (1997) The SEA Intranet: Story of a long-distance collaboration. Presented at 48th AAAS Arctic Division Science Conference, Valdez Alaska, September, 1997.

Allen, J.R., Patrick, E.V. and Thomas, G.L. (1997) Scientific visualization in model-based study of a marine ecosystem. Presented at 127th Annual Meeting American Fisheries Society, Monterey CA, August, 1997.

Allen, J.R., Patrick, E.V. and Cooney, R.T. (1997) The SEA Intranet: Scientific collaboration in a shared information space by a multidisciplinary, geographically distributed research team. In preparation.

Patrick, E.V., Mason, D., Kulkarni, R. and Allen, J.R. (1996) The SEA evolution equation model for pink salmon fry: Results and visualization of the subecosystem of northwest Prince William Sound. Presented at AGU 1996 Spring Meeting, San Diego, February 1996

Thomas, G.L., Patrick, E.V., Kirsch, J. and Allen, J.R. (1996) Development of an ecosystem model for managing the fisheries resources of Prince William Sound. Presented at Second World Fisheries Congress, Brisbane Australia, August 1996.

Allen, J.R., Kulkarni, R. and Patrick, E.V. (1995) Visualizing data and processes for a marine ecosystem. Presented at the 46th Arctic Division Science Conference, American Association for the Advancement of Science, Fairbanks, AK, September 1995.

Thomas, G.L., Kirsch, J., Allen, J.R. and Willette, M. (1995) Temporal and spatial dynamics of the walleye pollock, *Theagra chalcogramma*, population along the outmigratory route of pink salmon fry, s, in Prince William Sound, Alaska. Presented at the 46th Arctic Division Science Conference, American Association for the Advancement of Science, Fairbanks, AK, September 1995.

Robert T. Cooney

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School of Fisheries and Ocean Sciences
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Fairbanks, AK 99775-7220
907-474-7407 cooney@murre.ims.uaf.edu

EDUCATION

1971	University of Washington; Ph.D., Oceanography
1967	University of Washington; M.S., Oceanography
1964	University of Washington; B.S., Oceanography

EXPERIENCE

Teaching:	OCN 650 Biological Oceanography, 1975-present
Lead Scientist:	Sound Ecosystem Assessment (SEA): An integrated science plan for the restoration of injured species in Prince William Sound . Exxon Valdez Oil Spill Trustee Council 1994-present.
Principal Investigator:	The application of real-time oceanographic monitoring and remote sensing to pink salmon management and enhancement. Alaska Science and Technology Foundation, 1991-1994.
Principal Investigator:	Cooperative Fisheries and Oceanographic Studies (CFOS). Alaska Sea Grant College Program, 1990-1994.
Principal Investigator:	Examining the structural properties of a near surface sound scattering layer in the Gulf of Alaska using remotely operated vehicle technology. National Undersea Research Program, 1988.

SELECTED PUBLICATIONS

Cooney, R.T., T.M.Willette, S. Sharr, D. Sharp and J. Olsen (1995) The effect of climate on North Pacific pink salmon (*Onchorhynchus gorbuscha*) production: Examining some details of a natural experiment. In: R.J. Beamish (ed.) Climate Change and Northern Fish Populations. Can. Spec. Publ. Fish. Aquat. Sci. 121:475-482.

Coyle, K.O. and R.T.Cooney (1993) Water column sound scattering and hydrography around the Pribilof Islands, Bering Sea. Cont. Shelf Res. 13(7):803-827.

Cooney, R.T. (1993) A theoretical evaluation of the carrying capacity of Prince William Sound, Alaska, for juvenile Pacific salmon. Fish. Res. 18:77-87.

Russel, W.R., G.L.Hunt, K.O.Coyle, and R.T.Cooney (1992) Foraging in a fractal environment: Spatial patterns in a marine predator-prey system. Landscape Ecol. 7(3):195-209.

Cooney, R.T. and T.M.Willette (1991) Regional-level investigations of pink salmon production responses to interannual variations in ocean temperatures: Cooperative Fisheries and Oceanographic Studies (CFOS). Proceedings of the 15th Northeast Pacific Pink and Chum Salmon Workshop 15:50-62.

Willette, T.M. and R.T.Cooney (1991) An emprirical orthogonal functions analysis of sea surface temperature anomalies in the North Pacific Ocean and cross-correlation with pink salmon returns to south-eastern Alaska. Proceedings of the 15th Northeast Pacific Pink and Chum Salmon Workshop 15:111-121.

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Allen, J.R. and Patrick E.V. (1997) The SEA Intranet: Story of a long-distance collaboration. Presented at 48th AAAS Arctic Division Science Conference, Valdez, AK September, 1997.

EVOSTC (1994). Exxon Valdez Oil Spill Restoration Plan. Anchorage, AK.

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IEMTF (1995) Interagency Ecosystem Management Task Force Report: The Ecosystem Approach. Volume II: Implementation Issues; Volume III: Case Studies. NTIS #PB95-265575.

Ozer, J. (1997) Publishing Digital Video. Chapter 11: Video Editing; Ch 13: MPEG-II Technology. Academic Press.

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Raggett, D. (1997) HTML 3.2 Reference Specification. W3C Recommendation, January 14, 1997. REC-html32. http://www.w3.org/TR/REC-html32.html

Stein, L.D. (1998) Web Security: Complete Reference. Addison-Wesley Publishing Co., NY.

Williams, R. (1994) The Non-Designers Design Book. Design and Typographic Principles. Peachpit Press, Berkeley, CA.

BUDGET

Justification

This proposal is primarily requesting salary support. Use of existing equipment and software installations will be emphasized to keep costs to a minimum. In addition, two newly purchased large equipment items are available to the project through cost-sharing with the Oil Spill Recovery Institute: the Proxima-92 XGA computer projector, list price $12,000; and IBM ThinkPad 770 portable graphics station, $7,600. Some software support is requested to assist in payment of the annual license fee for AVS, which will be required for visualization work; and to purchase video editing software, which has not previously been required in the SEA program. The requested equipment item (a medium level digital camera) will permit efficient collection of digital images for use in slide productions and will yield a higher quality product than use of a scanner or slide digitizer. The model selected is the Editor's Choice in an April 98 review published by PhotoGraphic magazine; it provides high pixel resolution together with useful operational features. The budgeted travel funds are requested to defray the costs of collaborative meetings with cooperating investigators. As far as possible, these trips will be timed to coincide with travel for other purposes, such as professional conferences, in order to keep expenses to a minimum. For FY 99, Dr. Ted Cooney is contributing his time to this work free of charge.

Itemized budget pages follow.

FY 99 EXXON VALDEZ TRU : COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$0.0
Travel		$0.0
Contractual		$88.8
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$88.8
General Administration		$6.2
Project Total	$0.0	$95.0
Full-time Equivalents (FTE)		0.7
Other Resources		$19.6

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2000	Estimated FY 2001	Estimated FY 2002
$100.0	$60.0	$0.0

Dollar amounts are shown in thousands of dollars.

Comments:

FY 99

Prepared: 4/11/98

Project Number: 99361
Project Title: Graphical Techniques for Ecosystem Synthesis
Agency: NOAA

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 99 EXXON VALDEZ TRU COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$52.2
Travel		$5.4
Contractual		$13.2
Commodities		$2.3
Equipment		$0.9
Subtotal	$0.0	$74.0
Indirect		$14.8
Project Total	$0.0	$88.8
Full-time Equivalents (FTE)		0.67
Other Resources		$19.6

LONG RANGE FUNDING REQUIREMENTS					
	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
	$100.0	$60.0			

Dollar amounts are shown in thousands of dollars.

Comments:

Other resources include equipment purchases by OSRI, value $19.6K

FY 99

Prepared: 4/11/98

Project Number: 99361
Project Title: Graphical Techniques for Ecosystem Synthesis
Name: Jennifer R. Allen
Agency: NOAA

FORM 4A
Non-Trustee
SUMMARY

FY 99 EXXON VALDEZ TRC : COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Personnel Costs:			Months	Monthly		Proposed
	Name	Position Description	Budgeted	Costs	Overtime	FY 1999
	Jennifer R. Allen	Info Systems / Communications Specialis	6.0	6.0		36.0
	Ravi Kulkarni	Graphics consultant	1.0	7.5		7.5
	Vince Patrick	Modeling applications consultant	1.0	8.7		8.7
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	8.0	22.2	0.0	
					Personnel Total	$52.2

Travel Costs:		Ticket	Round	Total	Daily	Proposed
	Description	Price	Trips	Days	Per Diem	FY 1999
	Cordova - Anchorage	0.17	2	9	0.14	1.6
	Cordova - Fairbanks	0.40	2	10	0.14	2.2
	Cordova - Seward	0.30	1	3	0.14	0.7
	Cordova - Oakland, CA	0.60	1	3	0.11	0.9
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$5.4

FY 99

Prepared: 4/11/98

Project Number: 99361
Project Title: Graphical Techniques for Ecosystem Synthesis
Name: Jennifer R. Allen
Agency: NOAA

FORM 4B
Personnel
& Travel
DETAIL

FY 99 EXXON VALDEZ TRL . COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Contractual Costs:	Proposed FY 1999
Description	
Software: digital video editing (Adobe Premiere or similar)	1.9
Software: AVS license ($5K/year * 0.5 year)	2.5
Telephone/fax ($0.15K/mo * 12mo)	1.8
Network/connectivity ($0.5K/mo * 12mo)	6.0
recording studio time for audio (voiceover) editing	1.0
Contractual Total	$13.2

Commodities Costs:	Proposed FY 1999
Description	
5GB removable hard drive	1.1
dyesub printer supplies	0.6
office supplies including blank CD's	0.6
Commodities Total	$2.3

FY 99

Prepared: 4/11/98

Project Number: 99361
Project Title: Graphical Techniques for Ecosystem Synthesis
Name: Jennifer R. Allen
Agency: NOAA

FORM 4B
Contractual & Commodities DETAIL

FY 99 EXXON VALDEZ TRI : COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FY 1999
Digital camera (Agfa ePhoto or similar)	1	0.9	0.9
			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**		$0.9

Existing Equipment Usage:	Number	
Description	of Units	
IBM ThinkPad 770 with DVDm, MPEGII, video I/O --- new purchase, value $7,600	1	
Proxima92 high resolution computer projector --- new purchase, value $12,000	1	
Sun Sparc20-ZX/192MB workstation	1	
Sony CDU926S CDROM recorder, 2x6 speed	1	
HP Scanjet II color scanner	1	
Codonics dye sublimation color printer		

FY 99

Prepared: 4/11/98

Project Number: 99361
Project Title: Graphical Techniques for Ecosystem Synthesis
Name: Jennifer R. Allen
Agency: NOAA

FORM 4B
Equipment
DETAIL

Intertidal Invertebrate and Vegetation Communities Associated with NOAA Environmental Sensitive Index (ESI) Mapping Types in Southeast Alaska

Project Number: 99362

Restoration Category: Ecosystem Synthesis

Proposer: DOI-FWS

Lead Trustee Agency: DOI-FWS
Cooperating Agencies: ADFG

Alaska SeaLife Center: no

Duration: first year, 1-year project

Cost FY 99: $18,860

Cost FY 00: $0

Geographic Area: Juneau

ABSTRACT

NOAA ESI maps used during EVOS were found to commonly have inaccurate shoreline typing and minimal intertidal zone biological data. NOAA ESI maps were prepared for Southeast Alaska in 1990. To assure a greater degree of accuracy for these maps, a ground-truthing effort by DOI-FWS and ADFG biologists recorded shoreline types and intertidal invertebrate and vegetation species and abundance by percent cover. Data were collected from 167 sites and 488 plots during a four-week period throughout the summer for the ten ESI types in this region from high, mid-, and low intertidal zones. These data have not been collated or analyzed to provide an intertidal community profile for each of the ESI types. This project's objectives are to put these data into a usable format and statistically determine if there are discreet intertidal communities for each ESI type and at the three intertidal zones. An appendix including tables of intertidal community species assemblages for each ESI type and intertidal zone will be developed to include with ESI maps; an additional appendix with subsistence/traditional use information will be developed by a Southeast tribal biologist. These appendices will be available electronically or as hard copy. Information on intertidal communities associated with each ESI type can be used in spill response planning and natural resource damage assessment activities.

INTRODUCTION

The NOAA ESI maps produced in 1992, contain basic descriptions of the intertidal communities associated with each ESI type in Southeast Alaska. Species information is general and abundance data are indeterminate. More specific intertidal community data would be useful in planning spill response actions and for natural resource damage assessment activities in the event of a spill incident. Detailed intertidal community data for all ten ESI types were collected by biologists from ADFG and DOI-FWS as part of an ESI ground-truthing effort in 1990. Data were collected during a four-week period throughout the summer for each of the ten ESI types in this region from high, mid-, and low intertidal zones. These data have not been collated or analyzed to provide an intertidal community profile for each of the ESI types. This project's objectives are to put these data into a usable, electronically accessible format and to statistically determine if there are discreet intertidal communities for each ESI type and at the three intertidal zones. These data can also be considered as a useful appendix to the currently used ESI maps and shoreline habitat descriptions.

NEED FOR THE PROJECT

A. Statement of Problem

This effort can serve as a model for intertidal community identification throughout the state's coastal areas. This data assemblage will provide additional information on shoreline type sensitivity to augment the habitat descriptions in the ESI atlas. Additional information on the intertidal community will also be useful in planning response considerations to have the least impact to the species assemblages present.

B. Rational/Link to Restoration

This project's methods can be incorporated into the Prince William Sound ESI maps updating process. By including intertidal community analysis in the ESI mapping efforts, a more complete picture of the ESI types can be presented. These data will not be presented on the ESI maps but would be an electronically retrievable and/or a hard copy appendix to the maps.

C. Location

The data analysis would be conducted at the contractual statistician's office. Report preparation would occur in Juneau. The Southeast coastal area will benefit from this project as will other coastal areas of the state where ESI mapping has been completed or is scheduled to be initiated. Areas where ESI mapping has not been conducted will benefit by being able to incorporate invertebrate community analysis in their initial mapping efforts.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

If the intertidal community analysis was incorporated into ESI mapping, additional information on species of interest for subsistence/traditional use could be added to the data base. In Southeast Alaska or Prince William Sound, the species list and/or additional information on subsistence/traditional use, could be developed by a native community member with interest and expertise in traditional ecological knowledge.

PROJECT DESIGN

A. Objectives

1. Organize ESI intertidal community data into a usable, electronically accessible format .

2. Statistically determine if there are discreet intertidal communities for each ESI type and at the three intertidal zones.

3. Provide these data as an appendix to the currently used ESI maps and shoreline habitat descriptions.

4. Potentially add an appendix or separate document on species of interest for subsistence/traditional use.

B. Methods

The hypothesis for this study is the null hypothesis; there is no difference among the intertidal community assemblages for each ESI type. The dominant species percent cover data collected for each ESI type will be summarized statistically (means, ranges) and spatial statistics may be applied. The biostatistician hired to complete the analyses will determine if other statistical applications are appropriate.

Intertidal community data were collected during a four-week period at the lowest tidal cycles throughout the 1990 summer. Locations were selected randomly in Southeast but within the area that was mapped by ESI type. Each of the ten ESI types in Southeast Alaska were sampled, totaling 167 sites, and included the high, mid-, and low intertidal zones. Each zone was treated as a separate plot, the 488 plots were typed to ESI and intertidal community data were collected. Minimum plot size was 50m x 200m. Species occurrence and estimate of percent cover of the dominant species or species groups were recorded. The cover classes were 0-<1; 1-4; 5-10; 11-20; 21-5-; 51-75; and 76-100 percent. Estimates were made using the releve method. For data quality consistency, two biologists collected data from all the plots throughout the study. At the mid-point of each sample site, both team members walked from the supra-tidal zone to the water and estimated the average cover of the dominant species throughout the sample site. Several shallow holes were dug to describe the infauna and subsurface substrate. In addition, photographs were taken at each site. All data were recorded in the field.

A description of the intertidal community will be prepared for each ESI type and their three

intertidal zones. The mean and ranges of percent cover of the dominant species will be developed for each ESI type. A diversity index will be used to quantify the species observations. An analysis of variance may be appropriate for additional data interpretation. Significance will be p=0.05.

These data will be presented in a series of tables for each ESI type and each intertidal zone. Accompanying narrative will discuss similarities or differences among the intertidal communities for each ESI type.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The statistical analyses and data entry will be contracted to a university. The large data set and unavailability of agency statisticians make contracting the best choice to complete this project. Appendices preparation will be completed by existing DOI-FWS staff. A subsistence/traditional information appendix will be developed by a Southeast Alaska tribe biologist if they determine that it would be a useful product.

SCHEDULE

A. Measurable Project Tasks for FY 99 (October 1, 1998 - September 30, 1999)

March 1:	Data analyses completed from 1990 field season
March 10-20:	Meet with biologists from Southeast Alaska tribes to determine format for developing subsistence/traditional information appendix
March 23-27:	Attend 10th Anniversary Symposium in Anchorage
June 1:	Draft report with narratives and appendices completed
August 1:	Final report and appendices completed
August 15-31:	Distribute report copies to interested and applicable agencies and others. Meet with NOAA to discuss how these data can be incorporated into future ESI mapping efforts.

B. Project Milestones and Endpoints

The project objectives will be met through the final version of the ESI appendices and narrative report. Hard and/or electronic copies will be distributed to interested and applicable agencies and others.

C. Completion Date

All work will be completed by the end of FY 99.

PUBLICATIONS AND REPORTS

Project results may not be appropriate for a peer-reviewed journal and would be more suitable as a government publication available to users of ESI maps.

An annual report would be completed by April 15, 2000, as required by the Council.

PROFESSIONAL CONFERENCES

This project may be appropriate for presentation at a coastal zone management conference. No conference specifics were found at the time of proposal preparation.

NORMAL AGENCY MANAGEMENT

The USFWS and ADFG do not have additional funding to complete the intertidal component of this project. This project was originally undertaken because agency staff using the ESI maps during the Exxon Valdez spill found many instances of incorrect typing and other inaccurate coastal data. Because maps had not yet been produced for Southeast Alaska the agencies involved wanted to assure that these maps would have a greater degree of accuracy and be more useful during a spill incident. Agency funding covered staff time and limited field travel costs but not the use of a statistical consultant for large data set analyses.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This data set can be used by other entities when Prince William Sound ESI maps are updated. Data and final reports/appendices will be available electronically to any interested user.

PROPOSED PRINCIPAL INVESTIGATOR

Deborah Rudis
US Fish and Wildlife Service
3000 Vintage Blvd. #201
Juneau, AK 99801-7100
907/586-7240
fax 586-7154
deborah_rudis@mail.fws.gov

PRINCIPAL INVESTIGATOR

PI was initial co-lead on ESI ground-truthing project in Southeast. Familiar with data set and all methodology. PI is the Environmental Contaminants Biologist for USFWS in Southeast and worked on initial shoreline reconnaissance during EVOS.

OTHER KEY PERSONNEL

Biostatistician to be determined. Assistant DOI-FWS biologist to assist with report preparation.

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		2.25
Travel		2.5
Contractual		14.0
Commodities		0
Equipment		0
Subtotal		18.75
General Administration		1.11
Project Total		18.86
Full-time Equivalents (FTE)		.5 FTE
Other Funds		4.5

LONG RANGE FUNDING REQUIREMENTS

Estimated	Estimated	Estimated			
FY 2000	FY 2001	FY 2002			
0	0	0			

Dollar amounts are shown in thousands of dollars

Comments:
Personnel - 1.5 weeks salary for travel
Travel - (1.5) Anchorage March Meeting; (1.0) travel costs for PI or statistician to discuss data set
Contractual - (10.0) statistical analyses; (4.0) TEK
General Admin. - personnel costs for requested funds and Other Funds
FTE - .3 supporting biologist, .2 - PI
Other funds - FWS PI salary (3 weeks)

FY 99	Project Number: 99362 Project Title: Intertidal invertebrate and vegetation communities associated with NOAA Environmental Sensitive Index (ESI) mapping types in Southeast Alaska Agency: U.S. Fish and Wildlife Service (DOI-FWS)	FORM 3A TRUSTEE AGENCY SUMMARY
Prepared: 4/15/98		

99365

Determining the Extent and Magnitude of Straying of Hatchery-Released Pink Salmon *Onchorynchus gorbuscha* in Prince William Sound

Project Number:	99365
Restoration Category:	Research
Proposer:	Alaska Department of Fish and Game
Lead Agency:	Alaska Department of Fish and Game
Cooperating Agencies:	U.S. Forest Service
Alaska SeaLife Center:	No
Duration:	1st year, 3-year project
Cost FY 99:	$147,600
Cost FY 00:	$151,100
Cost FY 01:	$140,000
Geographic Area:	Prince William Sound
Injured Resource/Service:	Pink Salmon

ABSTRACT

This project will estimate the magnitude and extent of straying for the odd-year class of hatchery-released pink salmon *Onchorynchus gorbuscha* in Prince William Sound. Otoliths will be sampled from pink salmon carcasses in randomly selected streams located within each of the major fishing districts. Otoliths of hatchery origin will be identified by specific thermal marks applied to fry at the four Prince William Sound pink salmon hatcheries in the fall of 1997. The proportion of Prince William Sound escapements comprised of spawning hatchery pink salmon will be estimated by area, stream zone (tidal vs. upstream) and for the sound as a whole. The study will be repeated in FY00 to evaluate straying for the even-year class.

INTRODUCTION

Prince William Sound, Alaska, is home to several hundred anadromous streams which collectively produce from 2 to 21 million adult pink salmon annually (Morstad et al., 1996). Returning adults convey nutrients and minerals from marine environments to estuaries, freshwater, and terrestrial ecosystems and they play a major role in local commercial, sport, and subsistence fisheries.

In 1989, wild pink salmon stocks suffered both lethal and sub-lethal injuries as a result of the *Exxon Valdez* oil spill (EVOS) (Bue et al., 1996, Willette and Carpenter, 1994) and effective management of the resource became critical. Adding to the complexity of the management task is a large hatchery pink salmon return that results in mixed stock fisheries and exploitation rates entirely unsuitable for the less productive, damaged wild populations. To address this problem, the Alaska Department of Fish and Game used funds provided by the EVOS Trustee Council to develop stock identification and aerial survey programs that provide fishery managers with information enabling them to target hatchery stocks and monitor stream escapements. A second, less studied, aspect of the large hatchery return is the possibility that a portion of the migrating hatchery-released fish stray into wild escapements.

While natural straying provides a mechanism for a slow, steady introduction of new genetic material to populations, and for colonization of new habitats (Milner and Bailey, 1989; Thorpe, 1994), large-scale straying of hatchery fish into streams may be detrimental in a number of ways. First, hatchery pink salmon will compete with indigenous fish for physical resources important for spawning. The problem is exacerbated if hatchery-released fish also compete for spawning partners. If a mating between a fish of hatchery origin and a wild fish is not successful, the productivity of the wild fish is wasted. If such matings are successful, the question of outbreeding depression is raised. Traits advantageous to survival in a hatchery environment may well be detrimental when imparted to wild stocks, and transferred genetic homogeneity to a wild population may mean a higher susceptibility of the population to any one disease (Allendorf et al. 1987; Allendorf and Leary, 1988; Hindar et al. 1991; Waples 1991; Williams et al. 1997; Fleming and Gross, 1993). Habicht et al. (1998) and Seeb et al. (1996) have documented genetic differences of pink salmon populations among streams within Prince William Sound, and in the Pacific Northwest, Currens et al. (1990) and Carl and Healey (1984) have found differences within the same drainage for rainbow trout *O. mykiss* and chinook salmon *O. tshawytscha*, respectively. These findings indicate the existence of ecological niches at highly stratified levels, and that an influx of large quantities of homogenous hatchery-derived genetic material is likely to be detrimental to the invaded wild populations.

Large numbers of hatchery-released fish entering stream escapements may also influence the homing fidelity of indigenous fish. Groot et al. (1985) found members of a population of sockeye salmon *O. nerka* to follow olfactory cues left by forerunners of the same population. If a significant proportion of a stream escapement consists of hatchery-released pink salmon, such an olfactory beacon may be compromised. Finally, a less direct influence of stray hatchery fish on the health of wild populations relates to the interpretation of aerial survey data. If a significant proportion of observed escapements are of hatchery origin, the value of the data becomes questionable (Quinn, 1993).

While reports of straying of hatchery-released fish into wild populations are numerous (Nicholas and Dyke 1982; Lister et al. 1981; Quinn and Fresh, 1984), Sharr et al. (1995) were the first to examine the phenomenon in Prince William Sound. They recovered adult pink salmon marked with hatchery coded wire tags in 27 of 32 streams examined. The possibility that the coded wire tags themselves might have caused the straying precluded any general conclusions, however. Indeed, when Habicht et al. (*In press*) examined X-ray images of heads of homing and straying tagged pink salmon, they found a significant relationship between tag placement and homing ability in some of their comparisons. Further, Morrison and Zajac (1987) and Schnute et al. (1990), working with chum salmon *O. keta* and chinook salmon, respectively, cite evidence that suggests that coded wire tag implementation is not as innocuous as commonly believed.

In 1997, the first hatchery pink salmon bearing thermally marked otoliths returned to Prince William Sound. These fish were also the last brood to be marked with coded wire tags on a sound–wide scale and they provided a means for the examination of the effect of coded wire tags on straying. Thirteen streams believed to be predisposed to straying were sampled in southwest Prince William Sound for coded wire tags and otoliths. Hatchery pink salmon were found in all streams examined with estimates of hatchery contributions ranging from 10% to 91%; higher percentages occurred later in the spawning season. Consistent with the findings of Sharr et al. (1995), coded wire tag recoveries also indicated a substantial contribution to the spawning escapements. The study supports the concept that stray coded wire tagged pink salmon have at least some cohort representation and that they did not stray solely because of coded wire tag placement. While this study provided evidence of large-scale straying, it was not possible to expand the findings to the remainder of the southwest area because of the nature of the sample design (selection of streams predisposed to straying).

This study proposes two fully comprehensive straying studies, one relevant to each of the odd (FY99) and even-year (FY00) brood classes. They will use properly randomized sampling methodologies to determine the extent of straying into upstream and tidal areas of spawning escapements in the sound by region, and to the sound as a whole. An independent proposal has been submitted to the Oil Spill Response Institute (OSRI) for a pilot study to be conducted in 1998. The pilot study will sample streams considered predisposed to straying in the Northern, Eastern and Southeastern Districts. Information obtained from the pilot study, if funded, will be used to improve the sampling designs for the proposed studies, especially the FY00 work.

Should the proposed studies detect widespread straying, work on the significance of the finding may be warranted. Studies into the genetic consequences of straying could involve a comparison of the genetic diversity between a set of streams determined to be susceptible to straying and a set consisting of streams in which little straying was detected. If straying is causing genetic homogenization of stocks, the genetic diversity index in the set of streams disposed to straying will be lower than that in the set not subject to straying. Additionally, similar comparisons of variability in any of a number of phenotypic traits may be conducted. While further removed from the genetic base, phenotypic measurements are considerably easier to gather, and result in more powerful comparisons. Studies into the relevance of straying to aerial survey data would first necessitate a determination of whether stray fish reproduce, and investigations into the physical effects of hatchery fish in wild escapements may require on-site controlled experiments, in which productivity is compared between areas of artificially-created high and low-density spawning. Additionally, studies to estimate the straying tendencies of wild pink salmon

populations may be needed to provide a background against which hatchery straying rates are considered.

The project is linked to EVOS projects 97186 (*Coded Wire Tag Recoveries From Pink Salmon in Prince William Sound*), 97188 and 98188 (*Otolith Thermal Mass Marking of Hatchery Reared Pink Salmon in Prince William Sound*) and 94320D, 95320D and 96196 (*Genetic Structure of Prince William Sound Pink Salmon*). It will also provide input to the Sound Ecosystem Assessment project.

NEED FOR THE PROJECT

A. Statement of Problem

Wild pink salmon stocks suffered as a result of the *Exxon Valdez* oil spill in 1989, and efforts to conserve wild pink salmon populations became more important. A large hatchery return complicated management issues, and inseason stock identification and aerial survey programs were developed to target the large hatchery returns and monitor wild escapements. Another, as yet poorly studied, phenomenon associated with the migration of hatchery pink salmon is that of straying. Stray hatchery fish may be detrimental to wild stocks by competing physically for space and breeding partners, by introducing undesirable genetic material, and more indirectly, by confusing the interpretation of aerial survey data routinely used to assess inseason escapements.

Preliminary studies by Sharr et al. (1995) and a study using thermal otolith marks in 1997 suggest the problem may be severe. These studies were by no means comprehensive in nature, and general conclusions were elusive. Before any determination of the significance of straying is made, or any management-oriented mitigating action is taken, the magnitude and extent of the straying problem for both even and odd-year brood classes need to be gauged. It is believed that this will be most effectively accomplished by comprehensive randomized studies capable of providing district and sound-wide estimates of the extent of straying.

B. Rationale/Link to Restoration

This project will provide estimates of the extent and magnitude of straying of hatchery pink salmon in Prince William Sound. Once such information is available, and if warranted, work can begin on the significance of the finding. If straying is found to be deleterious to wild pink salmon populations, new management strategies may be introduced that reduce the incidence of straying, and managers will be forced to re-examine the use of aerial survey data. Action may also be required to stem increases in production by hatcheries, and, or to curtail practices that have been shown to lead to increased straying, such as those pertaining to remote release programs (Quinn, 1993).

Information from this study and that obtained from EVOS projects 97186 (*Coded Wire Tag Recoveries From Pink Salmon in Prince William Sound*), 97188 and 98188 (*Otolith Thermal Mass Marking of Hatchery Reared Pink Salmon in Prince William Sound*), and 94320D, 95320D and 96196 (*Genetic Structure of Prince William Sound Pink Salmon)* will be used to better understand past, present and future hatchery production and its effect on Prince William Sound wild stock escapements.

C. Location

Carcass sampling will be conducted weekly on representative streams located in the Southwestern, Eshamy, Northern, Eastern, Southeastern and Montague Districts. Initial otolith processing will be conducted at the Cordova Otolith Processing Laboratory.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

There is considerable support for the project within the local community of Prince William Sound. A proposal for a pilot straying study was submitted to the Oil Spill Response Institute (OSRI) for funding in 1998, and received strong support from the Regional Planning Team. The latter is a body responsible for oversight of enhancement programs within Prince William Sound, and is comprised of local fishermen, processor representatives, and members of the Prince William Sound Aquaculture Corporation and the Alaska Department of Fish and Game.

Results of the study will be made available to the community through annual and final reports. Season summaries, which provide a synopsis of the fishing season, and which are made readily available to the local community, will also report the findings of the project.

Direct community involvement in the project will occur through the hiring of local residents into field positions, and the use of local vendors for logistical support.

PROJECT DESIGN

A. Objectives

FY99

1) Obtain an accurate and precise estimate of the proportion of odd-year class hatchery-released pink salmon in Prince William Sound escapements.

2) Obtain accurate and precise estimates of the proportion of odd-year class hatchery-released pink salmon in escapements by upstream and downstream spawning zone and by selected region.

FY00

3) Obtain an accurate and precise estimate of the proportion of even-year class hatchery-released pink salmon in Prince William Sound escapements.

4) Obtain accurate and precise estimates of the proportion of even-year class hatchery-released pink salmon in escapements by upstream and downstream spawning zone and by selected region.

B. Methods

Sample Design

General Design. The proportion of hatchery-released pink salmon in Prince William Sound stream escapements will be estimated using otoliths extracted from fish sampled from streams randomly selected within predefined strata. A two-stage sampling design will be used within each stratum, with streams forming primary sampling units, and individual fish within streams forming secondary sampling units. When estimates are combined over strata, stream escapements will be used as weights. Estimates of the proportion of hatchery-released fish in stream escapements will be made by tidal area for each region and by tidal area for the sound as a whole. Estimates will also be combined over stream area for each region and then over regions to provide a sound-wide estimate of the total proportion of Prince William Sound stream escapements comprised of hatchery-released pink salmon.

Stratification. Estimates of area-specific proportions of hatchery-released pink salmon in stream escapements are of interest, and Prince William Sound will be divided into five geographic regions using the boundaries of the Southwestern, Northern, Eastern, Southeastern, and Montague fishing districts. The streams within each region will be further stratified into those routinely monitored by the Alaska Department of Fish and Game aerial-survey program and those not routinely monitored. The groupings represent streams with larger and smaller escapements, respectively, and allow a more efficient sample allocation.

A pilot study conducted in 1997 found a relationship between distance of stream from a hatchery and the proportion of hatchery-released pink salmon in the stream escapement, and an alternative within-region grouping of streams by distance from a hatchery was considered. If the relationship between distance and straying is real, such a design could lead to reduced within-stratum variabilities, and higher precision of estimates. The relationship was considered too preliminary for use as a stratifying criterion at this time, however.

Stream Allocation Among Strata. A total of approximately 70-80 streams will be sampled sound-wide. Division of the sample among strata will be made in order to minimize the variance of the overall estimate of the proportion of hatchery-released pink salmon in Prince William Sound escapements, and will take into account the number and productivity of streams within strata. Constraints will be incorporated into the minimization routine such that a minimum of 10 streams is sampled from each geographic region. Figure 1 shows an estimated relationship between the relative precision of a stratum-specific estimate of the estimated proportion of hatchery-released pink salmon in escapements, and the number of streams and otoliths per stream sampled from the stratum. The figure is relevant for a stratum containing 50 streams. Data collected from streams in the Southwestern district in 1997 provided estimates of the first and second-stage variances needed to derive the sample size surface shown in the figure.

Within-Stream Sampling and Identification of Hatchery Fish. Thermal marks were applied to all hatchery-released pink salmon in the Fall of 1997 under project 98188. These marks will allow identification of hatchery pink salmon in escapements sampled during the 1999 return. Each selected stream will be sampled four times over the migration of 1999. At each sampling event, 75 otoliths will be collected from carcasses in both upstream and tidal zones of the stream, if they exist. To ensure that tidal spawners are sampled from the tidal areas, only dying or recently-

dead fish will be selected. For each stream, a single weighted otolith sample will be formed for each stream-zone from the samples taken over the migration. The weights used will be formed from estimates of the sizes of the populations of fish from which the otolith samples were taken. Counts of live fish at each sampling event will be used with an area-under-the-curve method (English et al., 1992) to provide appropriate estimates of population size, and therefore weightings. Tidal escapements will be estimated as the difference between upstream and total escapements. The proportionally-allocated (weighted) stream sample will mimic a simple random sample taken from the entire stream escapement (Cochran, 1977). In addition to providing appropriate weightings for the construction of the within-stream samples, escapement estimates will also be used in the Equations 1, 2, and 3.

Identification of selected otoliths will be made at either the Alaska Department of Fish and Game Cordova Otolith Reading Laboratory, or the Statewide Otolith Reading Laboratory in Juneau.

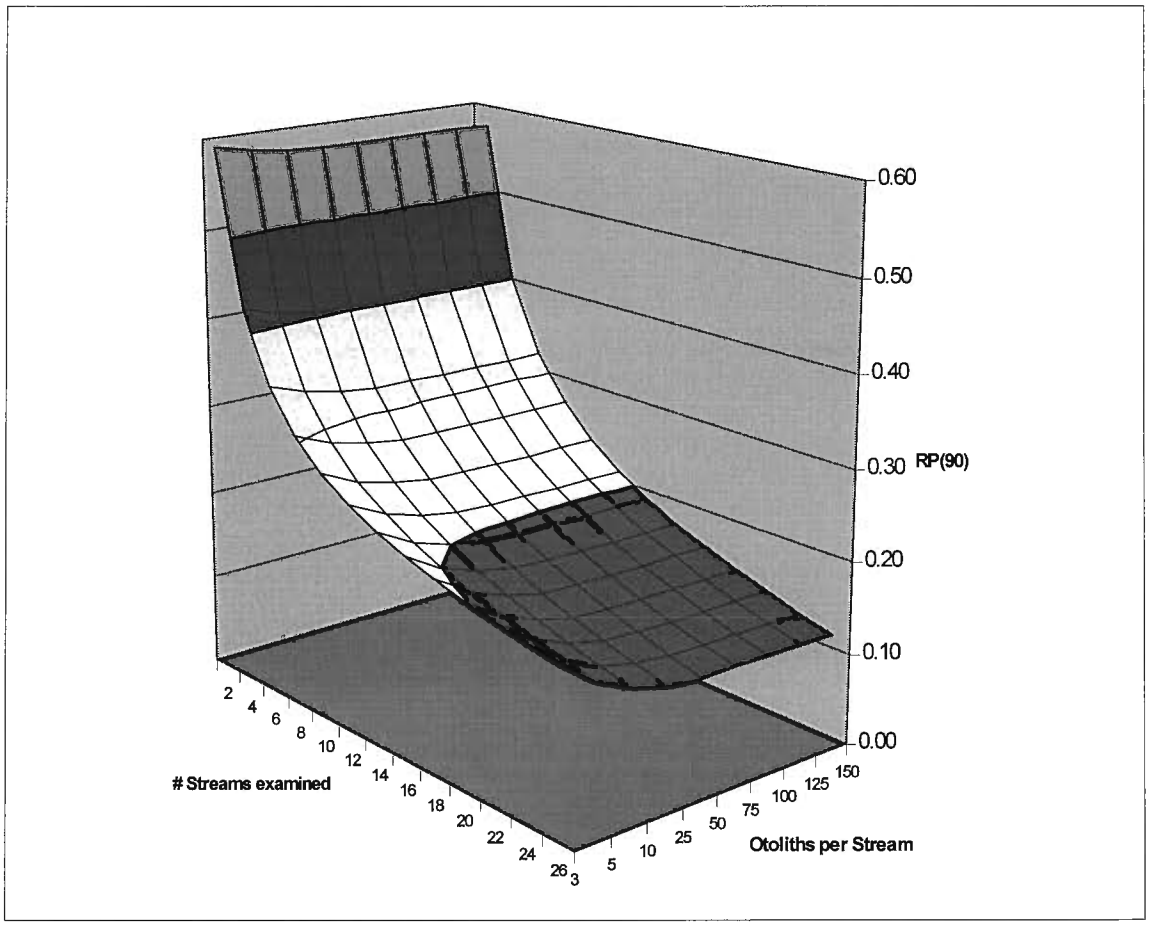

Figure 1. Influence of sample size on relative precision of stratum-specific estimates of the proportion of hatchery-reared fish in Prince William Sound stream escapements.

Estimation

An estimate of the proportion of hatchery-released pink salmon in the escapement of a given stream zone, z (upstream/tidal) for stratum, g, will be calculated using the ratio estimator of the population total. The resulting estimator is :

$$\hat{p}_{zg} = \frac{\sum_{i=1}^{n_g} M_{zgi} \frac{h_{zgi}}{m_{zgi}}}{\sum_{i=1}^{n_g} M_{zgi}} \qquad (1)$$

where M_{zgi} is the escapement for stream zone z in the i^{th} stream in stratum g, n_g is the number of streams sampled in stratum g, m_{zgi} is the number of otoliths sampled from M_{zgi}, and h_{zgi} is the number of otoliths of hatchery origin found in m_{zgi}. The M_{zgi} will be estimated from frequent ground-based observations. While the ratio estimator used in Equation 1 is biased, its variance is routinely smaller than its unbiased counterpart; the latter is highly susceptible to variability in size of primary units (stream escapements).

A variance estimate for $\hat{p}_{zg}$ is given by:

$$\hat{V}(\hat{p}_{zg}) = \frac{1}{\left[N_g \sum_{i=1}^{n_g} \frac{M_{zgi}}{n_g}\right]^2} \left[\frac{N_g^2 \left[1 - \frac{n_g}{N_g}\right] \sum_{i=1}^{n_g} M_{zgi}^2 \left[\frac{h_{zgi}}{m_{zgi}} - \frac{\sum_{i=1}^{n_g} M_{zgi} \frac{h_{zgi}}{m_{zgi}}}{\sum_{i=1}^{n} M_{zgi}} \right]^2}{n_g (n_g - 1)} + \frac{N_g}{n_g} \sum_{i=1}^{n_g} \frac{M_{zgi}^2 \left[1 - \frac{m_{zgi}}{M_{zgi}}\right] \frac{h_{zgi}}{m_{zgi}} \left[1 - \frac{h_{zgi}}{m_{zgi}}\right]}{(m_{zgi} - 1)} \right] \qquad (2)$$

where N_g is the total number of streams in stratum g.

An estimate of the proportion of hatchery-released pink salmon in stream zone z sound-wide, p_z, is calculated by weighting stratum estimates $\hat{p}_{zg}$ by w_{zg}, calculated from estimates of total escapements to the G strata into which Prince William Sound is divided:

$$\hat{p}_z = \sum_{g=1}^{G} \frac{\frac{N_g}{n_g} \sum_{i=1}^{n_g} M_{zgi}}{\sum_{g=1}^{G} \frac{N_g}{n_g} \sum_{i=1}^{n_g} M_{zgi}} \hat{p}_{zg} = \sum_{g=1}^{G} w_{zg} \hat{p}_{zg} \qquad (3)$$

Sampling among the G strata is independent, and an approximate variance estimate is given by:

$$\hat{V}(\hat{p}_z) = \sum_{g=1}^{G} w_{zg}^2 \hat{V}(\hat{p}_{zg}) \qquad (4)$$

In the above estimate of variance (Equation 4), the weightings w_{zg} are treated as constants, when they are in fact subject to sampling variation; repeated selections of streams will yield different weights. In addition, estimates $\hat{p}_{zg}$ are subject to the same sampling variation as the w_{zg}, and they are therefore correlated. Further, the w_{zg} are correlated among themselves because each component contains the same estimated total escapement in the denominator. The variance estimate for $\hat{p}_z$ should ideally account for these facts. Two solutions will be considered.

(i) Remove correlations between $\hat{p}_{zg}$ and w_{zg} by using aerial-survey data to generate weights, and explicitly account for covariances among the w_{zg}. The approach is to base stratum weights on aerial survey estimates of escapements into the sound; the aerial survey program is an independent sampling program and the weights w_{zg} generated from the program are independent of the $\hat{p}_{zg}$. If the aerial survey estimate for zone z in the g^{th} stratum is denoted by A_{zg}, and the aerial survey estimate of the total escapement to zone z in the sound is A_{zG}, the w_{zg} are given by A_{zg}/A_{zG}. The method of Goodman (1960) is then invoked, which yields the exact variance estimate of the product of the (independent) variables. An unbiased estimate of the variance of this product is $\hat{V}(w_{zg}\hat{p}_{zg}) = w_{zg}^2\hat{V}(\hat{p}_{zg}) + \hat{p}_{zg}^2\hat{V}(w_{zg}) - \hat{V}(\hat{p}_{zg})\hat{V}(w_{zg})$. To estimate $\hat{V}(w_{zg}) = \hat{V}(A_{zg}/A_{zG})$, the multivariate delta method is used along with an estimate of the covariance between A_{zg} and A_{zG}. The estimated Cov(A_{zg},A_{zG}) is derived as $\hat{V}(A_{zg})$. Aerial survey methodology provides $\hat{V}(A_{zg})$. Option (i) necessitates that surveys be made of streams selected from the strata not-routinely examined by the escapement-monitoring program.

While the problem of correlation between the $\hat{p}_{zg}$ and the w_{zg} has been solved, derivation of $\hat{V}(\hat{p}_z) = \hat{V}(\sum_{g=1}^{G} w_{zg}\hat{p}_{zg})$ still requires knowledge of the covariance among the w_{zg} $\hat{p}_{zg}$. This is derived as $\hat{Cov}(\hat{p}_{zi}w_{zi}, \hat{p}_{zj}w_{zj})) = \hat{p}_{zi}\hat{p}_{zj}w_{zi}w_{zj}$. Hence we have:

$$\hat{V}(\hat{p}_z) = \sum_{g=1}^{G} \hat{V}(w_{zg}\hat{p}_{zg}) + 2\sum_{i=1}^{G}\sum_{j>i}^{G} \hat{p}_{zi}\hat{p}_{zj}w_{zi}w_{zj} \qquad (5)$$

(ii) Estimate $\hat{V}(\hat{p}_z)$ using the bootstrap method (Effron and Tibshirani, 1993). Modifications of Sitter (1992) and Rao and Wu (1988) to the simple bootstrap will be considered. The simple bootstrap method proceeds as follows (bootstrap quantities are denoted by '*'):

a) Resample streams with replacement.
b) From each resampled stream, resample otoliths with replacement.
c) Calculate w_{zg}^* and $\hat{p}_{zg}^*$ from resampled streams and otoliths.

d) Calculate $\hat{p}_z^* = \sum_{g=1}^{G} w_{zg}^* \hat{p}_{zg}^*$

e) Repeat a) through d) B times and calculate $\hat{V}(\hat{p}_z) = \frac{\sum_{i=1}^{B} (\hat{p}_{zi}^* - \bar{p}_z^*)^2}{B-1}$

Method (i) provides a closed form expression for the estimate, but depends on the delta-method approximation, knowledge of variances of aerial survey estimates, and additional aerial surveys. Method (ii) does not yield a closed form solution, but relies on fewer assumptions and given contemporary computing power is easily invoked.

An estimate of the proportion of hatchery-released pink salmon in stream escapements sound-wide is given by :

$$\hat{p} = \sum_{g=1}^{G} \sum_{z=1}^{Z} \frac{\frac{N_g}{n_g} \sum_{i=1}^{n_g} M_{zgi}}{\sum_{g=1}^{G} \sum_{z=1}^{Z} \frac{N_g}{n_g} \sum_{i=1}^{n_g} M_{zgi}} \hat{p}_{zg} \qquad (6)$$

A variance approximation will be provided by the bootstrap method.

To compare hatchery proportions between upstream and tidal zones within a stratum, the following model will be used:

$$p_{ij} = \mu + \beta_i + \tau_j + \beta\tau_{ij} \qquad (7)$$

where p_{ij} is the measured proportion of hatchery fish in the sample of otoliths taken from the i^{th} stream in the j^{th} stream zone, μ is the overall mean, β_i is a random effect of the i^{th} stream, τ_j is the fixed effect of the j^{th} stream zone, and $\beta\tau_{ij}$ is a random effect associated with the i^{th} stream and j^{th} stream zone. The model described in Equation 7 is commonly used in the analysis of experiments designed in randomized complete blocks. The effect of stream zone on the proportion of hatchery fish (1 df) will be tested using the $\beta\tau$ error mean-square. Since the analysis is based on proportions, appropriate attention will be paid to the nature of residual patterns, and the need for data transformations or weighting.

Logistics

Field-sampling crews, each consisting of two people, will be stationed throughout Prince William Sound from 15 August through 15 September 1999. Crews will reside onboard an Alaska Department of Fish and Game vessel patrolling the Southwestern District; one crew will be stationed in Cordova, and a U.S. Forest Service crew will be stationed on another vessel located in the Northern District of the sound. Collected otolith samples will be labeled and stored for later processing in Cordova. Otoliths will be processed in the Cordova Fish and Game Office Laboratory with confirmation second readings being performed at the Statewide Coded Wire Tag and Otolith Laboratory in Juneau.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The Alaska Department of Fish and Game and the U.S. Forest Service will complete all work on this project. Thermal marks have been applied to pink salmon otoliths by the Prince William Sound Aquaculture Corporation and the Valdez Fisheries Development Association. Otoliths will be extracted in the field by Alaska Department of Fish and Game and U.S. Forest Service field crews, and then prepared and read at either the Alaska Department of Fish and Game Area Office Laboratory in Cordova or the Statewide Otolith Laboratory in Juneau.

SCHEDULE

A. Measurable Project Tasks for FY 99 (October 1,1998 - September 30, 1999)

May 1 - August 15, 1999	Project preparation.
August 15 - September 15, 1999	Field data collection.
September 15 - September 30, 1999	Otolith reading.
October 1, 1999 – April 15, 2000	Otolith reading, analyze data, write reports.

B. Project Milestones and Endpoints

FY99 Objectives (as in Project Design section):

Objective 1: Overall estimate of hatchery proportion for odd-year class : Dec. 1999.
Objective 2: Estimate of hatchery proportion by stream zone and selected district for odd-year class : Dec. 1999.

FY00 Objectives:

Objective 3: Overall estimate of hatchery proportion for even-year class : Dec. 2000.
Objective 4: Estimate of hatchery proportion by stream zone and selected district for even-year class : Dec. 2000.

FY01 Objectives:

Complete final report and write articles as warranted: September 30, 2001.

C. Completion Date

September 30, 2001.

PUBLICATIONS AND REPORTS

All work will be documented as a final report to the EVOS Trustee Council in 2001. Technical papers will be submitted to professional journals for publication as project findings dictate.

PROFESSIONAL CONFERENCES

Project results may be presented as either posters or oral reports at professional meetings (e.g. American Fisheries Society, Pink and Chum Salmon Workshop, EVOS Restoration Workshops).

NORMAL AGENCY MANAGEMENT

Although the Alaska Department of Fish and Game has been conducting pink salmon stock identification studies in Prince William Sound since 1987, the study proposed herein involves a special and specific problem not addressed through normal agency management.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The project will be conducted jointly by the Alaska Department of Fish and Game and the U.S. Forest Service. Edited data will be provided to the Information Modeling portion of SEA for incorporation into a centralized ecosystem database.

Other efforts to obtain funding to study the straying phenomenon include a proposal submitted to OSRI for a pilot study to be conducted in 1998. The study is designed to provide information which will facilitate design of the even-year study proposed for FY00.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Not applicable.

PROPOSED PRINCIPAL INVESTIGATOR

Name	Timothy L. Joyce, Fishery Biologist III
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PRINCIPAL INVESTIGATOR: Timothy L. Joyce

Employment:

Mr. Joyce was appointed as a Fisheries Biologist III with the Alaska Department of Fish and Game in Cordova in July of 1995. Prior to this appointment he worked for the State of Alaska as a hatchery manager for over 17 years at Kitoi Bay, the location of the largest multi-species salmon production facility administered by the state. From 1982 through 1987, Mr. Joyce conducted some of the initial half-length coded wire tagging work on emergent pink salmon fry, and co-authored an article titled 'Retention Rates of Half-Length Coded Wire Tags Implanted in Emergent Pink Salmon', published in the American Fisheries Society Symposium 7:253-258. Prior to his position at Kitoi Bay, Mr. Joyce worked in Sand Point, Alaska as a high school teacher, teaching aquaculture, fish culture and biology, and was responsible for a small demonstration hatchery run by the school district with Johnson O'Malley funds. Mr. Joyce also has extensive experience in warm water fish culture, gained while working as a Peace Corps volunteer for a United Nations development project in Africa administered by the Food and Agriculture Organization.

Other Experience:

Commercial herring spotter pilot, 1985 -1994
Research aid, Oak Creek Laboratory, Corvallis, OR. 11/71 - 6/73
Construction, 1964 - 1971

Education:

1973 - Bachelor of Science , Fisheries Science, Oregon State University.

OTHER KEY PERSONNEL

David G. Evans, Biometrician I

Affiliation	Alaska Department of Fish and Game
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Employment:

October, 1991 - present: Biometrician I with the Alaska Department of Fish and Game. Primary responsibilities: 1) Sample design and statistical procedures, 2) Oversight of the post season data analyses, 3) Co-author of interim and final reports, and professional papers.

Education:

1991 Master of Science, Statistics, Oregon State University
1988 Doctor of Philosophy, Soil Science, University of Guelph (Ontario, Canada)
1984 Master of Science, Soil Science, University of Guelph (Ontario, Canada)
1981 Bachelor of Science, Soil Science, University of Nottingham (U.K.)

Renate Riffe, Fishery Biologist II

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Mailing address	P.O. Box 669, Cordova, Alaska 99574
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Employment:
Since October 1994, Ms. Riffe has worked on the coded wire tag project in the capacity of Assistant Project Leader. In 1998 Ms. Riffe will be shifting here duties to the Assistant Project leader in the otolith project as well as working on the final report for the coded wire tag project. From June 1991 - October 1994, she was a biologist with the Alaska Department of Fish and Game, Sport Fish Division in Fairbanks, Alaska, and assisted in projects concerning abundance estimation and population evaluation of pike, grayling, humpback whitefish, least cisco, rainbow trout, burbot, chum salmon, and king salmon. From May 1982 - January 1991, she worked as a technician with the Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division in Juneau, Alaska. Her primary duties involved sampling commercial salmon fisheries and salmon escapements. She also developed scale pattern discriminant functions used in stock separation of Lynn Canal sockeye salmon and developed a computer model which simulated migratory timing of salmon escapements and evaluated truncated escapement counts. She has authored reports for the Alaska Department of Fish and Game on estimates of abundance and survival rates of round whitefish, compilation of age and length data for rainbow trout in southwest Alaska, and migratory timing of salmon in the Situk River, Alaska.

Education:
1994 Master of Science , Statistics, Colorado State University.
1987 Master of Science, Fisheries Management, University of Alaska, Fairbanks.
1981 Bachelor of Science, Fish Biology, Colorado State University.

Felipe Carrillo - Fisheries Biologist I

Employment:
Since May of 1997, Mr. Carrillo has worked as the laboratory supervisor and chief reader at the Cordova Fish and Game Otolith Laboratory. He will continue to act in the same capacity in 1998 and1999. In 1996 year, Mr. Carrillo worked on the coded wire tag project in Cordova as a technician, and scanned adult pink salmon for tags. He has had several years' experience as a crewman on purse seine vessels in Prince William Sound and at local processors. Mr. Carrillo was an observer for the Inter-American Tropical Tuna commission for two years.

Education:
1986: Bachelor of Science, Fish Biology, University of Sinaloa, Mazatlan, Mexico.

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1998 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1998	Proposed FY 1999	PROPOSED FY 1999 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	NOAA
				$132.5		$15.1		
Personnel	$0.0	$113.7						
Travel	$0.0	$1.0						
Contractual	$0.0	$5.0						
Commodities	$0.0	$10.4						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$130.1		Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
General Administration	$0.0	$17.5						
Project Total	$0.0	$147.6		$151.1	$140.0	$0.0		
Full-time Equivalents (FTE)	0.0	1.6						
	Dollar amounts are shown in thousands of dollars.							
Other Resources	$0.0	$0.0		$0.0	$0.0	$0.0		

Comments:

The close-out costs for FY2001 are similar to the first year of the project costs as most of the data collection occurs in the month of September and much of the analysis of the data occurs in the following fiscal year. Thus the close-out year would include data analysis as well as writing the final report.

1998

Prepared: 1 of 9

Project Number: 99365
Project Title: Pink Salmon Straying in PWS
Lead Agency: ADF&G

FORM 2A
MULTI-TRUSTEE
AGENCY
SUMMARY

4/15/98

1998 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$105.2
Travel		$0.0
Contractual		$1.0
Commodities		$10.4
Equipment		$0.0
Subtotal	$0.0	$116.6
General Administration		$15.9
Project Total	$0.0	$132.5
Full-time Equivalents (FTE)		1.4
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
	$133.1	$140.0			

Dollar amounts are shown in thousands of dollars.

Comments:
In Kind Services Provided:
65 ft. vessel crew and maintenance (3 man crew)
3 small skiffs with outboaqrds
Fuel and labor for applying otolith marks to pink salmon fry
2 man months of laboratory technician time to assist in otolith preparation and reading

1998

Prepared: 2 of 9

Project Number: 99365
Project Title: Pink Salmon Straying in PWS
Agency: ADF&G

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/15/98

1998 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1999
Tim Joyce	Fishery Biologist III	18M	3.0	7.2	0.0	21.6
Renate Riffe	Fishery Biologist II	16E	3.0	5.4	0.0	16.2
David Evans	Biometrician I	17J	4.0	6.1	0.0	24.4
Felipe Carrillo	Fishery Biologist I	14B	2.0	4.3	1.0	9.6
Andy Craig	Fishey Biologist I	14E	1.0	4.8	2.0	6.8
Roger Dunbar	Fishery biologist I	14C	1.0	4.5	2.0	6.5
Cordova Technicians	F&W Tech. II	9A	3.0	3.2	4.5	14.1
Sea duty	3 man vessel crew					6.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		17.0	35.5	9.5	
					Personnel Total	$105.2

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1999
					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

1999

Prepared: 3 of 9

Project Number: 99365
Project Title: Pink Salmn Straying in PWS
Agency: ADF&G

FORM 3B
Personnel
& Travel
DETAIL

4/15/98

1998 EXXON VALDEZ TRU[illegible] COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed FY 1999
Description	
Air charter for logistic support	1.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$1.0

Commodities Costs:	Proposed FY 1999
Description	
Otolith lab consumables (slides, slide boxes, glue, polishing cloth,etc)	6.0
boat gas	0.6
boots	0.4
Human food ($10/day X 30 days X 8 people	2.4
vessel fuel (diesel)	1.0
Commodities Total	$10.4

1999

Project Number: 99365
Project Title: Pink salmon straying in PWS
Agency: ADF&G

FORM 3B
Contractual & Commodities DETAIL

Prepared: 4 of 9

4/15/98

1998 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

New Equipment Purchases:	Number of Units	Unit Price	Proposed FY 1999
Description			
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.	**New Equipment Total**		$0.0

Existing Equipment Usage:	Number of Units	Inventory Agency
Description		
Boiler module	1	VFDA
Boiler module	2	PWSAC
Boiler module	1	ADF&G
MZ6 Dissecting Microscope	2	ADF&G
DMLS Binocular Microscope	2	ADF&G
Labapol-5 grinders	2	ADF&G
Bar-code scanner	1	ADF&G

1999

Project Number: 99365
Project Title: Pink Salmon Strayingin PWS
Agency: ADF&G

FORM 3B
Equipment
DETAIL

1998 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$8.5
Travel		$1.0
Contractual		$4.0
Commodities		$0.0
Equipment		$0.0
Subtotal	$0.0	$13.5
General Administration		$1.6
Project Total	$0.0	$15.1
Full-time Equivalents (FTE)		0.2
Other Resources		

LONG RANGE FUNDING REQUIREMENTS					
	Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
	$18.0	$0.0			
Dollar amounts are shown in thousands of dollars.					

Comments:
In Kind Services Provided:
Inflatable raft and outboard
L/C operator and deck hand
Field supplies and camp equipment

1999

Prepared: 6 of 9

Project Number: 99365
Project Title: Pink Salmon Straying in PWS
Agency: USFS

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/15/98

1998 EXXON VALDEZ TRUS[illegible] COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1999
Technician	Fisheries	GS-9	1.3	4.0	0.0	5.2
Technician	Fisheries	GS-7	1.3	2.5	0.0	3.3
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.6	6.5	0.0	
					Personnel Total	$8.5

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1999
Train Tickets personnel	0.1	1	0	0.0	0.1
Train Tickets truck	0.1	2	0	0.0	0.2
Crew per diem (60 days X $12/day)			7	0.1	0.7
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$1.0

1999

Project Number: 99365
Project Title: Pink Salmon Straying in PWS
Agency: USFS

FORM 3B
Personnel
& Travel
DETAIL

1998 EXXON VALDEZ TRU[illegible] COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

Contractual Costs:	Proposed
Description	FY 1999
Glacier District Landing Craft (30 days at $135/day)	4.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$4.0

Commodities Costs:	Proposed
Description	FY 1999
Commodities Total	$0.0

1999

Project Number: 99365
Project Title: Pink Salmon Straying in PWS
Agency: USFS

FORM 3B
Contractual & Commodities DETAIL

1998 EXXON VALDEZ TRU[illegible] COUNCIL PROJECT BUDGET

October 1, 1997 - September 30, 1998

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1999
			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

1999

Project Number: 99365
Project Title: Pink Salmon Straying in PWS
Agency: USFS

FORM 3B
Equipment
DETAIL

EXXON VALDEZ Oil Spill Trustee Council

FY 99 Detailed Project Description

Improved salmon escapement enumeration using remote video and time-lapse recording technology

Project Number:	99366
Restoration Category:	Monitoring
Proposer:	ADF&G
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	
Alaska SeaLife Center:	No
Duration:	1st year, 3-year project
Cost FY 1999:	$ 60.0 K
Cost FY 2000:	$ 53.3 K
Cost FY 2001:	$ 12.3 K
Cost FY 2002:	$
Geographic Area:	Lower Cook Inlet
Injured Resource/Service:	salmon/commercial fishing

ABSTRACT

Salmon resources and services within the spill area, and particularly within Prince William Sound, were injured by the 1989 *Exxon Valdez* oil spill and have not yet fully recovered. To monitor the recovery of salmon stocks in the spill area and improve escapement information used to set spawning escapement goals, we propose to develop remote video and time-lapse recording technology for enumerating salmon escapement. Remote video has the potential to provide accurate, archivable documentation of salmon escapements well beyond the capacity of aerial survey indices, and well below the cost of weir and sonar projects. Videotapes can be retrieved and reviewed weekly to facilitate in-season management of commercial fisheries.

INTRODUCTION

Aerial survey has been used to monitor salmon escapement in clear streams throughout Alaska for over 35 years (Bevan 1961). This technique is favored for marginally productive drainages which otherwise may go unassessed due to the high cost of intensive monitoring methods (e.g., weir, sonar) relative to the stream's modest escapement. However, aerial survey has several drawbacks. Observer experience, water clarity, stream morphology and habitat type, timing of survey flights, and stream residency are just a few factors shown to influence the accuracy and precision of aerial survey estimates of salmon escapement (see Bevan 1961, Evzerov 1981, Neilson and Geen 1981, Cousens et al. 1982, Shardlow et al. 1987, Perrin and Irvine 1990, Hill 1997, and Bue et al. 1998a). At best, aerial survey provides consistent indices of in-river escapement among years. It does not provide accurate, reliable estimates of spawner-abundance, particularly when in-river exploitation of salmon is high and observer efficiency and stream residency are not precisely known (Perrin and Irvine 1990, Bue et al. 1998a).

Accurate, reliable estimates of spawner abundance are required to monitor the recovery of damaged salmon resources, set appropriate spawning escapement goals for individual streams, and manage commercial fisheries in season. Because aerial survey does not provide this level of information and more accurate methods are prohibitively expensive for streams with marginal escapements, a niche exists that remote video technology may be able to fill.

Video and time-lapse recording technology has proven effective for capturing remote images of adult salmonids (Hatch et. al 1994) and juvenile salmonids in controlled field situations (Irvine et. al 1991). In Alaska, researchers have used underwater video equipment to facilitate enumeration of adult salmon passing a deep-water weir (Dave Owens, ADF&G Kodiak, personal communication). In the Pacific Northwest, researchers are experimenting with stand-alone underwater video systems associated with partial weirs (P. Mundy, P. Mundy and Assoc., personal communication). An unmanned underwater system is not practical for most Alaskan streams because the camera would be vulnerable to inquisitive bears. In FY99 we propose to develop an unmanned video that can be deployed above small streams, out of the reach of bears. The video system will document sockeye salmon escapement into a small lake system. Time-lapse images will be recorded onto a VCR powered by 12-volt batteries. Wind and solar power generators will maintain the batteries. A weir will be operated concurrently to determine the accuracy of video counts. If FY99 results are promising, in FY00 we will evaluate the camera's performance counting pink and chum salmon escapement in a short, intertidal stream.

NEED FOR THE PROJECT

A. Statement of Problem

Salmon resources and services were injured by the 1989 *Exxon Valdez* oil spill. Accurate, reliable estimates of spawner abundance are required to monitor the recovery of damaged salmon resources, set appropriate spawning escapement goals for individual streams, and manage commercial fisheries in season. Aerial survey estimates of spawning escapement are often biased by conditions (e.g., observer experience/efficiency, timing of flights, etc.) that are difficult to account for, leading to imprecise indices of spawning escapement. Because accurate

escapement monitoring is so important for salmon management and documenting the recovery of salmon resources and services, reliable, cost-effective techniques should be developed to improve escapement estimation where aerial survey is currently used.

B. Rationale/Link to Restoration

Salmon resources throughout the spill area, and particularly in Prince William Sound (Bue et al. 1996, Bue et al. 1998b) were damaged by the 1989 *Exxon Valdez* oil spill (EVOS) and have not fully recovered (1998 EVOS Trustee Council Status Report). This project has potential for improving long-term monitoring and management of salmon stocks within the spill area and statewide. Improved escapement monitoring will enable more effective evaluation of recovery efforts. It will also facilitate improved in-season management of fisheries, which will help restore injured sport and commercial fishing services.

C. Location

Development of this improved escapement monitoring technology will occur in Lower Cook Inlet (Southern Kenai Peninsula). However, project benefits could be realized throughout the spill area and anywhere in Alaska where aerial surveys are currently being used to monitor salmon escapement in small, clear streams.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

Although McCarty Fiord and much of the Kenai Peninsula's outer coast is contained within Kenai Fiords National Park (KFNP), Delight Lake and its outlet stream (Delight Creek) are owned by the Port Graham Corporation (PGC). Port Graham residents have a long history of using these salmon resources for commercial and subsistence purposes and are concerned for the area's continuing productivity. Although the remote video system could be evaluated elsewhere, a unique opportunity exists at Delight Lake to fulfill PGC and KFNP requests to provide improved monitoring of salmon escapement and production.

PROJECT DESIGN

A. Objectives

1. (FY99): Determine the accuracy and reliability of a remote video system for estimating sockeye salmon escapement in small streams, and
2. (FY00): Determine the accuracy and reliability of a remote video system for estimating pink and chum salmon escapement in tidally influenced streams where intertidal spawning occurs.

B. Methods

The straightforward nature of this monitoring project precludes the need to test hypotheses. A remote video camera positioned above the stream channel will capture images onto a time-lapse

video cassette recorder (VCR). A conventional picket weir will be operated concurrently with the camera so the accuracy of video escapement estimates can be determined. The reliability (i.e., field durability) of the video system will be judged by the percentage of time that it is inoperable or unable to count fish effectively.

We selected Delight Lake outlet to test the video system for several reasons: 1) a low-gradient, clear-water stream exists, on which a weir and video system can readily be operated; 2) the lake is typical of lake spawning sockeye systems where fish are only visible to aerial surveyors while they're ascending the outlet stream; because fish disappear when they enter the lake, area-under-the-curve estimates of spawning escapement are problematic; and 3) evaluating the video system on Delight lake provides an opportunity to supplement adult escapement data collected under EVOS Project No. 97254 (Edmundson et al. 1998).

Video

Siting of the camera will be critical to its performance. The preferred stream section will be relatively shallow (<1.5 m), narrow (<20 m) and free of excessive surface turbulence. Pools and slow runs will be avoided as fish may have a tendency to mill about and be counted multiple times. If an overhanging tree is not available to position the camera above the chosen site, a video tower will be erected. A temporary structure (e.g., tripod) can be constructed with local materials during FY99. However, once the site has proven effective, a more permanent video tower may be erected for subsequent long-term use with normal agency funding.

A video camera will be positioned approximately 5-7 m above the stream and oriented downward. A light colored material (0.635-cm mesh beach seine) will be fixed to the streambed to enhance the contrast of fish swimming below the camera. A polarizing filter will be attached to the camera to reduce water surface glare. The camera will feed video continuously to a time-lapse VCR that will record one image every 1.9 seconds. This interval will allow a single 120-minute VHS tape to last nine days. The camera's field of view will be sufficiently wide to assure that no fish bypass the video site without being documented on film, facilitating near-census-quality escapement data. The only fish not photographed will be those that pass during about four hours of darkness. Staff will periodically monitor the site at night to estimate the proportion of the run not captured on film. This will enable estimation of the total escapement for independent comparison with weir counts.

The camera and VCR will be powered by four 12-V deep-cycle batteries (105 amp-hour) and recharged by a small wind generator and possibly two 4.1 amp/hour solar panels. The VCR and batteries will be housed in a weather/bear proof strong box secured to the streambank. All necessary wiring will be inside conduit so it will not be vulnerable to birds, bears or rodents. Approximately once a week, research staff will service the equipment, change cassette tapes in the machine, and fly the recorded tape to Homer (ADF&G) for timely review.

It is quite possible that microwave technology could allow ADF&G to transmit video images directly to Homer in the near future. This would preclude the need to switch out videotapes, enabling considerable savings in air charter costs. A Homer based videographer recently succeeded in transmitting remote images from Gull Island (Kachemak Bay) to Homer, a distance of approximately 6 miles (Daniel Zatz, personal communication). Further experimentation in the coming months will determine the feasibility of using a repeater to facilitate transmissions up to

100 miles. Developing the ability to monitor salmon escapements remotely, and then transmit video imagery directly to field offices for archival onto VHS tapes, would represent a tremendous improvement in salmon escapement monitoring.

Weir

A conventional picket weir will be operated concurrently with the video camera to provide a basis for determining the accuracy of video counts. The weir and associated field camp will be operated in the same location and manner as project 97254 (Edmundson et al. 1998). Weir operation will begin prior to the start of the adult run and continue until the daily passage rate is <1% of the total escapement to date.

Intertidal spawning (FY00)

If remote video technology proves feasible for enumerating sockeye escapement, we would like to investigate its application for estimating pink and chum salmon escapement into tidally influenced streams. Pink and chum salmon often spawn in intertidal areas where weirs are difficult to operate. Aerial and foot surveys are frequently used to assess escapement in these situations (Bucher and Hammarstrom 1997). It should be feasible to deploy a remote camera in the intertidal section of a stream to document intertidal spawners and count salmon escaping upstream. Because many individuals may enter and exit the stream with the tides, the daily escapement of upstream spawners would be tallied as the number of upstream migrants minus the number of downstream migrants. Separate estimates will be made for the number of intertidal spawners by factoring streamlife into an area-under-the-curve estimate of total observed spawners (Hill 1997, Bue et al. 1998a). Total spawning escapement will be estimated by adding the estimated escapements of the upstream and intertidal spawning components of the run. Port Dick Creek would be an excellent candidate to pursue this application because it sustains runs of both pink and chum salmon. Pursuing the project on Port Dick Creek also provides an opportunity to continue monitoring the success of project 97139A2 (Dudiak et al. 1998).

C. Cooperating Agencies, Contracts, and other Agency Assistance

Not applicable

SHEDULE

A. Measurable Project Tasks for FY99

October-January:	Purchase video equipment and associated materials.
January-April:	Fabricate strongbox for video equipment; arrange logistics for field camps and weir installation.
June:	Deploy camp, weir, and video equipment.
June-August:	Operate weir camp, maintain camera equipment, review tapes.
September:	Evaluate camera's performance against weir counts

B. Project Milestones and Endpoints

September 1999	Objective 1:	Determine video system's accuracy and reliability by comparing video counts against weir counts.
September 2000	Objective 2:	Determine feasibility of using remote video to count pink and chum salmon escapement in tidally influenced streams.
September 2001	Obj. 1-2:	Complete project final report.

C. Completion Date

All project objectives will have been met by FY00 and the project will close out in FY01. If remote video proves to be a reliable and cost-effective method for improving upon aerial survey estimates of spawning escapement, ADF&G may use normal agency funding to replace aerial surveys with video, where suitable.

PUBLICATIONS AND REPORTS

Internal (ADF&G) and external (EVOS Trustee Council, Chief Scientist, etc.) peer review of project documents (DPD, Annual and Final Reports) will occur throughout the project's duration. We will seek to present significant findings at scientific symposia (e.g., Lowell Wakefield Fisheries Symposium, October 27-30, 1999) and publish them in a peer-reviewed journal (e.g., Transactions of Fisheries Management).

PROFESSIONAL CONFERENCES

Travel funds have been requested to attend the EVOS annual workshop in Anchorage. If analyses can be completed in time, FY99 results will be presented at the 1999 Lowell Wakefield Conference in Anchorage (October 27-30, 1999).

NORMAL AGENCY MANAGEMENT

Along with monitoring the recovery of injured resources, the proposed project will improve the department's ability to assess and manage salmon resources within the spill area and elsewhere in Alaska. The department has few resources with which to develop new technology; without the Trustee Council's financial support, this project may not be funded.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Does not apply.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Does not apply.

PROPOSED PRINCIPAL INVESTIGATOR

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PRINCIPAL INVESTIGATOR

Edward O. Otis, Asst. Area Research Biologist for Lower Cook Inlet, Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division (CFMD), P.O. Box 1402 Homer, AK 99603.

Education: Master of Science, Fisheries Science, University of Arizona, 1994. Bachelor's of Science, Environmental Science, University of New Hampshire, 1988.

Professional Experience: April 1996-present: Asst. Area Research Biologist for Lower Cook Inlet, Alaska Department of Fish and Game, CFMD, Homer, AK. Supervised by William R. Bechtol. Responsible for assessment and forecasting of Kamishak Bay herring stock; direct salmon and herring catch/escapement-sampling programs; forecast Lower Cook Inlet salmon returns. April 1994-March 1996: Fishery Biologist, Kenai Fishery Resources Office, U.S. Fish and Wildlife Service, Kenai, AK. Supervised by Gary Sonnevil. Project leader for Andreafsky River (Yukon) adult salmon enumeration project: constructed and deployed resistance board/floating weir to count adult salmon; project leader for Kenai River rainbow trout radio-telemetry project: surgically implanted radio transmitters and tracked fish using mobile receivers and remote data loggers. June 1991-March 1994: Graduate Research Asst., Univ. of Arizona, Dept. of Renewable Natural Resources, Tucson, AZ. Supervised by Dr. O. Eugene Maughan. Designed and implemented field studies to assess the composition, abundance, and distribution of fishes in streams tributary to the Colorado River in Grand Canyon. Designed and implemented field study to inventory aquatic habitat available to stream fishes in Grand Canyon. August 1987-June 1991 (intermittent): Field biologist/technician, Kenai Fishery Resources Office, U.S. Fish and Wildlife Service, Kenai, AK. Supervised by Gary Sonnevil. Project Leader or team member on various field projects including: assessing adult salmon returns using weirs (Uganik R, Kodiak); developing new approaches to aging dolly varden and lake trout otoliths; enumerating emergent salmon fry (Tustumena Lake); investigating steelhead distribution and angler effort (Cold Bay); investigating run-timing and migration rates of chinook salmon (Kuskokwim River); and inventorying salmon spawning habitat (Ayakulik R., Kodiak).

OTHER KEY PERSONNEL

Project Manager: Mark Dickson, Fish and Wildlife Technician IV. Mr. Dickson has been employed as a fish culturist and fish and wildlife technician with the Alaska Department of Fish and Game for the past 20 seasons. He has considerable experience managing salmon escapement related field projects, including: the *EVOS* Trustee Council funded Delight and Desire Lakes project (97254) and currently, the Port Dick Creek Restoration project (97139A2).

LITERATURE CITED

Bevan, Donald E. 1961. Variability in aerial counts of spawning salmon. Journal of the Fisheries Research Board of Canada 18(3):337-348.

Bucher, W.A., and L.F. Hammarstrom. 1997. 1996 Lower Cook Inlet annual finfish management report. Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, Anchorage.

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Bue, B.G., S.M. Fried, S. Sharr, D.G. Sharp, J. Wilcock, and H.J. Geiger. 1998a. Estimating salmon escapement using area-under-the-curve, aerial observer efficiency, and stream-life estimates: the Prince William Sound pink salmon example. North Pacific Anadromous Fisheries Commission Bulletin 1:240-250.

Bue, B. G., S. Sharr, and J.E. Seeb. 1998b. Evidence of damage to pink salmon populations inhabiting Prince William Sound, Alaska, two generations after the *Exxon Valdez* oil spill. Transactions of the American Fisheries Society 127:35-43.

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Dudiak, N., M. Dickson, and G. Coble. 1998. Tributary restoration and development project: Port Dick Creek, Lower Cook Inlet, Alaska, Exxon Valdez oil spill restoration project 1997 annual report (Restoration Project 97139-A2), Alaska Department of Fish and Game, Homer, Alaska.

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Hatch, Douglas R., M. Schwartzberg, and P.R. Mundy. 1994. Estimation of pacific salmon escapement with a time-lapse video recording technique. North American Journal of Fisheries Management 4:626-635.

Hill, R.A. 1997. Optimizing aerial survey count frequency for the area-under-the-curve method of estimating escapement. North American Journal of Fisheries Management 17:461-466.

Irvine, J.R., B.R. Ward, P.A. Teti, and N.B.F. Cousens. 1991. Evaluation of a method to count and measure live salmonids in the field with a video camera and computer. North American Journal of Fisheries Management 11:20-26.

Neilson, J.D. and G.H. Geen. 1981. Enumeration of spawning salmon from spawner residence time and aerial counts. Transactions of the American Fisheries Society 110:554-556.

Perrin, C.J. and J.R. Irvine. 1990. A review of survey life estimates as they apply to the area-under-the-curve method for estimating the spawning escapement of Pacific salmon. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1733. 49 pp.

Shardlow, T., R. Hilborn, and D. Lightly. 1987. Components analysis of instream escapement methods for Pacific salmon (Oncorhynchus spp.). Canadian Journal of Fisheries and Aquatic Sciences 44:1031-1037.

FY 99 EXXON VALDEZ TRU[illegible]E COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999
Personnel		$38.0
Travel		$1.5
Contractual		$4.9
Commodities		$5.4
Equipment		$4.2
Subtotal	$0.0	$54.0
General Administration		$6.0
Project Total	$0.0	$60.0
Full-time Equivalents (FTE)		0.8
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FY 2000	Estimated FY 2001	Estimated FY 2002
$53.3	$12.3	

Dollar amounts are shown in thousands of dollars.

Comments:

FY00 costs include deploying the video and weir on another system to evaluate a different application. Thus, FY00 costs will be similar to those expended in FY99 except that new equipment purchaces will be reduced. FY01 costs are closeout expenses related to completion of final and publishable reports.

FY 99

Prepared:

Project Number: 99366
Project Title: Improved salmon escapement enumeration using remote video and time-lapse recording technology
Agency: ADF&G

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 99 EXXON VALDEZ TRU.. ..E COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Personnel Costs:		GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	Proposed FY 1999
Name	Position Description					
Field Personnel (15 June through 31 July) Maintain and operate adult weir and video equipment						
Carla Milburn	Fisheries Technician II	9B	2.5	3337.0	1408.0	9.8
Josephine Ryan	Fisheries Technician II	9B	2.5	3337.0	1408.0	9.8
Project Supervision Field site and gear preparation, project management, video screening and report writing.						
Mark Dickson	Fisheries Technician IV		4.0	4600.0	0.0	18.4
	Subtotal		9.0	11274.0	2816.0	
					Personnel Total	$38.0

Travel Costs:	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FY 1999
Description					
Homer-Anchorage and return. Annual EVOS Restoration Workshop	135.0	2	6	45.0	0.5
Lodging			6	75.0	0.5
Homer-Anchorage and return. Lowell Wakefield Fisheries Symp.	135.0	1	3	45.0	0.3
Lodging			3	75.0	0.2
				Travel Total	$1.5

FY 99

Prepared:

Project Number: 99366
Project Title: Improved salmon escapement enumeration using remote video and time-lapse recording technology
Agency: ADF&G

FORM 3B
Personnel
& Travel
DETAIL

FY 99 EXXON VALDEZ TRUS[illegible]E COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Contractual Costs:	Proposed FY 1999
Description	
Air charter to transport camp. 2 round trips @ 1.5 hrs/ trip @ $580.00/hr. (Dehavilland Otter)	1.7
Air charter to support camp (food and supplies) and service remote video equipment, 8 round trips @ 1.25 hrs / trip @ $225 / hr.	2.3
Air charter standby 3 hrs. @ 112.50 / hr.	0.3
Photo developing and graphic arts work	0.6
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$4.9

Commodities Costs:	Proposed FY 1999
Description	
Food: 2 people @ $20.00 / day @ 75 days(2x20x75)	3.0
Consumables: lumber, additional fencing (weir materials), video tape etc.	0.3
100 gals. stove oil @ $1.25 per gallon	0.1
1 marine cycle battery (for camp lighting and radio communications)	0.1
4 marine cycle batteries (to power video equipment) @ $90.00	0.4
1 kerosene tent heater	0.2
Materials and labor to fabricate remote camera stand and weather/bear proof strongbox to house video equipment	0.9
Miscellaneous electrical supplies	0.2
Pelican case for VCR	0.2
Commodities Total	$5.4

FY 99

Prepared:

Project Number: 99366
Project Title: Improved salmon escapement enumeration using remote video and time-lapse recording technology
Agency: ADF&G

FORM 3B
Contractual & Commodities DETAIL

FY 99 EXXON VALDEZ TRU[illegible]E COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1999
Remote video equipment:			
Underwater camera and video cable/connections	1	1500.0	1.5
Video Cassette Recorder	1	1800.0	1.8
Solar or wind powered electrical generation unit (depending on application)	1	900.0	0.9
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$4.2

Existing Equipment Usage: Description	Number of Units	Inventory Agency
12 x 15' Weatherport portable shelter and platform	1	ADF&G
Portable electrical generator	1	ADF&G
75' adult salmon counting weir	1	ADF&G
High frequency radio	2	ADF&G
Camp supplies (cooking set, lighting, etc.)	1	ADF&G
Rain gear, hip boots	2	ADF&G
Adult salmon sampling kit	1	ADF&G
Personal computer	2	ADF&G

FY 99

Project Number: 99366
Project Title: Improved salmon escapement enumeration using remote video and time-lapse recording technology
Agency: ADF&G

FORM 3B
Equipment
DETAIL

Prepared:

Synthesis and Publication of Fisheries Research

Project Number:	99367
Restoration Category:	Research
Proposer:	ADF&G
Lead Trustee Agency:	ADF&G
Cooperating Agency:	University of Washington, American Fisheries Society
Alaska SeaLife Center:	None
Duration:	4 years
Cost FY 99:	$ 53,200
Cost FY 00	$ 56,000
Cost FY 01	$ 59,000
Cost FY 02	$ 62,000
Geographic Area:	Greater Gulf of Alaska Spill Area
Injured Resource/Service:	Salmon, Herring, Rockfish

ABSTRACT

The American Fisheries Society (AFS) has agreed to work with ADF&G to synthesize, edit, and publish the legacy of research conducted on fisheries resources in the Gulf of Alaska spill zone. Many EVOS reports written by ADF&G staff provide key information on injured resources. However, some do not form stand-alone publications, and some contain information suitable for more than one article or are too bulky for publication in their current form; additional synthesis and editing are needed to move these from report status to publication in peer-reviewed literature. In this project AFS editorial staff will work with ADF&G staff to synthesize research reports into manuscripts that will then undergo peer review for consideration in the leading fisheries journals in North America.

INTRODUCTION

Projects funded by the EVOS Trustee Council have generated significant quantities of important fisheries-related information during the last decade. Currently, much of this information resides in EVOS-directed final and annual reports that do not receive wide attention. ADF&G has attempted, whenever possible, to publish research findings in peer-reviewed journals. But, it is not normal agency policy for ADF&G staff to publish in peer-reviewed journals. Consequently, without additional funding, much information will remain unavailable to the fisheries community at large. It is proposed that EVOS Trustee Council funding be used to distil the mass of information that has accumulated over the last ten years into a series of reports that will be submitted to peer-reviewed journals. The American Fisheries Society, publisher of the leading fisheries journals in North America, has agreed to support this proposal through an editorial subcontract. The timing of this process is of the essence as key personnel involved with many of the projects have already left ADF&G employment, and others will eventually leave, making additional syntheses increasingly difficult.

NEED FOR THE PROJECT

A. Statement of Problem

Since the oil spill of 1989, the Alaska Department of Fish and Game Division of Commercial Fisheries has administered numerous EVOS Trustee Council-funded projects designed to assess damage or restore resources. These projects have been wide-ranging in scope, involving management and research objectives pertaining to salmon, herring and groundfish. Projects have ranged from investigations of the genetic structure of sockeye salmon populations in Cook Inlet to studies assessing the potential of hydroacoustics to estimate herring populations.
Results from Trustee Council-funded projects have been recorded in annual and final reports and disseminated at annual Trustee Council sponsored workshops. While these fora provide access to much of the accumulated data, they are not widely frequented by fisheries scientists. It is believed that without further effort to publish project results in peer-reviewed journals, a significant portion of the information collected over the last ten years will not be assimilated by the scientific community. ADF&G has made an effort to publish many reports; but, normal agency management practices do not facilitate publication in peer-reviewed journals, and external funding is required to meet the burden.

Rationale/Link to Restoration

The Trustee Council has made a major investment into the study of the effects of the oil spill on fisheries resources in the Gulf of Alaska. Substantial efforts were also funded to improve the management of injured species that support commercial, sport, and subsistence fisheries. In recent years the Trustee Council increasingly emphasized the need to publish research findings and solicited proposals to integrate research results into peer-reviewed publications. This project directly responds to the Council's goal to move EVOS reports into the peer-reviewed literature in order to provide the scientific community with ready access to and a broad understanding of the effects of the spill and the efforts to ameliorate them.

B. Location

This project will address research and restoration efforts in the Gulf of Alaska spill area.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

As no field activities are planned, only limited community involvement is envisioned for this project.

PROJECT DESIGN

A. Objective

Synthesize CFMD Division reports of Trustee Council research into peer-reviewed publications.

B. Methods

1. Review reports of fisheries research conducted the past nine years to identify publishable units
2. Collate, coordinate, and integrate results from an array of projects to provide clear evaluation of impacts, results of restoration activities, and showcase improved understanding and management of salmon and marine fisheries resources resulting from Trustee Council-sponsored agency research

C. Cooperating Agencies, Contracts, and Other Agency Assistance

The bulk of the budget for this project is a contract to the American Fisheries Society and the University of Washington for synthesis and editing services. Dr. F. M. Utter, coeditor of Transactions of the American Fisheries Society, is housed at the University of Washington School of Fisheries in Seattle. Celia Rozen is housed ½ time at the Alaska Resources Library and Information Center (ARLIS). ARLIS capabilities will be used by Celia to provide archival documents, literature searches, and other information services necessary for manuscript synthesis.

NORMAL AGENCY MANAGEMENT

ADF&G has statutory authority to manage the commercial, sport, and subsistence harvest of salmon, herring, pollock, rockfish, and other marine fish and shellfish in the spill area. However, the research into affects of the spill and improved management of affected species would not have been conducted if the oil spill had not occurred. The CFMD Division has substantially subsidized the publication of EVOS research and will continue to subsidize research and publications. This project proposes an effort that greatly exceeds the Commissioner of ADF&G expectations of the Division through additional contracting of editing and publishing tasks to the American Fisheries Society.

Bibliography of Selected EVOS Publications Co-authored by Commercial Fisheries Management and Development Staff

Bue, B.G., S.M. Fried, S. Sharr, D.G. Sharp, J.A. Wilcock, and H.J. Geiger. 1998. Estimating salmon escapements using area-under-the-curve, aerial observer efficiency, and stream-life estimates: the Prince William Sound example. North Pacific Anadromous Fish Commission Bulletin Number 1:240-250.

Bue, B.G., S. Sharr, S.D. Moffitt, and A. Craig. 1996. Injury to pink salmon embryos and preemergent fry due to the T/V Exxon Valdez oil spill. Pages 619-627 in S.D. Rice, R.B. Spies, D.A. Wolfe, and B.A. Wright, editors. Proceedings of the Exxon Valdez oil spill symposium. American Fisheries Society Special Publication 18.

Bue, B.G., S. Sharr, J.E. Seeb. 1998. Evidence of damage to pink salmon populations inhabiting Prince William Sound, Alaska, Two generations after the Exxon Valdez oil spill. Transactions of the American Fisheries Society 127:35-43.

Cooney, R.T., T.M. Willette, S. Sharr, D. Sharp, J. Olsen. 1995. The effect of climate on Pacific salmon production in the northern Gulf of Alaska: examining the details of a natural experiment. In Proceedings of the International Symposium on Climate Change and Northern Fish Populations, Can. Spec. Publ. Fish. Aquat. Sci. 121: 475-482.

Geiger, H.J., B.G. Bue, S. Sharr, A.C. Wertheimer, and T.M. Willette. 1996. A life history approach to estimating damage to Prince William Sound pink salmon caused by the Exxon Valdez oil spill. Pages 487-498 in S.D. Rice, R.B. Spies, D.A. Wolfe, and B.A. Wright, editors. Proceedings of the Exxon Valdez oil spill symposium. American Fisheries Society Special Publication 18.

Greene, B.A., and J.E. Seeb. 1997. SINE and transposon sequences generate high-resolution DNA fingerprints, "SINE prints" which exhibit faithful Mendelian inheritance in pink salmon *(Oncorhynchus gorbuscha)*. Mol. Mar. Biol. Biotech. 6(4): 331-341.

Habicht, C., S. Sharr, and J.E. Seeb. 1998. Coded wire tag placement affects homing ability of pink salmon. Trans. Am. Fish. Soc. (*revision in press for July 1998 issue*).

Hilborn, R. and B.G. Bue. 1998. Estimating spawning escapements from periodic counts: a comparison of methods. Canadian Journal of Fisheries and Aquatic Sciences (*revision accepted and in press*).

Miller, G.D., J.E. Seeb, B.G. Bue, and S. Sharr. 1994. Saltwater exposure at fertilization induces ploidy alterations, including mosaicism, in salmonids. Canadian Journal of Fisheries and Aquatic Sciences 51(Suppl. 1):42-49.

O'Connell, M., M.C. Dillon, J.M.Wright, P. Bentzen, S. Merkouris, and J. Seeb. 1998. Genetic structuring among Alaskan Pacific herring (*Clupea harengus pallasi*) populations identified using microsatellite variability. J. Fish Biol. (*revision accepted and in press*).

Olsen, J.B., L.W. Seeb, P. Bentzen, and J.E. Seeb. 1998. Genetic interpretation of broad-scale microsatellite polymorphism in odd-year pink salmon. Trans. Am. Fish. Soc *(revision in press for July 1998 issue*).

Seeb, J.E., C. Habicht, J.B. Olsen, P. Bentzen, J.B. Shaklee, and L.W. Seeb. 1988. Allozyme, mtDNA, and microsatellite variants describe structure of populations of ink and sockeye salmon in Alaska. North Pacific Anadromous Fish Commission Bulletin Number 1:300-318.

Willette, T.M., R.T. Cooney, K. Hyer. 1998. An evaluation of some factors affecting piscivory during the spring bloom in a subarctic embayment, Can. J. Fish. Aquat. Sci. (in review).

Paul, A.J. and T.M. Willette. 1997. Geographical variation in somatic energy content of migrating pink salmon fry from PWS: a tool to measure nutritional status. In Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems, Alaska Sea Grant College Program, Report 97-01, pp. 707-720.

Willette, T.M. 1996. Impacts of the Exxon Valdez Oil Spill on the migration, growth, and survival of juvenile pink salmon in PWS. In Proceedings of the Exxon Valdez Oil Spill Symposium, American Fisheries Society Symposium 18: 533-550.

SCHEDULE

A. Measurable Project Tasks for FY99

October 1998	Establish contract with UW and AFS
November 1998	Review reports, identify publishable units in conjunction with AFS editorial staff
Dec. 1998-Sept. 1999	AFS integrates and edits
Mar. 1998-Sept. 1999	ADF&G submits manuscripts to Transactions of the American Fisheries

Society or North American Journal of Fisheries Management

B. Project Milestones and Endpoints

The goal of this project is to provide, on average, one published manuscript per quarter. Milestones will be the submittal of the manuscripts to the peer-review process; endpoints will be the final acceptance of revised versions.

C. Completion Date

The project will be completed in FY02. Requests for renewal are predicated on the success of reaching annual milestones.

PUBLICATIONS AND REPORTS

Topics proposed for year 1 include but are not limited to:

The use of thermal mark technology for management of a large-scale salmon fishery: pink salmon of Prince William Sound

Hatchery/wild stock interactions detected through the use of otolith-marked salmon

The strengths and weaknesses of coded-wire-tag technology in management of a large-scale salmon fishery

Improved management of sockeye salmon through discrete-stock research using molecular markers

PROFESSIONAL CONFERENCES

None

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project will be coordinated with other fisheries projects conducted by Divisions of ADF&G, NOAA, and university scientists contracting with ADF&G and NOAA. NOAA is currently synthesizing the toxicological impacts of oil on pink salmon (TC project 99329); this project is designed to complement project 99329 by emphasizing restoration research on the improved management of affected species.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

None

PERSONNEL

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FY 99 EXXON VALDEZ TRU[illegible]E COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Budget Category:	Authorized FY 1998	Proposed FY 1999						
Personnel	$0.0	$11.9						
Travel	$0.0	$0.0						
Contractual	$0.0	$36.9						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$48.8		Estimated FY 2000	Estimated FY 2001	Estimated FY 2002		
General Administration	$0.0	$4.4						
Project Total	$0.0	$53.2		$56.0	$59.0	$62.0		
Full-time Equivalents (FTE)		0.2						
			Dollar amounts are shown in thousands of dollars.					
Other Resources								

Comments:

FY 99

Prepared:

Project Number: 99367
Project Title: Synthesis and Publication of Fisheries Research
Agency: AK Dept. of Fish & Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

FY 99 EXXON VALDEZ TRU[illegible]E COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FY 1999
Rozen	Librarian II	17J	1.0	5800.0		5.8
David Evans	Biometrician I	17J	1.0	6100.0		6.1
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		2.0	11900.0	0.0	
					Personnel Total	$11.9

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FY 1999
					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

FY 99

Prepared:

Project Number: 99367
Project Title: Synthesis and Publication of Fisheries Research
Agency: AK Dept. of Fish & Game

FORM 3B
Personnel
& Travel
DETAIL

FY 99 EXXON VALDEZ TRU[illegible]E COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

Contractual Costs:		Proposed FY 1999
Description		
Contract with University of Washington		36.9
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	$36.9

Commodities Costs:		Proposed FY 1999
Description		
	Commodities Total	$0.0

FY 99

Project Number: 99367
Project Title: Synthesis and Publication of Fisheries Research
Agency: AK Dept. of Fish & Game

FORM 3B
Contractual & Commodities DETAIL

Prepared:

FY 99 EXXON VALDEZ TRU[illegible]E COUNCIL PROJECT BUDGET

October 1, 1998 - September 30, 1999

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FY 1999
			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

FY 99

Project Number: 99367
Project Title: Synthesis and Publication of Fisheries Research
Agency: AK Dept. of Fish & Game

FORM 3B
Equipment
DETAIL

Prepared: