EXXON VALDEZ Oil Spill Trustee Council
FY 97 Detailed Project Description

Herring Natal Habitats

Project Number: 97166

Restoration Category: General Restoration

Proposer: ADF&G

Lead Trustee Agency: ADF&G

Cooperating Agencies: University of Alaska

Alaska SeaLife Center:

Duration: Continue population monitoring until Pacific herring population in Prince William Sound has recovered.

Cost FY 97: $260,700

Cost FY 98: $190,200

Cost FY 99: $22,400

Cost FY 00: $0

Geographic area: Prince William Sound

Injured Resource/Service: Pacific Herring

ABSTRACT
The 1989 *Exxon Valdez* oil spill coincided with the spring migration of Pacific herring *Clupea pallasi* to spawning grounds in Prince William Sound (PWS). Studies of oil spill injuries to herring documented damage from oil exposure in adult herring, reduced hatching success of embryos, and elevated levels of physical and genetic abnormalities in newly hatched larvae. The PWS herring spawning population has drastically declined since 1993, and pathology studies implicated viral hemorrhagic septicemia (VHS) and ichthyophonus as potential sources of mortality as well as indicators of stress. The current project will monitor the abundance of the injured herring resource in PWS using SCUBA and hydroacoustic techniques. In addition, we will evaluate the feasibility, cost, and precision of each technique with the intent to use either SCUBA or hydroacoustics after FY98.

INTRODUCTION

The *Exxon Valdez* oil spill coincided with the spring migration of Pacific herring *Clupea pallasi* to spawning grounds in Prince William Sound (PWS). Adult herring swam through oiled waters on their way to nearshore staging areas. Studies of oil spill injuries to herring were initiated in 1989 and research continued through 1992. Significant histopathological damage was measured in adults collected in oiled areas in both 1989 and 1990 confirming exposure of the fish to toxins (Brown 1995). Oiling of over 40% of the spawning areas (42 of 98 miles) caused elevated levels of physical and genetic abnormalities in newly hatched larvae and reduced hatching success of the embryos (Brown 1995). Over 80% of the summer rearing and feeding areas of herring were oiled in 1989, based on oil trajectory and historic fisheries records from 1914 to the present (Brown 1995).

In 1993, the herring population in PWS collapsed. The total observed spawning population was less than one third of preseason predictions and the average sizes of herring in each age class were some of the smallest on record. The total commercial harvest for that year was one of the lowest on record. In 1994, the total observed spawning population was the below threshold biomass required to conduct a commercial harvest and no fishing occurred. Pathology studies implicated viral hemorrhagic septicemia (Meyers et al. 1994) and a second potentially lethal pathogen, ichthyophonus, as possible sources of mortality and stress. Pathology studies continued in 1995 included laboratory investigations of the lethality of suspect pathogens and the role of environmental contaminants in disease transmission.

This project will provide a direct measure of adult herring abundance necessary for monitoring recovery of the injured PWS herring population. ADF&G will perform the field collection and data analysis constituting the continuation of herring spawn deposition surveys. A second field component will investigate the feasibility and cost effectiveness of estimating biomass of spawning herring using acoustic surveys as an alternative to spawn deposition surveys. Acoustic surveys will be subcontracted through a competitive bid process and will rely on ADF&G base funding for much of the vessel and personnel costs.

During spawn deposition surveys, SCUBA divers will estimate the abundance and distribution of herring eggs. This information will be incorporated with aerial observations of spawn distribution and basic biological information (age composition, sex ratios, average size, and fecundity) to estimate adult spawning biomass. Estimates of spawning biomass are used to forecast spawning returns the following year and form the basis of herring fishery management in PWS.

Biomass of herring migrating to PWS spawning grounds will also be estimated acoustically using echo integration techniques. Dual or split beam *in situ* measurements and fish species composition and average size from seine hauls will be used to evaluate and correct for target strength assumptions. Acoustic biomass estimates will be compared with spawn deposition biomass estimates to evaluate the accuracy, reliability, and cost effectiveness of each method.

NEED FOR PROJECT

A. Statement of Problem

Adult Pacific herring on their way to PWS spawning areas swam through oil from the *T/V Exxon Valdez* oil spill, eggs incubated in the oil, and larvae and juvenile herring may have been exposed to oil in rearing and feeding areas. Histopathological damage was found in adult herring collected in oiled areas in both 1989 and 1990, mortality of young herring was significantly greater in oiled areas in 1989 and 1990, and sublethal effects were measurable in larvae and adults in 1989 and 1990 (Brown 1995). Persistent sheening and suspended oil-sediment droplets leaching from beaches and cleaning operations in 1989 and 1990 continued to expose adult and juvenile herring to oil. Laboratory exposures of pre-spawning adult herring to oil show high concentrations of oil in the ovarian tissue (Brown 1995). Laboratory studies measuring the effect of known doses of oil on newly hatched larvae provided a direct link between estimated doses of oil measured in PWS and the level of injury observed in samples collected from the field (Brown 1995). In addition, measurements of oil in mussel tissue collected adjacent to spawning beds was significantly correlated to several indices of injury in herring larvae from those beds, the highest correlation being with the genetic injury endpoints (Brown 1995).

Although herring survival varies tremendously under normal conditions, abundance for the 1989 year class was extremely low and results to date strongly implicate the oil spill as a major cause. One hypothesis is that injury to germ tissue caused by exposure to oil may have resulted in non-viable embryos and larvae. A pilot experiment to measure the ability of herring from this age class to produce viable offspring was conducted in 1992 and hatching success of eggs collected from fish spawning in previously oiled areas was less than half that of eggs collected from fish spawning in pristine areas (Brown 1995). Additionally, there were approximately twice as many abnormal larvae from fish spawning in previously oiled areas (Brown 1995).

In 1993, the total observed spawning population was less than one third of preseason predictions and the average sizes of herring in each age class were some of the smallest on record. The total commercial harvest for that year was one of the lowest on record. Pathology studies from the spring of 1993 implicated viral hemorrhagic septicemia (VHS) as a potential source of mortality and stress (Meyers et al. 1994). In 1994 and 1995, the total observed spawning population was below threshold biomass required to conduct commercial harvest and no fishing occurred. Later, pathology studies indicated the presence of both VHS and a second potentially lethal pathogen, ichthyophonus. Pathology studies continued in 1996 include laboratory investigations of the lethality of suspect pathogens and the role of environmental contaminants in disease transmission.

B. Rationale/Link to Restoration

This project provides estimates of spawning herring abundance and a better understanding of some of the factors which contributed to the collapse of the population. This information is needed for monitoring recovery of the injured Prince William Sound (PWS) herring population. Project results can be used to judge recovery of the herring resource, including recovery to population levels sufficient for sustainable commercial harvest, and can also serve as the basis for setting harvest strategies. In addition, this project provides information about the abundance and survival of early life history stages which will improve our understanding of the ecological importance of herring in the PWS ecosystem.

C. Location

This project will be conducted entirely within PWS. Project results will directly affect the management of PWS herring fisheries. All major PWS communities, including Cordova, Seward, Valdez and Whittier, are directly affected by these fisheries since these communities house not only commercial fishers but also the various support services relating to vessel and gear repair and storage, as well as fish processing. Many native villages in PWS, such as Tatitlek and Chenega, also depend upon PWS herring for subsistence needs.

COMMUNITY INVOLVEMENT

Since the dramatic decline of the PWS herring spawning population in 1993 there has been vigorous public support for herring research from PWS communities as well as various private and professional organizations. The Public Advisory Group (PAG) for the Trustee Council has also voiced support for these studies. Spawn deposition surveys have been recognized by commercial fishermen, fishery managers, and peer reviewers as a valuable tool for stock assessment in the absence of direct methods of estimation. Accurate and precise estimates of stock abundance are needed for ecosystem based studies of processes that affect abundance. In addition to peer review through the EVOS process, herring stock assessment and embryo survival studies have received critical review through the intensive SEA research planning and public review effort. The ecosystem approach to PWS studies adopted by the SEA planning group recognized the commercial and ecosystem importance of herring and included them as a co-target species for study along with pink salmon.

Some people from communities in PWS will have an opportunity to directly participate in this project by providing logistical support for field sampling. One vessel will be chartered as a research platform for spawn deposition surveys, while one or more purse seine vessels will be chartered to capture fish for various purposes (e.g. identification of acoustic targets, disease studies, biological characteristics of spawning population).

PROJECT DESIGN

A. Objectives

The overall goal of this project is to monitor the spawning population of Pacific herring in PWS to determine when this injured population has recovered. The project has three specific objectives in FY97:

1. Estimate the biomass of spawning herring in PWS using SCUBA diving spawn deposition survey techniques such that the estimate is within $\pm$ 25% of the true value 95% of the time, and describe the age, sex and size composition of the spawning population.

2. Investigate the feasibility of estimating biomass of spawning herring using acoustic surveys and net sampling.

3. Compare estimates from spawn deposition with estimates from acoustic surveys.

While the overall goal of the project will not change in future years, specific objectives might be altered to better achieve this goal. Estimation of the spawning herring population biomass, as well as its age,sex and size composition, will continue to be the most important objective of this project.

B. Methods

Spawn Deposition Survey and Biomass Estimation

The survey design of the existing ADF&G spawn deposition project was modified for NRDA studies in 1989 to more accurately assess response of the PWS herring population to the *T/V Exxon Valdez* oil spill. Beginning in 1989, the spawn survey was conducted to obtain biomass estimates within $\pm$ 25% of the true biomass 95% of the time. Study design alterations included increasing the number of (1) SCUBA divers, (2) survey transects, and (3) skiff and diver surveys used to correct aerially mapped spawning area boundaries.

Biomass estimates based on spawn deposition surveys consist of three major components: (1) a spawn deposition survey; (2) age-weight-length (AWL), sex ratio, and fecundity sampling; and (3) egg loss determination.

Spawn Deposition Survey Design. Survey design has been described in detail by Biggs and Funk (1988), and closely follows the two-stage sampling design of surveys used in British Columbia (Schwiegert et al. 1985) and Southeast Alaska (Blankenbeckler and Larson 1982, 1987). These surveys use random sampling for the first stage (transects) and systematic sampling for the second stage (quadrants within transects). Random sampling for the second stage is not feasible because of underwater logistical constraints (Schwiegert et al. 1985).

Additionally, our surveys will be stratified by area to account for geographic differences and the potential of sampling discrete herring stocks. Areas surveyed may include Southeast, Northeast, North Shore, Naked Island and Montague Island depending upon the locations of spawning.

Mean egg densities along each transect will be combined to estimate an average egg density by area. Spawning bed width along each of the transects will be used to estimate average spawning bed width by area. Average width, average density, and total spawning bed shoreline length (from aerial surveys) will be used to estimate total number of eggs deposited in each summary area surveyed. Average fecundity and sex ratio, derived from AWL sampling, and estimates of total number of eggs deposited will be used to calculate herring population numbers and biomass. Based on variances obtained from the 1984, and 1988 to 1992 surveys, a minimum sampling goal of 0.035 % of all potential transects within the spawning area should ensure that the estimated biomass is within 25% of the true biomass 95% of the time. Based on the size of the sampling quadrant, there are 3,163 potential transects per kilometer. Therefore, 100 km of herring spawn would require 110 transects to meet our goals for accuracy and precision. Confidence intervals will be calculated assuming that total egg estimates follow a normal distribution.

Spawn Deposition Survey Sampling Procedure. The general location of spawning activity will be determined from milt observed during scheduled aerial surveys that are part of an existing agency program. This information will be compiled and summarized on maps showing spawning locations and the number of days on which milt is observed. Total linear miles of shoreline containing herring spawn will be estimated from aerial survey maps and corrected by skiff and diver reconnaissance at the time of dive surveys. Skiff surveys will be performed close to shore at low tide by both walking along exposed intertidal areas and by viewing the shoreline from the skiff.

Each shoreline area containing herring spawn will be divided into the narrowest resolvable segments on the map scale (approximately 0.18 km). The total number of potential transects will be calculated from the total shoreline km of observed spawn. A minimum of 0.035% of all potential transects will be selected for dive surveys. Random numbers will be assigned to each potential transect and rounded to the nearest number divisible by 0.18 km to enable mapping of shoreline segments. Shoreline segments will be randomly selected and used to locate transects. Each transect selected will be assigned a sequential transect number and charted on waterproof field maps.

Diving on herring spawn will begin about 5 days after spawning has ceased to allow water turbidity due to milt to decrease and for the large numbers of sea lions usually present near spawning herring to disperse. Two three-person dive teams will complete the surveys. Each team will consist of a lead diver to count eggs (typically the person most experienced at this survey task), a second diver to record data, and a third diver on the surface performing as a tender. Diving and tending duties will be rotated daily. Based on information from previous PWS surveys, two diving teams can generally complete 6 to 12 transects daily under favorable weather conditions and in areas with average spawning density and distribution. A sample size

total of 100 or more transects will require from 10 to 20 days of diving, depending upon weather and location of spawn. This time includes collection of diver calibration samples for a team of experienced divers. If inexperienced divers are hired, training will require about one additional week.

Location for each survey transect will be fixed as the dive skiff approaches the shore and before bottom profiles, bottom vegetation, or herring spawn are visible from the skiff. The tender will choose a shoreline feature to use as a reference point such as a tree, rock, or cliff located above the high tide line within the randomly selected shoreline segment. The sampling transect will extend seaward perpendicular to shore from this fixed reference point along a compass course.

Divers will estimate the numbers of eggs deposited within a sampling quadrant placed at regular intervals along the length of the transect. The sampling quadrant will consist of a 0.1 m^2 PVC pipe frame with a depth gauge and compass attached. The first quadrant location will be randomly selected within the first 5 meters of spawn. Succeeding quadrant locations will be systematically spaced every 5 meters along the compass course until the apparent end of the spawn is found. Within each quadrant, the lead diver will estimate the number of eggs in units of thousands (K) within the quadrant, communicating the numbers through hand signals to the second diver to record. Number of eggs as well as vegetation type, percent cover, substrate, and depth will be recorded using a large weighted carpenter's pencil on water-proof plastic paper data forms attached to a clipboard. Divers will verify the end of the spawn by swimming at least an additional 20 m past the end of the spawn until a steep drop-off is encountered or vegetation is no longer present. Becker and Biggs (1992) documented methods used for diver surveys in greater detail including sample data forms, key codes for vegetation types, standard operating procedures for ADF&G diving, chemical recipes for sample preservatives, and other practical information.

Diver calibration samples will be collected throughout the dive survey and stratified by diver, vegetation type within four broad categories, and by egg density over three broad categories. Both divers will independently estimate the number of eggs on removable vegetation in each calibration quadrant. All egg-containing vegetation within the quadrant will be removed and placed in numbered mesh bags. The number of loose and attached eggs left after removal will be estimated by the lead diver and recorded. Based on accuracy estimated for previous survey results, approximately 80 calibration samples will be needed for each uncalibrated diver (less than three years survey participation) and 40 for each calibrated diver (three or more years survey participation). One quarter of the total samples will be taken for each of the four vegetation categories: eelgrass (EEL), fucus (FUC), large brown kelp (LBK), and hair kelp (HRK). One third of the calibration samples will be stratified over three ranges of egg densities: low (0-20,000), medium (20,000-80,000), and high ($>$80,000) within each vegetation category. Calibration samples will be preserved in Gilson's solution and labelled (Becker and Biggs 1992).

Biomass Estimation. Analysis of the spawn deposition survey data will be similar to methods used in 1988 (Biggs and Funk 1988), 1989-1992 (Biggs et al. *in press*). The biomass

estimator will be

$$B = TB', \tag{1}$$

where

B = estimated spawning biomass in tonnes,
T = estimated total number of eggs (billions) deposited in an area, and
B' = estimated tonnes of spawning biomass required to produce one billion eggs.

Estimates for T and B' will be derived from separate sampling programs and will be independent. The estimated variance for the product of the independent random variables T and B' will be (Goodman 1960)

$$Var(B) = T^2 Var(B') + B^2 Var(T) - Var(T)Var(B'), \tag{2}$$

where

Var(B') = an unbiased estimate of the variance of B', and
Var(T) = an unbiased estimate of the variance of T.

Total Number of Eggs (T). The total number of eggs deposited in an area will be estimated from a two-stage sampling program with random sampling at the primary stage, followed by systematic sampling at the secondary stage, using a sampling design similar to that described by Schwiegert et al. (1985). To compute variances based on systematic second stage samples, it will be assumed that eggs will be randomly distributed in spawning beds with respect to the 0.1 m^2 sampling unit. While this assumption will not be examined, in practice the variance component contributed by the second sampling stage will be much smaller than that contributed by the first stage, so violation of this assumption would have little effect on the overall variance. The total number of eggs (T), in billions, in an area will be estimated as

$$T = N\hat{y}10^{-6}/(1-R), \tag{3}$$

where

L = the shoreline length of the spawn-containing stratum in meters,
N = $L/0.1^{0.5}$ = the total number of possible transects,
$0.1^{0.5}$ = 0.3162 m = width of transect strip,
$\hat{y}$ = average estimated total number of eggs (thousands) per transect,
10^{-6} = conversion from thousands to billions of eggs, and
R = estimated proportion of eggs disappearing from the study area from the time of

spawning to the time of the survey.

Average total number of eggs per transect strip (in thousands) will be estimated as the mean of the total eggs (in thousands) for each transect strip using

$$\hat{y} = \frac{\sum_{i=1}^{n} \hat{y}_i}{n}, \tag{4}$$

$$\hat{y}_i = M_i \bar{y}_i, \tag{5}$$

where:

n	=	number of transects actually sampled,
i	=	transect number,
M_i	=	$w_i/0.1^{0.5}$ = number of possible quadrants in transect i,
w_i		spawn patch width in meters measured as the distance along the transect between the first quadrant containing eggs and the last quadrant containing eggs, and
$\bar{y}_i$	=	average quadrant egg count in transect i (in thousands of eggs).

Average quadrant egg count within a transect, $\bar{y}_i$, will be computed as

$$\bar{y}_i = \frac{\sum_{j=1}^{m_i} y_{ij}}{m_i}, \tag{6}$$

where

j	=	quadrant number within transect i,
m_i	=	number of quadrants actually sampled in transect i, and
y_{ij}	=	adjusted diver-estimated egg count (in thousands of eggs) from the diver calibration model for quadrant j in transect i.

The variance of T, ignoring the unknown variability in R, is similar to that given by Cochran (1963) for three stage sampling with primary units of equal size. In this case the expression is modified because the primary units (transects) do not contain equal numbers of secondary units (quadrants), and the variance term for the third stage comes from the regression model used in the diver calibration samples. Therefore the estimated variance of T, conditioned on R, is

$$Var(T) = \frac{[N^2(10^{-6})^2[\frac{(1-f_1)}{n}s_1^2 + \frac{f_1(1-f_2)}{\sum_{i=1}^{n} m_i}s_2^2 + \frac{f_1 f_2}{\sum_{i=1}^{n} m_i}s_3^2]]}{(1-R)^2}, \quad (7)$$

where

$$s_1^2 = \frac{\sum_{i=1}^{n}(\hat{y}_i - \bar{\hat{y}})^2}{n-1} = \quad (8)$$

variance among transects,

$$s_2^2 = \sum_{i=1}^{n} M_i^2 \sum_{j=1}^{m_i} \frac{(y_{ij} - \bar{y}_i)^2}{n(m_i - 1)} = \quad (9)$$

variance among quadrants,

$$s_3^2 = \sum_{i=1}^{n}\sum_{j=1}^{m_i} Var(y_{ij}) = \quad (10)$$

sum of the variances of the individual predicted quadrant egg counts from the diver calibration model,

$$f_1 = \frac{n}{N} \qquad = \qquad (11)$$

proportion of possible transects sampled, and

$$f_2 = \frac{m_t}{M_t} \qquad = \qquad (12)$$

proportion of quadrants sampled within transects (same for all transects).

Diver Calibration. Divers will be calibrated to correct systematic biases in their estimates of numbers of eggs. This calibration consists of the derivation of the relationship between diver estimates of eggs within a quadrant and actual counts obtained in the laboratory on the same eggs. Calibrations will be performed for each combination of diver and vegetation category as defined by the structural and phylogenetic similarities of egg-bearing plants. The four vegetation categories are designated eelgrass, fucus, hair kelp and large brown kelp (Becker and Biggs, 1992).

Diver bias will be determined using methods described in an as-yet unpublished report of the 1995 calibrations. The analysis will follow that described in the 1994 detailed project description in that the distribution of the random component will be assumed to be lognormal. However, the choice of random component (dependent vs. independent variable) will be reversed from that of previous analyses and diver estimate rather than laboratory egg count will be assumed lognormally distributed. Analysis of variance of Log(Diver Estimate), along with graphical methods, will be used to assess the significance of year, diver, and vegetation factors. The final model relating diver estimates to laboratory egg counts will be that which is simplest but retains suitable precision and lack of bias. Within the analysis of variance, attempts will be made to account for the repeated measures nature of the diver estimates, possibly using a split-plot analogy. Prediction of laboratory counts from the diver estimates made in the main spawn survey will, as a result of the designation of dependent and independent variables, be made in an inverse way. Variances of predicted laboratory counts will be estimated by the bootstrap method.

Spawning Biomass per Billion Eggs (B'). Data from the herring sampling program for AWL, sex ratio, and fecundity will be used to estimate the relationship between spawning biomass and egg deposition. Once the age composition and sex ratio of a spawning population is determined, the average weight of the females in that population will be calculated. The relationship between fecundity and female weight will be used to calculate total numbers of

eggs deposited and tonnes of herring spawners. The tonnes of spawning biomass required to produce one billion eggs (B') will be estimated as

$$B' = \frac{\bar{W}S}{F(\bar{W}_f)} 10^3, \tag{13}$$

where

$\bar{W}$ = estimated average weight in grams of all herring (male and female) in the spawning population in an area,

S = estimated ratio of total spawning biomass (male and female) to female spawning biomass,

$F(\bar{W}_f)$ = estimated fecundity at the average weight of females in the spawning population in an area, in numbers of eggs, and

$$10^3 = \text{conversion factor} = \frac{10^{-6}}{10^{-9}} = \begin{matrix}\text{grams to tonnes} \\ \text{eggs to billions}\end{matrix}$$

Because average weight, sex ratio and fecundity will all be estimated from the same herring samples, the estimates will not be independent. The variance of B' is approximately:

$$\begin{aligned} Var(B') = (10^3)^2 \Bigg(& \left[\frac{S}{F(\bar{W}_f)}\right]^2 Var(\bar{W}) \\ & + \left[\frac{\bar{W}}{F(\bar{W}_f)}\right]^2 Var(S) \\ & + \left[\frac{\bar{W}S}{F(\bar{W}_f)^2}\right]^2 Var(F(\bar{W}_f)) \\ & + 2Cov(\bar{W},S)\left[\frac{S}{F(\bar{W}_f)}\right]\left[\frac{\bar{W}}{F(\bar{W}_f)}\right] \\ & - 2Cov[\bar{W},F(\bar{W}_f)]\left[\frac{S}{F(\bar{W}_f)}\right]\left[\frac{\bar{W}S}{F(F(\bar{W}_f))^2}\right] \\ & - 2Cov[S,F(\bar{W}_f)]\left[\frac{\bar{W}}{F(\bar{W}_f)}\right]\left[\frac{\bar{W}S}{F(\bar{W}_f)^2}\right]\Bigg). \end{aligned} \tag{14}$$

Because S will be estimated from pooled or single AWL samples (depending on availability of

fish), it will not be possible to estimate the covariance terms containing S, $Cov(\bar{W},S)$ and $Cov[S,F(\bar{W}_f)]$. Because the term involving $Cov[\bar{W},F(\bar{W}_f)]$ has been shown to be very small in previous analyses and probably contributes little to Var(B'), these covariance terms will not be included in the estimate of Var(B').

Herring Age, Weight, Length, Sex, and Fecundity:

The largest portion of this project element has traditionally been part of an existing agency program conducted annually by ADF&G using volunteer commercial seine vessels to capture herring for basic biological sampling. Because commercial herring fishing is not likely to be open again in 1997, AWL samples will be collected from major concentrations of spawning herring using purse seine vessels under short term vessel charter in conjunction with acoustic surveys. Sampling will generally occur soon after concentrations of herring appear in nearshore areas and are accessible to purse seines. Samples will be taken periodically from major herring concentrations throughout PWS during the spawning migration. AWL samples collected during the peak of spawning in each summary area, as determined from aerial survey sightings of milt and herring schools, will be used to estimate age and sex composition as well as average herring size from all major biomass concentrations in each area.
AWL sampling will be stratified by date and area for test fishing catches in each spawning area. Sample size for each stratum will be set to simultaneously estimate proportions by age when sampling from a multinomial population (Thompson 1987). The goal will be to select the smallest sample size for a random sample from a multinomial population such that the probability will be at least $1-\alpha$ (precision = 0.05) that all the estimated proportions will be simultaneously within 5% (accuracy = 0.05) of the true population age proportions. A sample size of 450 herring per stratum will be set to ensure that this level of precision and accuracy would be obtained for any number of age classes and proportions when less than 5% of the collected scales will be unreadable. Wilcock et al. (*In press*) provide a thorough description of PWS herring AWL sampling program procedures.

From an analysis of 5 years of fecundity data for PWS herring (personal communication, Tim Baker, Alaska Department of Fish and Game, Anchorage), Baker found that for a given year the relationships between herring weight and fecundity were very similar among areas, but less so among years for a given area. Year was found to be significant as were all interaction terms with year in an analysis of co-variance. As a result, we determined that it is probably important to collect fecundity data from PWS every year, but within a year, samples can be pooled across areas. Fecundity samples will be subsampled from all female herring in AWL samples and stratified by fish length. Egg and gonad weights will be measured and used to calculate average fecundity at the average female weight ($F(\bar{W}_f)$).

A fecundity sampling goal was set such that fecundity estimates would contribute no more than 1% to the confidence interval width of the biomass estimate. This was achieved for surveys from 1988 through 1990 and 1992 during which area stratum sample sizes ranged from 100 to 400 fecundity samples and the standard error represented from 1.5 to 2.8% of the mean fecundity estimate. A sample size of 150 to 200 herring pooled across areas should be

sufficient to maintain the coefficient of variation below 2.0%. To collect females over the range of possible sizes, we will sample 20 to 30 fish within each 10 mm length category from 181 to 250 mm standard length. In addition, we will collect 20 to 30 females 180 mm or smaller if available.

The female gonad weight will be assumed to be the equivalent of the weight of the ovaries removed from each female. Gonadal somatic index will be defined as the percentage of total herring weight represented by gonad weight and will be calculated by dividing the gonad weight by body weight of each fish sampled.

Mean Weight and Sex Ratio. Mean weight and sex ratio will be estimated from AWL samples collected from each spawn deposition summary area. AWL samples collected during peak spawning in each area will be pooled to estimate mean weight and sex ratio for that area. Average weight and sex ratio for PWS will be estimated as a weighted average of estimates from all areas. Average weight and sex ratio for each area will be weighted by the escapement biomass estimate based on spawn deposition surveys for that area.

Sex ratio, S, will be calculated as the ratio of the number of herring of both sexes in AWL samples to the number of females. The binomial distribution is applicable to estimating the proportion, p, of females in AWL samples, where S = 1/p. The variance of S is

$$Var(S)=\frac{S^2(S-1)}{n}, \qquad \textbf{(15)}$$

where n is the number of fish in the AWL sample.

Fecundity for Biomass Estimates. Average fecundity for PWS will be estimated from a fecundity-weight relationship as $F(\bar{W}_f)$, and used in equation 13 to estimate biomass from spawn deposition. The variance of estimated average fecundities will be approximated by the variance of predicted means from the fecundity-weight linear regression (Draper and Smith 1981)

$$Var[F(\bar{W}_f)]=s^2\left[\frac{1}{n}+\frac{1}{q}+\frac{(\bar{W}_f-\bar{W}\bar{F})^2}{\sum(W_i-\bar{W}\bar{F})^2}\right], \qquad \textbf{(16)}$$

where

s^2 = the residual mean square from the fecundity-weight linear regression,

$\bar{W}_f$ = the average weight of female fish in the spawning population,
$\overline{WF}$ = the average weight of females in the fecundity sample,
W_i = the weights of individual females in the fecundity sample,
n = the total number of females in the fecundity sample from each area, and
q = the total number of females in the representative AWL sample or pooled samples from the corresponding area.

A linear relationship between female body weight and fecundity will be used because Hourston et al. (1981) found that female body weight at spawning explained 70% of the variation in fecundity among individuals while length and age only explained another 2% of the variation.

A secondary purpose for determining average fecundity annually, will be to obtain information about natural fluctuations in reproductive potential in relation to fish size, fish growth, and environmental conditions. This information will be important for ecosystem studies such as project 97320 (SEA) that will test hypotheses about constraints to fishery production in PWS. For example, sea surface temperature appears to be an important natural factor affecting reproductive potential of herring. Tanasichuk and Ware (1987) found that sea surface temperatures 60 to 90 days before spawning best accounted for variations in size specific fecundity for herring in British Columbia, Canada. Using five years of PWS fecundity data, Biggs et al. (*in press*) showed egg production to be a function of fish body weight and to be strongly correlated with sea surface temperatures 13 to 15 months prior to spawning. Egg weight was best correlated with sea surface temperatures 4 to 9 months prior to spawning and fecundity decreased as water temperatures increased.

Acoustic Survey and Biomass Estimation

Standard acoustic techniques (Thorne 1983b; Ehrenberg and Lytle 1972) for echointegration and dual beam processing of target strength will be used to independently estimate the biomass of herring present near spawning grounds during the spring migration. Energy reflected from fish concentrations will be measured and converted to fish density using measurements of energy reflected from single fish (target strength) and knowledge of the sample volume (transducer directivity). Net sampling will be conducted to subsample the acoustic targets to verify species, size and obtain other biological information on the insonified fish.

The acoustic survey will employ one commercial purse seiner under short term vessel charter to assist in searching for herring schools and to conduct net sampling. The scientific echosounding equipment will be located aboard the ADF&G research vessel *Montague* for acoustic mapping of biomass. The acoustics vessel will be outfitted with either a 70 or 120 kHz echosounder with a dual beam pre-amplified 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 at approximately 5 m off to one side of the vessel. The catching vessel will be equipped with a seine approximately 30 m deep typical of the gear-type used in the commercial sac roe herring

fishery.

Survey Design. The acoustic survey will be a multistage sampling design (Cochran 1963). Historical information about location of spawning, aerial surveys of herring schools, and wide scale searches using ship's searchlight (sweeping) and down-looking echosounders will be used to locate concentrations of herring schools in a first stage search. The second stage of sampling will be to map school groups and measure the density using the scientific echosounder. Acoustic survey transects will be run in a zigzag fashion over the school groups and will be replicated during both day and night for large school groups.

Acoustic Parameters. Target strength information for herring will be derived from average length to target strength (in decibels) per kg fish after Thorne (1983a). Thorne's (1983a) empirical relationship assumes the following logistical equation:

$$\gamma = \frac{\bar{\sigma}}{\bar{W}} = a\bar{l}^{-b} \qquad \textbf{(17)}$$

where σ is the mean acoustic backscattering coefficient, W is the mean weight (in kg), l is the mean length (in cm), and a and b are constants. Values for the constants (a and b) are obtained from data for a variety of fisheries presented by Thorne using a linear regression of $\log_{10} l$ versus 10 log (σ/w), where 10 log (σ/w) is referred to in Thorne (1983a) as "target strength per kg." Average herring length and weight data will be compiled from samples obtained by the purse seine catcher vessel. These measured data will be applied to Thorne's (1983a) empirical relationship to obtain the ratio $\gamma = \sigma/w$ and the mean backscatter coefficient (σ). As a cross check, *in situ* measurements of target strength from dual beam acoustic data will be generated and compared with Thorne's (1983a) empirical formula.

Biomass estimation. Herring biomass will be calculated for each zigzag survey. The general calculation of the population density using echointegration for a single cell *jk* on a transect is given as

$$\beta_{jk} = \rho_{jk} \cdot \bar{w}_{jk} = \frac{C(ei)_{jk} \cdot P_{jk}}{\frac{\bar{\sigma}_{jk}}{\bar{w}_{jk}}} \qquad \textbf{(18)}$$

where β_{jk} is the population density (mass per unit volume), ρ_{jk} is the density of scatterers, w_{jk} is mean weight of scatterers, C is acoustic constant (calibration settings ie., gain etc.) ei_{jk} is the mean of the voltage squared, P_{jk} is percentage of cell *jk* within the water column, and σ_{jk} is mean backscattering coefficient for targets within cell *jk*.

The biomass for a region of surface area A is determined by using a set of line transects along which a total of nrs point estimates of biomass per unit area is obtained. Specifically,

$$B = \frac{\sum_{j=1}^{nrs} \sum_{k=1}^{nst} \beta_{jk}}{nrs} \cdot A \qquad (19)$$

where nrs is number of reports (along the line transects), nst is number of depth strata, and A is survey area.

Herring biomass estimates will follow Thorne (1983a), assuming that σ_{jk}/w_{jk} is independent of cell *jk*, hence, for all *jk* σ_{jk}/w_{jk} is a constant γ, and γ is given by equation 1. With this assumption, equation 4 simplifies to:

$$\beta_{jk} = \frac{C}{\gamma} \cdot (ei)_{jk} P_{jk} \qquad (20)$$

and the herring biomass B in an area is given as

$$B = \frac{C}{\gamma} \frac{\sum_{j} \sum_{k} \cdot (ei)_{jk} P_{jk}}{nrs} \cdot A \qquad (21)$$

C. Cooperating Agencies, Contracts and Other Agency Assistance

Through a competitive bidding process, one or more purse seine vessels will be chartered to capture fish for species and size composition of acoustic targets, AWL/fecundity samples, spawning adult herring for histopathology samples (project 97320S), and reproductive impairment samples for (project 97074). Depending upon the duration of the work and other competing uses, the ADF&G *R/V Montague* may be used as a sampling platform and as a scientific acoustics vessel either at no charge or at a standard rate of $1,100/d. In the event the *R/V Montague* is not available for use, another vessel will be secured on short term vessel charter agreement. This field work will occur over approximately 2 weeks during mid-April.

One vessel will be chartered through a standard competitive bid process to be a research platform for spawn deposition surveys. This vessel will be used to house and transport

SCUBA divers and their equipment. This portion of the project will last approximately 3 weeks from early to mid-April through early-May.

SCHEDULE

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

February:	1996 Biomass estimates - Dept. Forecast and Stock Assessment Reports
April:	Submit FY96 annual report - biomass estimate
	Before onset of spawning:
	Conduct acoustic survey (5-7 d)
	Collect AWL, fecundity, disease, genetic stock ID, and bioenergetics samples
	After onset of spawning:
	Initiate dive surveys
	Assist reproductive impairment sample collection
	Submit FY98 Draft Detailed Project Description
	Complete dive surveys
	Begin lab processing of diver calibration and fecundity samples
June:	Complete calibration sample processing samples
September:	Finalize estimate of spawning biomass
November:	Finalize projection of 1997 run biomass

B. Project Milestones and Endpoints

The following milestones and endpoints will be achieved over the life of the project:

October 1996	Objective 2:	Finalize acoustic estimate of spawning biomass of herring in 1996 & decide whether to continue or modify program.
November 1996	Objective 3:	Compare spawn deposition and acoustic survey estimates of herring spawning biomass in 1996. After FY98 a decision will be made to continue either spawn deposition

surveys or hydroacoustic assessments at a reduced cost.

September 1997	Objective 1:	Finalize estimate of spawning biomass of herring in 1997 using spawn deposition methodology.

C. Completion Date

Monitoring of the abundance, age composition and size composition of the PWS Pacific herring spawning population will be continued until the population has recovered.

PUBLICATIONS AND REPORTS

Scientific and technical aspects of the study will be subject to an internal peer review process within ADF&G's Commercial Fisheries Management and Development Division (CFMDD). Work plans, study design, and annual status reports will be subject to the peer review process established by the EVOS Trustee Council and Chief Scientist. Significant findings presented in annual and final reports will be submitted for publication in peer reviewed journals and presentation at scientific symposia as they are obtained. An annual report will be submitted for FY97 by April 15, 1998.

PROFESSIONAL CONFERENCES

Travel funds have been requested for this project to attend meetings with herring management staff in Anchorage and the EVOS annual workshop.

NORMAL AGENCY MANAGEMENT

Plans are being developed for transfer of this program back to ADFG as part of normal agency management. After FY98 a decision will be made to continue either spawn deposition surveys or hydroacoustic assessments at a reduced cost.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Project 97166 will be integrated closely with project 97320, SEA. Data management will be coordinated as outlined in SEA for integration of results. Other components of SEA will require sharing of information. Juvenile Herring Growth and Habitat Partitioning (97320T)

will require location and abundance of spawn as well as information about age and size structure of sampled catches. Physical measurements taken for project 97166 may be useful to project 97320M. Information about spawn distribution will also be useful in drafting a study design for herring larval advection studies.

Project 97166 will also share information and resources with Project 97165, Herring Genetic Stock Identification in PWS. Additional samples required for this project beyond FY97 collections will be collected during AWL sampling and results will be used to refine our definition of stock structure. This improved stock definition will aid in recovery monitoring and the formulation of fisheries harvest strategies.

Other projects which will rely on sharing of resources with project 97166 for sample collection include Reproductive Impairment (97074), Somatic and Spawning Energetics of Herring/Pollock (97320U), and Disease Impacts on PWS Herring Populations (97162).

Finally, integration of research will require data sharing and coordination with Project 97163, Forage Fish Influence on Injured Species. Herring are an important forage fish species. Herring and other forage fish are predators, competitors, and prey for each other at various stages throughout their life histories. Understanding the population dynamics of all forage species will lead to a better understanding of food availability, population fluctuations, and breeding success of birds and mammals that prey on them.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

The field work associated with the egg loss study component of this project has been completed by the University of Alaska. Data will be summarized and reported during FY96. No additional funds are requested for this portion in FY97.

PRINCIPAL INVESTIGATOR

Mark Willette
Alaska Department of Fish and Game
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PERSONNEL

Mark Willette (Principal Investigator), Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division, P.O. Box 669, Cordova, Alaska 99574, (907)424-3214. **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: Area 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, Otolith Thermal Mass Marking of Hatchery Pink Salmon in Prince William Sound, 1995; Principal Investigator, SEA: Salmon Growth and Mortality, 1994-1995; Principal Investigator SEA: Salmon Predation, 1994-1995; 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. 1996. Impacts of the Exxon Valdez Oil Spill on the migration, growth, and survival of juvenile pink salmon in Prince William Sound. *In* Proceedings of the Exxon Valdez Oil Spill Symposium, American Fisheries Society Symposium Series, (in press).

R.T. Cooney, T.M. Willette, and S. Sharr. 1992. 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.

Willette, T.M. and R.T. Cooney. 1991. An empirical orthogonal functions analysis of sea surface temperature anomalies in the North Pacific Ocean and cross-correlations with pink salmon (Oncorhynchus gorbuscha) returns to southern Alaska. *In* Proceedings of the 1991

Pink and Chum Salmon Workshop.

Eggers, D.M., L.R. Peltz, B.G. Bue, and T.M. Willette. 1991. Trends in the abundance of hatchery and wild stocks of pink salmon in Cook Inlet, Prince William Sound, and Kodiak, Alaska. *In* Proceedings of the International Symposium on the Biological Interactions of Enhanced Salmonids, Can. Spec. Publ. Fish. Aquat. Sci.

Member: American Fisheries Society, Alaska Chapter.

Greg S. Carpenter (Co-investigator), Herring Fisheries Research Biologist, Alaska Department of Fish and Game, P.O. Box 669, Cordova, Alaska 99574. **Education**: Bachelors of Science, Wildlife Management, University of Alaska-Fairbanks, 1988. **Professional Experience**: October 1995 - present: Biologist with the Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division in Cordova, Alaska. Supervised by Mark Willette. April 1989 - October 1995 Fishery Biologist I with the Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division in Cordova, Alaska. Supervised by Mark Willette. Assist with 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. **Research Projects:** SEA: Salmon Growth and Mortality, 1994-1995; SEA: Salmon Predation, 1994-1995; Coghill Lake Sockeye Salmon Restoration, 1994-1995; Survey and Evaluation of Instream Habitat and Stock Restoration Techniques for Wild Pink and Chum Salmon, 1991-1993; Fish\Shellfish Study No. 4A, Early Marine Salmon Injury Assessment in Prince William Sound, 1991-1993.

Selected Publications:

Willette, T.M., G. Carpenter, S. Carlson, G. Kyle. 1995. Restoration of the Coghill Lake sockeye salmon stock, *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 93024), Alaska Department of Fish and Game, Cordova, Alaska.

Willette, T.M., G. Carpenter, and E. Debevec. 1995. Sound Ecosystem Assessment: Salmon Growth and Mortality, *Exxon Valdez* Oil Spill Restoration Project Final Report (Restoration Project 94320A), Alaska Department of Fish and Game, Cordova, Alaska.

Edmundson, J.M., G.B. Kyle, T.M. Willette, and G.S. Carpenter. 1993. Juvenile sockeye salmon (*Oncorhynchus nerka*) stocking into Pass and Esther Pass Lakes, and nutrient enrichment of Pass Lake: and experiment on changes of the forage base. Fisheries Rehabilitation Enhancement and Development Report Series Number 125.

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Report of Fisheries and Aquatic Sciences, No. 1009. 31 pp.

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1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997						
Personnel	$186.1	$156.8						
Travel	$4.2	$2.6						
Contractual	$199.5	$63.8						
Commodities	$10.0	$8.3						
Equipment	$2.4	$1.2	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$402.2	$232.7	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
General Administration	$41.9	$28.0						
Project Total	$444.1	$260.7	$190.2	$22.4	$0.0			
Full-time Equivalents (FTE)	3.2	2.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Sea duty costs for each staff member are itemized under 'Overtime'.
After FY98, a decision will be made to continue either spawn deposition or hydroacoustic biomass assessments at a reduced cost.

1997

Project Number: 97166
Project Title: Herring Natal Habitats
Agency: AK Dept. of Fish & Game

FORM 3A
AGENCY
PROJECT
DETAIL

Prepared: 4/12/96

Received: 12 April 96; edit 12 April; WJH)

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:			GS/Range/	Months	Monthly		Proposed
PM	Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
*	Vacant	Program Manager	20M	0.0	7,432	0	0.0
*	Vacant	Librarian I	17J	0.0	5,530	0	0.0
	M. Willette	Fishery Biologist III	18D	4.0	5,866	0	23.5
	G. Carpenter	Fishery Biologist II	16C	9.0	5,093	6,187	52.0
	S. Moffitt	Fishery Biologist II	16C	0.0	5,093	2,839	2.8
	B. Haley	Fish & Wildlife Technician III	11C	2.0	3,643	4,850	12.1
	C. Becker	Fish & Wildlife Technician III	11A	4.0	3,643	3,677	18.2
	M. Miller	Fish & Wildlife Technician III	11B	1.0	3,643	3,677	7.3
	K. Hyer	Biometrician I	17A	6.0	4,753	0	28.5
	S. Shipley	Fish & Wildlife Technician II	9A	2.0	3,229	0	6.5
	A. DiBicarri	Fish & Wildlife Technician I	7A	1.0	2,696	0	2.7
	P. Trautman	Field Office Assistant	9A	1.0	3,200	0	3.2
		Subtotal		30.0	53,821	21,230	
Those costs associated with program management should be indicated by placement of an *.						**Personnel Total**	$156.8

Travel Costs:		Ticket	Round	Total	Daily	Proposed
PM		Price	Trips	Days	Per Diem	FFY 1996
	Description					
	RT Cordova-Anch., Attend herring synthesis meeting, 2 staff	200	2	4	95	0.8
	RT Cordova-Anch., Attend EVOS annual workshop, 2 staff	200	2	6	95	1.0
	RT Cordova-Anch., Attend meeting with herring mgmt staff, 2 staff	200	2	4	95	0.8
						0.0
						0.0
						0.0
						0.0
Those costs associated with program management should be indicated by placement of an *.					**Travel Total**	$2.6

1997

Project Number: 97166
Project Title: Herring Natal Habitats
Agency: AK Dept. of Fish & Game

FORM 3B
Personnel
& Travel
DETAIL

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Contractual Costs:	Proposed
Description	FFY 1997
Publication costs	2.0
Dive Master class (1 class @400)	0.4
CPR /FIRST AID training (5 classes @ $100 per class)	0.5
Vessel charter (18 days @ $1500 per day; logistical support for dive crew)	27.0
Vessel charter (14 days @ $1300 per day; Seine boat for sampling acoustic targets)	18.2
Dive physicals	2.0
Network operation & maintenance	0.5
Hazmat disposal	0.5
Aircraft charter (3 hours @ $275 per hour)	0.9
Dive equipment repair & maintenance	1.0
Repair dive skiffs	0.8
Contract for acoustic survey	10.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$63.8

Commodities Costs:	Proposed
Description	FFY 1997
Software upgrades	0.2
Office\Lab supplies	1.2
Bouyancy control devices (2@ $400 each)	0.8
SCUBA tank hydrostat tests (15 tanks @ $20 per tank)	0.3
Dive gear replacement parts	1.2
Groceries for (7 people x 18 days x $20 per day)	2.5
Skiff fuel (240 gals @ $1.67 per gal.)	0.4
Misc. field sampling supplies (outboard oil, spark plugs, bilge pumps, sample frame parts, etc.)	0.7
Skiff repair materials (floor and console repairs)	1.0
Commodities Total	$8.3

1997

Project Number: 97166

Project Title: Herring Natal Habitats
Agency: AK Dept. of Fish & Game

FORM 3B
Contractual & Commodities DETAIL

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

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
			0.0
			0.0
Dive suit & assoc. gear	1	1,200	1.2
			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**	$1.2

Existing Equipment Usage: (partial inventory) Description	Number of Units	Inventory Agency
Wave and tide recorder with computer interface	3	ADFG
Alumaweld Sea Dory (20 ft)	1	
Boston Whaler (17 ft)	1	
Dive regulators	29	
Dive depth\pressure gauges	14	
Dive backpacks	9	
Dive jumpsuits (various sizes)	12	
Dry suits (various sizes)	14	
Dive tanks	21	
(complete inventory on file at ADFG, Cordova)		

1997

Project Number: 97166
Project Title: Herring Natal Habitats
Agency: AK Dept. of Fish & Game

FORM 3B
Equipment
DETAIL

4/12/96

Preparation and Curation of Seabirds Salvaged from the *Exxon Valdez* Spill

Project Number: 97167

Restoration Category:

Proposer:	University of Washington Burke Museum
Lead Trustee Agency:	
Cooperating Agencies:	
Alaska Sealife Center:	
Duration:	First year, 1-year project
Cost FY 97:	$38,300
Cost FY 98:	None
Cost FY 99:	None
Cost FY 00:	None
Cost FY 01:	None
Cost FY 02:	None
Geographic Area:	All carcasses are at the Burke Museum in Seattle, where they will be prepared

Injured Resource/Service

Abstract

In 1992 the Burke Museum received emergency funds from NSF to salvage about 1500 of the most valuable bird carcasses from the *Exxon Valdez* Oil Spill. A year later we received another NSF grant to support the preparation, curation and storage of these specimens; unfortunately, that funding was not adequate to complete these tasks. With this proposal I seek funds to complete the preparation and curation of the remaining birds salvaged from the *Exxon Valdez* spill for the Burke Museum.

INTRODUCTION

Over 35,000 birds carcasses were recovered from the beaches of southern Alaska following the *Exxon Valdez* oil spill (Piatt et al 1990). In 1992, a National Science Foundation grant enabled personnel from the Burke Museum to sort through these carcasses and transport to Seattle those specimens that would be a critical systematic resource. Later the NSF funded preparation and curation of many of these carcasses as an orphaned collection. Unfortunately, that grant was not sufficient for the completion of this work, so 395 specimens salvaged from the *ExxonValdez* spill remain to be prepared. With this proposal I seek support to complete that task, preferably for all of these specimens, but at least for those of particular interest to the Trustees Council. I would much prefer to see all of these specimens saved because some of immediate interest to the Trustee's Council (e.g. Common Murres and kittiwakes) are probably have lower potential for long-term use than others that are not of immediate interest to studies of recovery (e.g. various ducks and fulmars).

There are compelling reasons for the Burke Museum taking on this project. Specimens of large seabirds are difficult to loan, so the *Valdez* collection will become an important resource for research only if the specimens are housed at a single institution. To be of maximum value, they should be uniformly preserved as a series of combination specimens, with associated data on their age and reproductive condition. The Burke has the facilities needed to process these birds, and would extract more data and resources (combination specimens) from these carcasses than would most other museums. We have pioneered techniques for saving a pelted skin, a fully extended wing, and a skeleton with one full set of wing and leg bones from such specimens. We are skilled at removing the fat from seabirds without losing molting feathers, an accomplishment essential both to the value of skins to research involving plumages and to their long-term preservation. Finally, our new prep lab is ideally suited for removing petroleum residues from seabird feathers, with ample workspace, fume hoods, and other facilities for handling solvents. We can fully clean carcasses that are heavily oiled.

The *Exxon Valdez* collection complements three other major collections of North Pacific seabirds at the Burke Museum. These are (1) over 1800 Summer and Fall birds from the North Central Pacific salvaged from drift nets by National Marine Fisheries Service observers; (2) over 1000 winter seabirds from the northeastern Pacific salvaged from four Washington oil spills; and (3) collections of seabirds made in the Sea of Okhotsk and off the Pacific coast of the Russian Far East.

NEED FOR THE PROJECT

A. Statement of the Problem

Seabird carcasses are routinely recovered from beaches following oil spills as part of clean-up efforts and as proof of damages. Ironically these birds are rarely preserved as scientific specimens, despite the fact that they may contribute in important ways to the investigation of the impacts of the spill and to other research into the life

history and population biology of the species affected by a spill. I have tried for years to obtain support for preserving samples of oil-spill casualties from the oil companies responsible for spills, but have not once succeeded. Evidence of the potential research value of such specimens lies in the fact that the National Science Foundation has provided support for the Burke to sort and salvage a sample of the carcasses from the *ExxonValdez* spill.

The Burke Museum is the only Museum in the Pacific Northwest committed to the onerous task of preserving large research series of North Pacific seabirds. We currently have the largest and most valuable such collection in the world. The *Exxon* birds will add to this strength by expanding the geographic and seasonal scope of our collections of North Pacific seabirds. Since seabird specimens are too large readily to be lent to researchers through inter-institutional loans, preserving large numbers of them at single institutions is an important service to researchers who conduct projects that demand measurements from many specimens. The Burke's geographic location, its ties to a major research university that is building its museum, its ties to the National Marine Fisheries Service, and its recent history of major private support have all contributed to it developing one of the most important collections of North Pacific Seabirds in the world.

Most oil spills occur in the nonbreeding season when seabirds may be far from their breeding colonies. Specimens salvaged from these spills can be used in genetic and morphometric analyses designed to map the birds that were killed back to their population of origin. Analyses of age and sex ratios among the killed specimens can also provide information of value in projecting population impacts and recovery rates. The various age and sex classes will not be impacted equally by a particular spill if they are wintering in different areas. Because most seabirds are monomorphic, age and sex data must be collected by the internal examination on specimens, requiring expertise that is often available only in museums.

Despite their potential value, little effort has been made to salvage samples of the bird carcasses recovered from oil spills. In this case we have a unique opportunity to do so because the NSF enabled us to sort, transport to Seattle, and partially prepare a large sample of the *Valdez* birds.

B. Rational/Link to Restoration

Scientific specimens are used to generate new knowledge. Restoration efforts have no effect unless they target the fundamental causes of population decline or the fundamental causes limiting population recovery. Specimens may serve these issues in ways that cannot be imagined at the time that they are saved. The unique value of specimens lies in the fact that they are real examples of individuals that constitute our only samples of past generations. When the information needed to answer historical questions does not exist in archival reports, then it may only be available in preserved specimens. For example the hypothesis that DDT was the cause of the egg shell thinning was first developed and tested by comparing measurements of egg-shell thickness in old and new museum specimens (Ratcliffe

1967). Were it not for museum collections, every European and North American race of the Perigrine Falcon would likely have been lost.

The skins, skeletons, extended wings, and tissue samples we save from the *Exxon Valdez* specimens will be the only source of new and original data on the bird populations that were in Prince William's Sound at the time the spill occurred. As such they could be the key to testing ideas that have yet to be developed concerning the progress of recovery of populations of birds impacted by this spill.

C. Location

Most of the specimens that were not incinerated following their release by the Department of Justice are now at the Burke Museum. The fraction of these specimens that could not be prepared with NSF support will either be prepared under this grant at the Burke Museum, or they will be incinerated in Seattle.

COMMUNITY INVOLVEMENT

There will be no involvement of local communities in this work because it will be conducted in Seattle. However, museum collections are held in public trust and are available for study by any qualified user. Thus the existence of these collections will ultimately benefit individuals from the communities affected by the spill if future questions, related to the biology and recovery of these species, are posed that require specimens to be answered.

PROJECT DESIGN

A. Objectives

My objective is to complete the preparation of the specimens salvaged from the spill. Our work will be done when the specimens are preserved, cataloged, and installed into our research collections. This process renders the specimens available for original research serving restoration studies or any other aspect of the biology of these birds.

B. Methods

The Burke Museum is internationally known for the extensive use it makes of individual specimens. For most of the *Exxon Valdez* collection we have salvaged combination specimens consisting of a pelted skin, a skeleton consisting of all the major elements, and a fully extended wing. In addition, the sex and breeding status of every individual is recorded by measurement and description of the gonads; its fat condition is recorded; and, its age is assessed by measuring and describing the bursa of Fabricus, a blind diverticulation off of the lower gut that serves the immune system in young birds. The bursa works unusually well as an indicator of

age in seabirds because it is resorbed under the stimulation of high blood titers of the sex steroid hormones, which first rise in seabirds when they come into breeding condition for the first time in their lives (Broughton 1994; Mase and Oishi 1991).

Skin specimens can be used to study plumage changes associated with age and season. Because the specimens that we save have good age and sex data they are particularly valuable to such studies. For example, the number of immature plumages that characterize the puffins of the North Pacific has not been described, presumably because the specimens needed for such descriptions have not been available. With the *Valdez* collection and other collections of puffins at the Burke that have been salvaged from the North Pacific, undertaking this research would be worthwhile. Being able to sort Tufted and Horned Puffins into several age classes could help assess the impact of the *Valdez* spill, as well as future catastrophes.

Skeletal specimens offer the possibility of making large numbers of measurements from individual specimens. For this reason they are particularly valuable to multivariate morphometric efforts to associate the birds killed in a spill with populations originating from different breeding areas. For example some of the populations of Common Murres breeding from western Alaska to southern California can be distinguished from each other using multiple skeletal measurements. Thus, if birds from a mix of these regions winter together and were killed in a spill, skeletal measurements from specimens preserved from the spill could be used to assigned individuals to different breeding populations (Warheit 1996).

Another interesting potential use for skeletal specimens from the *Valdez* collection concerns the validity of a newly described species of cormorant *(Phalacrocorax)* from Alaska. The original description of this purported new species was based almost exclusively on bones from archaeology deposits. Only three recent specimens of this purported new species were found in collections; all lack age data, and only one was sexed (Siegel-Causey, 1991). This raises the possibility that all the specimens attributed to this small new species may simply be young females that have not fully completed their growth. With the large series of reliably aged and sexed Pelagic and Red-faced Cormorants that we have salvaged from the *Valdez* spill, these questions can now be addressed in a rigorous manner. Should the species prove to be valid, then the spill could have more far-reaching consequences than already recognized. Alternatively, the species may not be valid, an important result to substantiate, but a result with no implications to recovery.

Finally, the replacement of flight feathers in the annual molt is one of the most time consuming activities in the annual cycle of large birds. Most birds do not molt and breed at the same time, so the time required for successful breeding places a severe constraint on the time available for the annual molt (Langston and Rohwer in press; Shugart and Rohwer, in press). This is a serious problem for large birds because all flight feathers grow at a constant rate, regardless of their length (Langston and Rohwer in press). If they must retain the ability to fly while they are molting, large birds can replace only a few of their wing feathers simultaneously, This means that the total time they must invest in molting is a function of the summed length

of all of their flight feathers. Many big birds simply do not have enough time to replace all of their flight feathers if they also bred successfully. Eventually the accumulation of overworn feathers apparently forces large birds to skip a year of breeding to undergo a complete molt of flight feathers, thereby eliminating overworn feathers from their wings (Langston and Rohwer 1996; Langston and Rohwer in press).

C. Cooperating Agencies, Contracts, and Other Agency Assistance

None.

SCHEDULE

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

Complete all specimen preparation. Catalog all specimens and install them in the collection.

B. Project Milestones and Endpoints

The first milestone is completing the preparation of the specimens . The second is entering all the associated data, which is originally recorded in preparator catalogs, into our electronic cataloging system, proofing this data, and generating the labels for the specimens. The last is affixing the labels to the specimens, and installing the specimens into the research collection.

C. Completion Date

All of this work will be completed by the end of FY 1997.

PUBLICATIONS AND REPORTS

The preservation of these specimens, *per se*, will not generate any research publications. However, they will be available for use in research projects as soon as they are prepared, and will serve a variety of projects in the future.

PROFESSIONAL CONFERENCES

We have developed a number of procedures for salvaging such specimens that would be of use to other institutions. I believe that it is important to demonstrate to the larger museum community the quality of specimens that can be salvaged from the often heavily oiled carcasses recovered following oil spills. For this reason I request support to send either my Collections Manager or my preparator to a meeting of the Society for the Preservation of Natural History Collections to present

a summary of these new techniques. I have also included in my budget the costs of me attending one of the workshops in Anchorage.

NORMAL AGENCY MANAGEMENT

The Burke Museum is a unit of the College of Arts and Sciences at the University of Washington. As such its charge is to develop teaching and research collections that serve programs at the University of Washington. While salvage of the *Exxon Valdez* collection serves the mission of the Museum, funding for this undertaking is much beyond our annual operating budget. Thus I have worked extensively to find outside funding to support this work. I contacted both Exxon and the Trustees Council after the spill, but found no interest in this project from either party at that time. Luckily, the National Science Foundation stepped in to cover the expenses of sorting the carcasses, as well as much of the preparation and all of the storage cases needed for this collection.

No statute or regulation requires that these specimens be prepared by the Burke Museum; they are available only because the spill occurred. We seek to prepare them because of the lasting benefit that may accrue to those studying the effects of the spill and to biology in general. However, we can only do so if we have the funding necessary to hire the extra preparator needed to finish the work.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The preservation of these specimens is not being coordinated or integrated with other restoration efforts. I have made clear above, however, that these specimens may be of use to a variety of workers studying the effects of the spill and the progress of recovery. Thus far, all funding for this work has come from the National Science Foundation, but those grants are now expired. Work on the entire lot of specimens was not completed because the time required to remove crude oil from plumages and the time required to defat these seabirds was underestimated, and because the NSF proposal I submitted was cut considerably.

PROPOSED PRINCIPAL INVESTIGATOR

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PERSONNEL

I am a professional Ornithologist interested in the Evolutionary biology of birds. I have served as Curator of Birds at the University of Washington Burke Museum for 24 years. In this time I have created much the largest avian research collection in the Pacific Northwest, including British Columbia and Alaska. A significant part of this effort has been directed at building what has become much the largest and most comprehensive collection of North Pacific seabirds in the world. The great majority of these specimens have been salvaged, either as by-catch causalities from various fisheries or from oil spills. Several of my recent research papers have addressed the life history implications of molt in large birds, including albatrosses.

My Collections Manager, Christopher Wood will oversee this project if it is funded, and we anticipate hiring one of the skilled preparators who has worked for us in the past to prepare and catalog these specimens.

LITERATURE CITED

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Mase, Y., and T. Oishi. 1991. Effects of castration and testosterone treatment on the development and involution of the bursa of Fabricius and the thymus in the Japanese Quail. Gen. Comp. Endocrinol. 84:426-433.

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Shugart, G. S., and S. Rohwer. 1996. Serial descendant primary molt or Stafflemause in Black-crowned Night-herons. Condor *in press.*

Siegel-Causey, D. 1991. Systematics and biogeography of North Pacific Shags, with a description of a new species. Univ. Kansas Mus. Nat. Hist. Occasional Papers, No. 140: 1-17.

Warheit, K. I. 1996. Assessment of the origin of and the demographic impact to Common Murres (*Uria aalge*) during the 1991 *Tenyo Maru* oil spill. U.S. Fish and Wildlife Service: Final report.

BUDGET OVERVIEW

The following table can be used to estimate our costs on a species-by-species basis, should the Council decline to fully fund this project.

Proposed budget for finishing preservation of the *Exxon Valdez* specimens.

Species	Total	# to prepare	Hours of work	Salary, benefits	Indirect Costs
Common Murre	**$6,051**	68	204	$4,075	$1,976
Thick-billed Murre	**$889**	10	30	$599	$290
Pigeon Guillemot	**$5,162**	58	174	$3,476	$1,686
Tufted Puffin	**$3,114**	35	105	$2,097	$1,017
Black-legged Kittiwake	**$4,984**	56	168	$3,356	$1,628
Northern Fulmar	**$5,073**	57	171	$3,416	$1,657
Fork-tailed Storm-Petrel	**$2,314**	26	78	$1,558	$756
various ducks	**$5,339**	60	180	$3,595	$1,744
Horned Grebe	**$2,224**	25	75	$1,498	$726
Total	**$35,150**	**395**	**1185**	$23,670	$11,480

Travel	**$2,100 + $1,018 IDC**
Total Budget	**$38,268**

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

Budget Category:	Authorized FFY 1996	Proposed FFY 1997	LONG RANGE FUNDING REQUIREMENTS					
		$23.7						
Personnel		2.1						
Travel		0						
Contractual		$0.0						
Commodities		$0.0						
Equipment		$0.0						
Subtotal		$25.8	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Indirect		12.5						
Project Total		$38.3						
Full-time Equivalents (FTE)		.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

University of Washington negotiated Indirect Cost Rate is 48.5%

1997	Project Number: Project Title: Name:	FORM 4A Non-Trustee SUMMARY

Prepared

4/4/96

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

Personnel Costs: Name	Position Description		Months Budgeted	Monthly Costs	Overtime	Proposed FFY 1997
Banin, Dimitri	Research Aide		6	$3945		23.7
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
		Subtotal	0.0	0.0	0.0	
					Personnel Total	

Travel Costs: Description	Ticket Price	Round Trips	Total Days	Daily Per Diem	Proposed FFY 1997
PI attend workshop in Anchorage	$450	1	3	$140	.9
Collection Manager travel to SPINCH	$600	1	6	$100	1.2
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	2.1

1997

Prepared:

Project Number:
Project Title:
Name:

FORM 4B
Personnel
& Travel
DETAIL

4/4/96

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

Contractual Costs:	Proposed
Description	FFY 1997
Contractual Total	$0.0

Commodities Costs:	Proposed
Description	FFY 1997
Commodities Total	$0.0

1997

Project Number:
Project Title:
Name:

FORM 4B
Contractual &
Commodities
DETAIL

Prepared:

4/4/96

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

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

Existing Equipment Usage Description	Number of Units	

1997

Project Number:
Project Title:
Name:

FORM 4B
Equipment
DETAIL

Prepared:

4/4/96

Restoration of Commercial Fishing Services: The Social Ecology of the Herring Fishery in Prince William Sound, Gulf of Alaska, Submitted Under the BAA.

Project Number:	97168-BAA
Restoration Category:	Research and Monitoring
Proposer:	Impact Assessment, Inc.
Lead Trustee Agency:	
Cooperating Agencies:	
Alaska SeaLife Center:	
Duration:	1st year, 1-year project
Cost FY 97:	$219,600
Cost FY 98:	$0
Cost FY 99:	$0
Cost FY 00:	$0
Cost FY 01:	$0
Cost FY 02:	$0
Geographic Area:	Prince William Sound, Kenai Peninsula, Kodiak
Injured Resource/Service:	Commercial fishing

ABSTRACT

Alaska commercial fishing is a service that was disrupted by the *Exxon Valdez* oil spill (*Restoration Plan* 1994:32, A-15). This project addresses the restoration of that service by developing data about the pre-and post-spill commercial fishing activity, focussing on the PWS herring fishery. The working hypothesis of this proposal is that restoration of commercial herring fishing services is based on socioeconomic as well as biological factors. Statistical data about the fishery will profile the pre and post-spill patterns of fishing. Interview data with fisheries participants will describe the dynamics of the fishery and the social and economic factors that affect restoration of the herring fishery and commercial fishery services.

INTRODUCTION

This proposal focusses on research and monitoring concerning the lost or reduced services in the area of commercial fishing. Specifically, it lays out a research and monitoring program directed at understanding aspects of the commercial Pacific herring fishery relevant to restoration and recovery.

Alaska's Pacific herring fishery is found in a number of areas around the state. The Pacific herring fishery in the Gulf of Alaska takes place in three primary areas: (1) off southeastern Alaska; (2) in Prince William Sound; and, (3) in the Kodiak Island-Cook Inlet region. While both of the latter two within the area directly affected by the oil from the *Exxon Valdez* spill[1], this proposal will focus on Prince William Sound. The herring fishery in this area has concentrated on harvesting herring-roe, primarily by purse seine, but also with gill net gear. A smaller amount of herring is taken in Prince William Sound for food, bait, and other uses. It is estimated that between 120 and 160 permits were fished for herring prior to 1993, with many fewer being fished with the closure of the roe herring fishery (gill netters did fish in 1993).

Toward the west, there are two areas of the state, Bristol Bay and Norton Sound, that historically have had significant herring-roe fisheries. The harvest levels for Bristol Bay and Norton Sound fisheries are presently at or somewhat above historical averages. In the Eastern Gulf of Alaska, the Southeast fishery is mixed. Within the spill area in the Central and West-Central Gulf, the Kodiak-Cook Inlet fishery is at or above historical averages, while the Prince William Sound fishery has been closed since 1993. Thus, the Prince William Sound herring-roe fishery is of primary concern for spill related research and monitoring.

The herring-roe fishery is an intense and potentially lucrative enterprise. Impact Assessment's past experience in the Prince William Sound area would indicate that perhaps 25% of a participating fisherman's total income may derive from this fishery, and from this it follows that there will be a number economic implications if the fishery is closed. These economic effects extend to the processing sector, and ultimately to the communities of the region. The Restoration Plan recognizes these effects: "Commercial fishing was injured through injury to commercial fish species and also through fishing closures. Continuing injuries to commercial fishing may cause hardships for fishermen and related businesses" (pg 41). What is not clear, however, is the relationship between current impacts and future service recovery and restoration. The Restoration Plan's restoration strategy is to restore the biological resource and to monitor the recovery of commercial fishing. This proposal would provide information to allow for this monitoring effort through a description of the pre-spill fishery, an assessment of effects through a description of the post-spill fishery, and a discussion of the working assumption that a restoration of the biological resource will restore commercial fishery services for the damaged user group.

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[1] It is understood that the significance of oil exposure effects/injuries at the population level and the relationship between the 1993 Pacific herring crash and the *Exxon Valdez* oil spill remain under investigation (e.g., "some of the . . . herring problems may be unrelated to the spill. However, the Council will continue to address these important problems").

NEED FOR THE PROJECT

A. Statement of the Problem

The restoration of commercial herring fishery service in areas of Alaska affected by the *Exxon Valdez* oil spill requires data about the relationship the biological resources with the pre and post-spill patterns of herring fishing activity. Specifically, to monitor the recovery and restoration of this commercial fishing service requires comparing current conditions with "baseline historical" information. Recovery can be defined as a restoration of pre-spill patterns in the "ecology of commercial herring fishing activity." We use this idea to build upon the notion of recovery suggested in the Restoration Plan:

> "Many communities that rely on commercial fishing will be significantly harmed *while waiting* for commercial fish resources to recover through natural recovery alone. Therefore, an objective of restoration is to accelerate recovery of commercial fishing" (pg 41, emphasis added).

This, and other statements in the Restoration Plan (hereafter referred to as the *"Plan")* and Invitation to Submit Restoration Proposals (hereafter referred to as the *"Invitation")* imply an underlying assumption that restoring the biological resources also restores commercial fishery services. This may be a valid assumption, but area commercial fishing exploits a biological resource based on multiple factors, including market pressures and a host of other economic and social considerations (Impact Assessment, Inc. [IAI] 1994, IAI 1995). Based on the social and economic structure of commercial fishing, another hypothesis is that the social effects of the herring-roe fishery dislocation may hinder the restoration of such services even if the biological resource recovers. That is to say, the biological resource upon which commercial fishing activity depends is not the same as the activity itself. Restoration of the service of the commercial herring fishery depends on the overall *ecology of commercial herring fishing activity* that is affected by biological, social, and economic factors. Based on worldwide knowledge about commercial fisheries practices and management (IAI 1994) and a knowledge of the organization of regional fisheries and their relationships with other community and regional economic and social structures (IAI 1991a, 1991b, 1994, 1995), conceptualizing commercial fisheries services damage and restoration strictly in terms of the biological health of the fish stocks involved is likely to prove inadequate.

In fact, it is likely that fishermen *do not* and *can not* wait for the herring resources to recover. Based on patterns in other fisheries (IAI 1994), harvesters and processors are likely to have adapted to this closure by pursuing other fisheries or other types of economic activity. For example, fisheries research indicates that nearly all fishermen make their living by participating in a variety of fisheries and sometimes other economic activities as well (IAI 1994). Thus, part of the effect of the closure of the herring-roe fishery is how the patterns of commercial fishing activity has been changed. These changes and adaptations can be expected to range from inactivity during the usual time of this fishery (with a concomitant reduction in income and overall economic activity) to a pursuit of alternative opportunities, both within as well as outside

of fishing. This "ecology of fishing activity" needs to be assessed and monitored in order to restore the service of commercial fishing that is inter-related with, but not entirely dependent upon the biological resources damaged by the oil spill. Information on what, if anything, has been economically substituted for the herring-roe fishery and understanding the implications these substituted activities may have for the herring-roe fishery in the future, if and when it reopens, is necessary for the full restoration of commercial fishing services.

To date, Council study efforts concerning the restoration of commercial fishing (in addition to stock studies) have focussed on an ecosystems approach to understanding the biological and environmental dynamics of Prince William Sound. However, to date fisheries are not yet managed on an ecosystems basis, nor are the systemic dynamics of commercial fishing in Prince William Sound understood. This proposal provides the basis to understand the ecology of commercial fishing activity in general and specifically the place of Pacific herring in relationship to other commercial fisheries, pre- and post-spill. Describing this ecology of commercial herring fishing is the basis for assessing how to restore the Pacific herring fishery affected by the *Exxon Valdez* oil spill and/or monitor that restoration.

B. Rationale/Link to Restoration

Restoration of commercial fishery services is a stated objective of the Restoration Plan. This proposal focusses on developing data about the link between the herring biological resources and the pattern or ecology of commercial fishing activity in areas affected by the *Exxon Valdez* oil spill. The working hypothesis of this proposal is that restoration of commercial herring fishing services requires more than the restoration of biological resources. Fisherman and processors who previously exploited those resources must also be available and motivated to engage in this fishery. Changes that have occurred during the period of closure may hinder the resumption of the herring-roe fishery, even if biological stocks recover. Data about the adaptations fishermen, processors, and marketers are making to the Prince William Sound herring-roe closure can thus provide the basis to understand if this fishery service is or can be restored, and to what degree. Specifically, these data can be used to understand: (1) how the herring fishery fits into the overall pattern of commercial fishing; (2) the relationship between biological stocks of fish and the pattern of fishing activity; and (3) the types of adaptations made by commercial herring fishermen and processors to past and present fishery closures or instability. Importantly, restoration depends on also understanding how changes in the ecology of fishing activity may have stressed the overall structure of commercial fishing in the area. As noted in the Restoration Plan, "Further stress on commercial fish resources could impede recovery . . . The Trustee Council can also contribute to the protection of commercial fish species by providing information needed to improve their management" (pg 41-42). The data to be developed by this proposal has direct bearing on the management of the herring fishery since it will provide information about the adaptations made by the commercial fishing industry to herring closures and the factors that may determine how these resources will be exploited as the resources recover. Some adaptations or changes may hinder the resumption of the fishery -- such as alternative fishery opportunities, changes in the distribution of permits, non-fishing economic opportunities, changes in processing lines or consolidation of processors, or some other effects. This proposal thus directly addresses

the links between the service of commercial fishing, the herring biological resources, and the past and present ecology of commercial herring fishing activity in the affected region.

C. Location

The location of our research is dependent on the project design and methodology, described below. Our focus will be on the Prince William Sound herring fishery, with a limited amount of comparative secondary data to be collected and analyzed for the Kodiak-Cook Inlet area herring fishery. For primary data, we intend to pursue a multi-method approach, combining telephone interviews of documented permit owners with more intensive face-to-face interviews in those Alaskan communities which participate most in the fisheries (Cordova and perhaps Homer, Seward, and Kodiak for the Prince William Sound fishery). Work will be conducted in these field sites for in-person interviews. Telephone interviews will be conducted primarily from IAI offices in Anchorage and La Jolla, California. Secondary data collection efforts will involve research in Anchorage and Juneau as well as in the field sites.

COMMUNITY INVOLVEMENT

We recognize the concerted effort the Trustee Council is making to increase the involvement of spill area residents in the restoration process, and we will work to assist the Council in its community involvement efforts. As applied social scientists, it is our professional policy that research incorporating community studies must include a process for local participation through both formal and informal channels. This not only fulfills an ethical responsibility, but also vastly increases the quality of the research (both in terms of the reliability of the information obtained and the applicability of the analytical results).

By design, the proposed research depends to a large degree on direct participation of area residents, in that it focusses on resident commercial fishermen (and "services" rather than "resources" directly). Thus, the proposed research differs in a fundamental way from projects focussed on direct investigations of resources *per se*. In this case it is not only *not desirable*, it is *not possible* to do the proposed research without a very substantial level of local resident involvement. Local involvement, however, does not stop with the participation of even significant numbers of residents. Beyond the persons contacted for participation as individuals, there are particular interest groups associated with the resource and service that will be approached for participation in the study. For example, one of the most important organizations to contact and involve in this research will be the Cordova District Fishermen United (CDFU). Similar fishing industry organizations in other communities will also be approached, but CDFU will clearly be a key organization in this regard, due to the importance of the community of Cordova to the overall research.

Beyond direct involvement of individual and group contributors to the study, we will notify the formal governmental institutions of the communities of the relevant communities of the nature and process of the proposed research. Typically, one of the first contacts we make with communities is through the mayor's office. By use of a snowball or network technique, we work

through the office of the mayor to contact other individuals the mayor and/or his/her designee recommend that we speak to -- individuals (or entities) who would have a particular interest in the research content or process. By these means, the recognized leaders of the community are informed of the research effort, and information regarding the research can then be disseminated through regular community information channels via public administrative processes and through leadership networks.

In addition to relevant service user groups (i.e., commercial fishermen and those other entities associated with the fishing industry) and local governmental institutions, we will contact appropriate Native organizations in the communities to assure that local and traditional knowledge relevant to the project, but that may otherwise fall outside of the first two means of community involvement, is considered in the research and monitoring process. Although the focus of the proposed effort is on research and monitoring related to commercial fishing services (as opposed to subsistence utilization of the involved resources), we see at least two primary reasons to contact Native organizations and appropriate subsistence resource users in the involved communities. First, such resource user groups often include commercial fishermen who incorporate a variety of different resource-oriented activities into their commercial fishing patterns -- and are thus in a position to offer an important perspective on the issues. For example, at least one of the local facilitators hired under the Trustee's Community Involvement Project for one of the proposed study communities is an active commercial fisherman. This individual thereby represents an especially important potential information node for the proposed project, both in terms of a personal perspective and in terms of networking resources. Second, following the general philosophy of the community involvement effort, contacting these groups will help to facilitate the research process through the use of traditional lines of communication. Our long experience conducting research in rural Alaskan communities has taught us the importance of such communication and serves to emphasize the critical role of respect in multicultural settings that such communication shows.

Again, we would emphasize that "commercial fishing services" are not the isolated activity of individuals, but rather are key activities within the cultural processes and social systems of the communities and region(s). To the extent possible, we will coordinate our research activities with the local community facilitators. We expect that local facilitators will be quite important in establishing contacts in a variety of domains as well as in the recruitment of local field assistants where required. Also, we would expect that community facilitators play a critical role in the dissemination of research findings back to the communities. Reports generated under the proposed research effort will be written in concise, readable form. While adhering to professional standards, they will be as free of jargon as possible, and will be designed to be readily usable by those individuals and groups that were/are participants in the reduced or lost services as well as by the general public.

PROJECT DESIGN

A. Objectives

This proposed project has three major objectives. First, we will describe the ecology of commercial herring fishery as it existed prior to the *Exxon Valdez* oil spill. Second, we will describe the ecology of this fishery as it has changed since the spill. Third, we will examine the implications of the observed changes for the monitoring and recovery of commercial herring fishing services. Each of these objectives are developed in the remainder of this section.

1. Objective One: Describe ecology of the commercial herring fishery as it existed prior to the *Exxon Valdez* Oil Spill.

Achieving this objective will result in a description of the herring fishery within the context of overall area commercial fishery patterns before the *Exxon Valdez* oil spill (EVOS). We will briefly review the historical development of the fishery, but will concentrate mainly on the period since the herring-roe fishery has assumed predominance, and especially the five years before the spill. The data to construct this description will come from both primary and secondary data sources. We will use personal interview data to develop descriptions for the years immediately prior to the spill (focussing on a relatively brief historical period because of the characteristics of informant recall and other factors), while statistical information will be available for a longer time series analysis. The description that will result from these data will consist of two primary components: (1) the herring fishery itself ("fishery"); and (2) the relationship of the herring fishery to other fisheries and economic activities ("context"). These components may be outlined as follows:

1. Description of herring fishery itself.
   a. Biological Stocks
   b. Seasons/what time of year, harvest levels, areas.
   c. Fleet, gear types, sectors (numbers, size, types), location.
   d. Types and location of processors, processing subsectors, types of products.

2 Description of context of herring fishery with respect to other fisheries and other economic activities.
   a. Harvesting: First, other species herring harvesters pursued in addition to herring (i.e., description of where herring fit in their yearly round, both in terms of timing/location and in terms of rough contribution to the yearly economics of the enterprise). Second, a description of what other economic activities, besides fishing, herring fishermen engaged in and how these activities were incorporated in the yearly round.
   b. Processing: Description of where herring fit into overall operations at processing entities.

The first component ("fishery") can be constructed at the community level from aggregated time-series information available from the Commercial Fisheries Entry Commission (CFEC) and the

Alaska Department of Fish and Game (ADF&G). The second component ("context") will require development of primary data using phone interviews and community studies. "Permit diversification" tables may be available from CFEC, but may need to be constructed especially for this project. Vessel and permit files publicly available do not allow for this sort of analysis in a straightforward manner.

Analytic points of Objective One: Achieving this objective will provide the descriptive context of the fishery by describing existing patterns of resource utilization, and trends within that pattern. For many commercial species, including Pacific herring, there is a significant degree of fluctuation over time, both in terms of stock availability and a number of other variables that influence the economics of the enterprise (price, location of buyers for harvesters, end markets, etc.). For subsequent objectives it is important to know what have been the magnitude and nature of historic changes in the fishery. That is to say, it is important to ask: what are the conditions herring harvesters and processing operations have adapted to in the past? Understanding the answer to this and related questions will assist in the analysis of adaptations to changing conditions subsequent to the *Exxon Valdez* spill.

2. Objective Two: Describe the ecology of the herring fishery as it has existed subsequent to the EVOS.

Here we will describe the herring fishery within the context of current overall commercial fishing patterns (post-spill), with explicit emphasis on comparing the role of herring in commercial fishing "pre-spill" and what, if any, substitutions have been made for the herring fishery. This also breaks into two primary components as in Objective 1 ("fishery" and "context"), with information derived sources as described under Objective 1. Objective 2 may be outlined as follows:

1. Description of herring fishery itself (for those seasons that it was open)
   a. Biological Stocks
   b. Seasons, harvest level changes
   c. Fleet, gear types, sector changes
   d. Location of processors, types of product changes

2. Context of herring with respect to other fisheries (i.e., changes in commercial fishing effort in response to changes in the herring fishery itself)
   a. Other species harvesters pursued in addition to herring (i.e., what are the changes in the patterns of harvesters seen -- what else are they doing, etc.)
   b. Other options pursued by processing operations (i.e., how have processing operations changed in response to herring changes -- workforces, products run, plant scheduling, etc. -- compared to the pre-spill operations)

Analytic points of Objective Two: Achieving this objective will result in the ability to analyze changes in the ecology of commercial herring fishing activity after the *Exxon Valdez* oil spill in the harvesting and processing sectors of the fishery. This analysis will address issues such as:

1. How have sectors adapted in response to changes in the fishery, and how have they done it?

   a. For harvesters, how has effort been redirected? Have there been changes in targeted species? What has been the adjustment in the annual round? How does this vary from area to area?
   b. For processors, how have changes in the availability of herring been accommodated?

2. Are there differences by area in how harvesters and processors have responded to changes in the availability of herring? That is, is there a differential distribution of adaptive response -- have communities and sectors of the fleet, or subsectors within processing differentially responded to changes in the herring fishery? Are there some options available in particular locations, but not others, or exercised in some areas but not in others?

3. Have these secondary efforts impacted other species or their commercial fisheries? That is, has the diversion of harvesting effort away from herring and toward other species caused any problems/damage to other species? Has it resulted in a noticeable increase in effort directed toward alternate species? Have other fisheries become "more crowded" as a result of the entry of fishermen previously targeting herring other otherwise effected the overall fabric of commercial fishing in Prince William Sound?

4. Are there dynamic interactions/effects with other spill damaged commercial fishing resources? For example, what is the degree of overlap between pink salmon and herring harvesting on a sector basis (e.g., within a given harvest sector, what is the percentage of participation in both fisheries?). The two resources do differ in that pink salmon are much lower in value, but historically available in much larger amounts. The dynamics of the recent market have made it very difficult to profitably fish for pink salmon, however. Should a fisherman wish to do so, pink salmon opportunities may well exist in other areas, whereas for herring this would not be as true. How has this correspondence influenced changes in patterns of effort?

3. Objective Three: Analyze the implications of post-spill changes in the ecology of commercial fishing activity for resource recovery and reduced or lost services.

Achieving this objective will result in an analysis of how post-spill changes in fishing ecology affect restoration of the commercial herring fishery, including attention to reduced or lost services. This analysis builds on the data collected to achieve objectives one and two and it requires data about those aspects of the herring-roe fishery closure that may effect the future of the fishery. There are three general issues that will be developed to achieve this objective. Each of these is briefly developed below, including some example hypotheses that we expect to expand and augment in the development of a detailed research design for this project.

1. If and when the Pacific herring stocks recover, what are the intentions of the formerly participating fishermen regarding retargeting the species? That is, in order to tie commercial fishing back to the biological impacts, what is the likely magnitude of effort that will go back into the system -- the targeted effort on the species once the stock recovers. Are those who were involved in herring in the past intending to be involved with herring in the future?

   Example Hypothesis: a significant number of herring-roe permit holders will be engaged in alternative activities which will hinder their resumption of the herring-roe fishery.

   Example Hypothesis: the ownership pattern of herring-roe permits is different pre- and post-spill. Restoration of stock upon which the services depend or even the services themselves may not benefit the damaged users.

2. Have harvesters made adaptations that would tend to move them away from the species into other pursuits within or outside of commercial fisheries, such that there is no motivation or incentive (social, economic, or otherwise) to pursue commercial herring fishing? Are there new recruits to the herring fishery that may replace any former fishermen who have made other adaptations that inhibit their return to this fishery?

   Example Hypothesis: the restoration of the fishery will depend on the recruitment of prior fishers or newly recruited fishers to exploit this resource.

   Example Hypothesis: at least some participants will have made economic investments in order to pursue herring alternatives that would make it uneconomic for them to resume commercial fishing for herring.

3. Have processors made adaptations that would tend to move them away from the species into other activities and biological stocks, such that there will not be a fluid movement back into the herring fishery (e.g. have there been capital investments in plants that make them less suitable for herring than they were in the past)?

   Example Hypothesis: processors will have made capital investments that will hinder resumption of herring-roe processing.

   Example Hypothesis: processors are flexible enough, and the fishery lucrative enough, that there are no barriers to resumption of herring-roe processing.

4. What are the projections for the fishery? (What is the range of variation of what may happen with the biological stock -- what are the set of assumptions that will be used to discuss potential future changes in the fishery and what might happen in terms of resource recovery and the associated damage to services?) How does

the variation in this range influence likely outcomes for damaged services? How do these differentially influence recovery?

Example Hypothesis: if rapid and full recovery projections prove to be accurate, not all commercial fishing operations will benefit equally. If lower recovery projections prove more accurate, other combinations of commercial fishermen will be differentially impacted.

B. Methods

Achieving the objectives proposed for this study will require the integration of both qualitative and quantitative data about the ecology of the commercial herring fishing. The overall implementation of the project can be conceived of as having two primary stages: one, the use of quantitative data to construct a statistical description of the herring fishery before and after the spill; and, two, the use of qualitative data to describe the decision making about participation in the herring fishery. The stage two qualitative data will consist of interviews with fisheries participants. These participants will be identified using information about permit holders since that information is available in public. Communities with a concentration of permits owners will be examined as "case studies" to develop the details of the social, economic, and other possible factors that affect decisions to participate in the herring fishery. In the remainder of this section we first review of essential background information about the structure of the herring fishery that affects the availability and content of existing data. Next, we develop the categories of data for the stage one statistical description of the fishery and then the methods and procedures for the collection of the stage two interviews with fishery participants.

Background

A key issue in implementing this research is the effect of the structure of the fishery on the sampling of fishery participants. We briefly review some of the issues in the structure of this fishery since these are critical for how the stage one and stage two data will be collected. This discussion in based upon the information publicly available from the CFEC. While using this information (permit files) can result in inexact totals, they are accurate enough (when compared to the limited number of "Basic Information Tables" available on the CFEC electronic bulletin board system [BBS], which do indicate exact figures) to indicate likely relationships. More exact information, requiring more time and effort, can and will be derived for the description developed for the proposed project.

Basic Information Tables are available for the purse seine roe herring fishery for Prince William Sound (PWS), as well as the purse seine herring for bait fishery in PWS. Information for other fisheries is derived from public CFEC files for selected years (1978, 1984, 1988, 1992, 1993, and 1994 were chosen somewhat arbitrarily for a brief overview). These years were chosen as illustrative and are not necessarily representative. The full description of the fisheries will be a product of the research, while this effort merely is a pragmatic assessment of the level of effort needed to accomplish this proposed study. The CFEC files used for this overview do not include harvest information.

Since 1978, the PWS purse seine roe herring fishery has been characterized by an issuance of between 103 and 107 permits, with between 74 and 105 of them actually being fished (except, of course, for 1989 and 1993 to the present, when this fishery has been closed). Total harvest varied from somewhat under 3,000,00 pounds (1978) to somewhat over 33,000,000 pounds (1992). The CFEC files indicate that the permits are owned predominately by Alaskans, with Cordova being the community with the most permits (20 to 30). Homer and Kodiak also are communities that historically owned a number of permits (nine to 20). Seward ownership had historically been at this level, but currently does not exceed the one to four permit range associated with a large number of communities. The PWS seine food/bait herring fishery since 1977 has been characterized by the issuance of eight to 24 permits, with two to 17 actually being fished. No harvest is reported for 1978-80. Total harvest ranged from confidential amounts (presumed to be low) to 8,500,000 pounds. While not a high-value fishery, it can be an important component of a fishing enterprise. It has been a more significant fishery since 1986 than before. Ownership of permits is overwhelmingly Alaskan, with Cordova again as the community with the largest number of permits. Homer may also have more than other communities.

The PWS gill net roe herring fishery is historically the most significant next to the purse seine roe herring fishery. The CFEC files indicate that in the 1970s roe herring gill net permits (drift and set) numbered almost as many as seine roe herring permits (87 gill net permits, 100 purse seine permits). By the mid-1980s, the ratio had shifted to approximately four purse seine permits to every one gill net permit, about the same as at present. Given that purse seine permits have remained about constant or increased slightly, this indicates a decline in gill net permits. Again Alaskan ownership greatly predominates and Cordova is the only community with a significant number of permits (16 to 20 of a total less than 30). The PWS gill net herring fishery has been variable, but can be considered a minor fishery. In the 1980s, 10 to 20 permits were issued annually, with no obvious ownership patterns (other than Alaskan). In the 1990s, fewer than five permits a year have been issued. The PWS otter trawl herring fishery appears in the CFEC files sporadically and is not a significant fishery. Permits issued recently (1993) were likely not fished. Herring spawn on kelp fisheries are discussed in ADF&G publications (Baker, Sharr, and Crawford 1990 and 1991; Baker, Wilcock, and McCracken 1991) but are not reported in the public CFEC files. Harvests are significant for individual operators and will be incorporated into the description produced for this project, but clearly the roe herring fishery (seine and gill net) are the most significant for the greatest number commercial fishermen.

Although the number of permits per year is relatively constant, it can not be assumed that the same individuals own them from year-to-year. It is likely that there is a large degree of continuity, but this is one of the aspects of the fishery that will be documented from the CFEC data. In terms of numbers of permits for current fishermen, we will be dealing with approximately 100 purse seine roe herring permits, up to 25 food/bait purse seine permits, up to 30 gill net roe herring permits, less than 10 gill net non-roe permits, and perhaps some miscellaneous permits as well. The overall universe of permits should be well under 200, with names and addresses available from CFEC records. Even given the need to contact some past permit holders to document pre-spill fishing patterns the universe should not expand over 250 individuals.

Statistical Description of the Herring Fishery

This section briefly discusses the categories of information required for a statistical description of the Prince William Sound herring fishery, possible sources for this information, and difficulties and problems likely to be encountered in the information. Since the PWS herring fishery is managed by the state, all historical information ultimately derives from the state. The PWS herring roe fishery is a limited entry permit fishery, so the Commercial Fisheries Entry Commission is the principal source of information. Information on other herring fisheries is available from the Commercial Fisheries Division of the ADF&G. In addition, current research on herring being conducted for the *Exxon Valdez* Trustee Council will be used to discuss the current biological status of the PWS herring population in relation to the historical information.

Such a description must begin from an historical sketch of the history of the biological resource itself. This will be abstracted from ADF&G information, supplemented by ongoing EVOS research. Historical catch information, by residence of fisherman or permit owner and place of landing will be abstracted from ADF&G and CFEC records. CFEC maintains data files pertaining to fishing vessels and fishing permits which will be used to characterize those participating in the fishery. Unfortunately, these files do not contain actual catch data, or even information on whether a given permit was actually fished in any given year. They will, however, allow us to discuss the pattern of effort in the herring fishery through time in terms of communities of residence, gear used, vessel numbers, and vessel characteristics. In theory, the permit and vessel files are cross linked by a field containing a five digit ADF&G vessel number, but this has proven to be difficult to use in our past projects (e.g., IAI 1994) for the North Pacific Fishery Management Council (NPFMC). If there were a feasible way to so link these files, it would be possible to generate the "suite" of state fisheries that any individual or vessel participated in. Since there is no easy way to do this, we will rely on the ability of the CFEC to generate "Permit Diversification Tables" by fishery and community for any given fishery. These tables will allow us to discuss the "bundle" of activities that a participant in the PWS purse seine roe herring fishery is also likely to take part in, and how important, in terms of percentage of yearly income to the enterprise, each such activity is. Aggregated catch data, by community of residence and community of landing is available, so that we will be able to construct "community suites" of fisheries as well. We will be able to use this information to construct a statistical description reaching back to the 1970s.

Census files are also available from CFEC, which list summary information for each state-permitted fishery by community -- the number of people participating, the number of permits fished, the number of pounds, and estimated gross earnings. Cells with less than four participants are treated as confidential information. For the most part this is only information from relatively "minor" fisheries, however, so that this is another source of information for placing the herring fishery within a larger economic context.

Similar information on processors is also maintained, but due to the relatively few processors in many Alaskan communities, confidentiality considerations often prevent these files being as useful as they are for harvesting operations. Since the number of processors is much more

limited, we expect that much of the required information can be obtained through in-person contacts (while recognizing that exact production numbers are not likely to be revealed).

A potential problem is that information on participation in Federal fisheries is not easily integrated into this task. Given the size of the vessels participating in the PWS herring fishery, this is not likely to be too serious a problem. Should this assessment be in error, it will become obvious in the field portion of the research, at which point corrective actions can and will be taken.

Methods and Procedures for Interviewing Fishery Participants

The 'stage two' interviews are intended to develop information about the social, economic, and other factors that affect participation in the commercial herring fishery. These data will be used to construct descriptions of how decisions are made to participate in the commercial herring fishery and the socioeconomic context of these decisions. In combination with the statistical data, the interview data will be analyzed to describe the dynamics in the ecology of the commercial herring fishery and how these dynamics are similar and different within the affected region. In describing the methods and procedures to implement these interviews we discuss sampling issues, the methods for conducting the interviews, interview content, data management, and analysis.

The herring fishery permit holders as well as fish processors within the region comprise the sampling population for this study. We propose to sample this permit universe in two ways. PWS herring fisherman in Cordova (up to 50, but probably considerably fewer), Homer (15), Kodiak (10), and perhaps Seward (5) will be contacted for participation in face-to-face interviews. Some past participants will also probably be interviewed in these communities. They will be identified using targeted sampling techniques (Johnson 1990) that ask known permit holders, processors, and locally knowledgeable persons (e.g., officials in fishing organizations) to identify past participants. We will sample the remainder of the permit universe by phone. The wide dispersal of this part of the permit universe precludes an in-person approach. Mail surveys could be used, but their effective implementation is time and labor intensive and because there is no guarantee that addresses in the CFEC records are current. A mail "no response" would be difficult to interpret. Contacting respondents for telephone interviews has its own sampling problems, but this allows a more exact determination of the actual rate of contacts and refusals. The size of the sample to be contacted will depend upon the final size of the documented permit universe, but a target of 60 may be obtainable. Additionally, we will also interview all (willing) processors who have participated in producing herring products.

This dual sample approach has two advantages. It minimizes travel expenses while maximizing information obtained. Phone interviews can be quite successful for structured information collection, but in-person contact often results in richer information because of the different nature of the interaction between the researcher and study participants. In-person contacts are usually very successful in smaller communities, but they can be inefficient in larger communities. This sampling approach will also allow us to construct richer community case studies (although Cordova may in fact be the only true case study, given the size of Homer, Seward, and Kodiak

and the relatively few permits owned by residents of those communities) and to compare the effects of a dispersed pattern of permit ownership versus a more concentrated one, in terms of individual communities.

As noted in the discussion of sampling above, both in-person and telephone interviews will be used in this stage of the study. These interviews will be structured by a protocol which specifies particular topics to be developed during the interview, but it also allows study participants and the interviewer to develop unique data that might be missed by a more structured questionnaire. That is, the protocol approach does not specify pre-determined response, but rather it allows the study participant to structure their own responses within a set of common topics asked of all study participants (cf. McCracken 1988; Bernard 1984). This approach will allow us to develop an 'insiders view' of decision making about participation in the herring fishery that will be used to understand the overall dynamics of the ecology of this fishery. We expect that the telephone and in-person protocols will be identical, but the protocol for interviews with processors will be structured to address their role and overall participation in the ecology of the herring fishery. We will protect the confidentiality of all study data collected for this project using the guidelines for ethical responsibility used by the American Anthropological Association and the Association for Applied Anthropology

These protocols will be developed after the statistical overview of the herring fishery is constructed as discussed previously. The content of these protocols will in part depend on the analysis of these secondary data, but we can also anticipate the topics to be addressed including: past and present levels of participation in fishing; vessel, gear, capacity, and crew; annual round of fishing activity; assessment of herring fishery requirements, opportunities and threats; comparisons and contrasts of requirements, threats, and opportunities in relationship to other fishing activity; past and present reasons for entry and exit into the fishery; market potentials; and, values, reputations, and evaluations of herring fishermen and their fishing activity. Again, the major topic areas will be structured to elicit the "insiders view" about how this fishery functions. These data can then be used to describe the overall ecology of the herring fishery in the affected region. All protocols developed during the research design phase of this study will be reviewed with appropriate personnel from the lead agency prior to their use in the field.

The data from these individual structured protocols will be coded using a "grounded-theory" topic coding technique (Strauss and Corbin 1990) and the responses aggregated into a master data base that will allow analysis by individual fields such that we can construct descriptions across or within geographical regions and other relevant analytical categories. Grounded theory coding approach is intended to develop descriptive categories and to assess the relationships among categories based on the information provided by fishery participants. Thus, the analysis constructed is "grounded" in the data. Using this approach, "open coding" methods (Corbin and Strauss 1990: 61ff.) are used to identify categories of information and their properties. Then qualitative analysis techniques (Miles and Huberman 1995; Dey 1993) are applied to link categories, describe relationships, and assess interactions among categories. These data result not only in textual descriptions, but also in matrices and diagrams that display the results of the analysis of the interview data.

There are several text analysis program that may be used for this type of coding and analysis. Some of these program are only text data bases or retrievers, while others are 'code and retrieve' or code-based text data bases. Most use some type of hypertext capability to link common topics across the various text files (e.g., AskSam©). Some programs such as NUD•IST© and HypeResearch© also facilitate the code-building and revision process and we favor these types of programs since they allow the collation of text by topics, easy indexing by codes, as well as code-building and text sorting and aggregation. Such computerized text analysis offers a powerful and efficient data management and analytical tool to organize and analyze a large amount of text data. Effective use of computerized analysis of the text data for this study will thus allow us to systematically link and compare data across topics and geographic regions.

The combination of the statistical and interview data will allow us to describe the overall ecology of the herring fishery and to illustrate its dynamics though the use of case studies. We expect that Cordova and possibly Homer and Kodiak will be case studies that illustrate the functioning of this fishery within the overall context of fisheries in Prince William Sound and the Gulf of Alaska. (A limited amount of analysis will also be conducted on analogous secondary data from the Kodiak-Cook Inlet area Pacific herring fishery to allow for a discussion of changes in adjacent open fisheries during a period paralleling the closure period for the PWS fishery; this information may also prove useful in alternative 'retargeting' discussions regarding the alternatives PWS fishermen have pursued during closure years.) We expect that using these techniques, we will be able to discuss adaptations of PWS herring fishermen to the continued closure of the fishery in more general terms, based on information from permit owners who live in communities less dependent upon herring than Cordova was in the past. This, in addition to a revised version of out first written task, will comprise the bulk of the final report. This will be the basis for a discussion of the implications for the restoration of damaged commercial fishing services.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

We do not anticipate formal cooperative arrangements with agencies, *per se*, as part of the proposed research. Clearly, CFEC information is vital for this project. In the past, similar information and specialized or custom analysis has been available with the payment of an appropriate fee. Fees are based on the staff time required to produce information in a format or configuration that differs from standard CFEC reporting categories, and this type of work does not require the conclusion of a formal cooperative agreement. We have built additional time into our schedule for this, based on our past experience that obtaining such information does sometimes require more time than might be anticipated. ADF&G personnel will also no doubt be helpful to the research effort, as will other agency people in Cordova, Kodiak, and Homer (and perhaps Seward), but it is anticipated that this effort will fall within the levels expected for the normal provision of information in response to inquiries from the public and standard research entities. We do not anticipate that this research will require the issuance of any subcontracts, although it is possible that field or research assistants may be needed on a limited basis to facilitate efficient contacts for interviews. Should this prove necessary, we will work through the local facilitators involved with the Community Involvement Project. We would also

hope that Trustee Council staff would facilitate communications with related ongoing research projects (e.g., the Pacific herring and Sound Ecosystem Assessment efforts).

SCHEDULE

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

We will briefly discuss tasks for this one-year project in terms of the deliverables to be produced. Timing is discussed in the following section.

1. Progress reports (monthly).

Although the *Invitation* suggests quarterly progress reports, we have found that more frequent progress letters are more effective. If they can be as brief as the *Invitation* indicates (i.e., that they will require only a few sentences on the Anchorage Restoration Office-supplied form), they will not impose a significant burden on either research staff or reviewers. Some periods of the project would not require monthly progress letters, but the regular schedule will aid our management of the project. As specified in the *Invitation*, these reports will be used to track meeting of project milestones and to flag significant problems, if any, being encountered.

2. Statistical description of the fishery (draft).

This report will be our first 'deliverable' and will be a building block for subsequent research products in two ways. First, it will serve as a draft for the first section of the final report. That is, it will be submitted for review by the lead agency, but a 'final' stand-alone version will not be produced. Rather, revisions will be incorporated when the document is modified to become a component of the final report. Second, this draft section will serve as the basis for the workplan and sampling strategy.

3. Fieldplan with protocols.

Once the draft statistical description is reviewed by the lead agency, we will produce a fieldplan for the completion of the project. This will require the definition of a data universe, a sampling strategy, and a logistical plan. We will also develop a series of protocols for the elicitation of information. At a minimum this will consist of protocols for past/present herring fishery participants for both in-person and telephone situations, and for processors for face-to-face interviews. We are also likely to wish to interview other people in Cordova in order to expand the information for contextualizing the place of the Pacific herring fishery in the larger economic and social context of the community and region (and its articulation with other fishery components in particular), for which protocols would need to be developed.

4. Community fishery descriptions, processing of phone interview data (draft).

In a similar way to the statistical description of the fishery, this will not be a finished, stand-alone product, but will be reviewed prior to incorporation into the final report. This does not mean that this will be a rough draft or 'work-in-progress,' but merely that it will not be produced as a finished work by itself. It is intended to allow for a review point at a stage of the research process that will allow for meaningful incorporation of review comments. Also, by this strategy, effort can be more usefully expended on the final report rather than several interim reports.

5. Draft final report.

The draft final report will incorporate the two draft documents described above, along with a final section of conclusions. This will include the assessment of effects of the closure of the herring fishery, as well as a discussion of the implications of research findings of the restoration of services. This report is expected to be complete, without substantive revisions required to make it a 'final' document.

6. Final report.

After the draft final report is reviewed by the lead agency, revisions will be made and the document will be resubmitted. It is anticipated that there will be no further need for significant revisions following submittal of the final report.

7. Project record (contact reports, documents obtained, etc.).

During the course of the project we will maintain brief records of all contacts made for purposes of this project. We will also compile bibliographic references and all correspondence between the lead agency and the researchers. The project record will be delivered along with the revised final report.

B. Project Milestones and Endpoints

The following listing represents our outline of projected timing for the proposed research effort:

10/01/96 Award of Contract (we are aware that response to Peer Review comments on the proposal may be required prior to the contract award).

11/01/96 Submission of first *Progress Report* (submissions continue monthly for balance of contract).

01/07/97 Submission of deliverable *Statistical Description of the Fishery* (draft), due three months after award of contract. This provides enough time to obtain the information, process it, and then produce the draft report.

01/22/97 Annual Restoration Workshop, Anchorage (four days).

02/18/97 Submission of deliverable *Fieldplan with Protocols*, due six weeks after delivery of draft statistical description. While this timing is somewhat tight, we feel this deadline is obtainable and will keep the research on track.

06/17/97 Submission of deliverable *Community Fishery Descriptions, Processing of Phone Interview Data* (draft), due four months after the delivery of the fieldplan. This timing allows for difficulty in contacting individuals in the sample as well as the time required to work up the interview data, i.e., it encompasses fieldwork and draft report preparation.

08/19/97 Submission of deliverable *Draft Final Report*. The two draft sections will be incorporated with revisions as suggested by the lead agency comments, and a concluding section focussed on implications for restoration of services generated.

09/16/97 Draft final report received back from lead agency (one month review period).

09/30/97 Submission of *Final Report*, two weeks after receipt of draft review.

09/30/97 Submission of *Project Record*.

10/??/97 Technical Review Session (two days).

01/??/98 Annual Restoration Workshop (four days).

C. Completion Date

The completion date for this project is set at September 30, 1997. All of the project's restoration objectives will have been met during FY 97. (The only project related activities that will carry over into FY 98 will be attendance at the Technical Review Session projected for October, 1997, and attendance at the Annual Restoration Workshop, projected for January, 1998. For the sake of simplicity, the costing information associated with these activities are attributed to FY 97 in the budget; if this is inappropriate, we will extend these costs into FY 98 and revise the completion date at the Council's request.)

PUBLICATIONS AND REPORTS

As noted in under the discussions of 'Measurable Project Tasks' and 'Project Milestones and Endpoints,' there will be a number of deliverables, including progress reports and draft technical reports, submitted under the auspices of the proposed research. This section focusses on reports and publications intended for wider dissemination.

1. Final Report

We will produce a final report for this project that will meet the specifications for Final or Annual Reports as provided by the Council. As specified, 32 double-sided copies of this report will be provided bound with the 'PERFECT' binding technique in addition to the required four unbound (and single-sided) copies.

2. Article(s) in Peer-Reviewed Journals

In accordance with the desires of the Trustee Council, we will submit project results for publication in peer-reviewed journals as soon as scientifically appropriate and logistically possible. It is our intention to publish project results in at least two journals, one oriented toward the applied social sciences in general and another oriented toward fisheries research in particular. Two social science journals that would be appropriate for these results are *Human Organization* and *Current Anthropology*. As for fisheries oriented journals, *Marine Resource Economics* or the *Journal of Fisheries Research* are appropriate choices.

PROFESSIONAL CONFERENCES

It is also our intention to disseminate project results at at least two professional conferences, one oriented toward Alaska specific research and one that is national in scope. To this end, we intend to present research findings at the annual meetings of the Alaska Anthropological Association (currently scheduled for March, 1997 in Whitehorse) and at the annual meetings of the American Anthropological Association that are scheduled for Washington, D.C., November 23-29.

In addition to these "outside" professional conferences, we will also attend the *Annual Restoration Workshop* (noted in the *Invitation* as tentatively scheduled for January 22-25, 1997 in Anchorage) and the restoration *Technical Review Session* (noted in the *Invitation* as being two-day session, often held in the fall, usually in Anchorage, but that may occur at other times and in other locations).

NORMAL AGENCY MANAGEMENT

<Note: in accordance with instructions in the Invitation, this section is skipped as the members of the proposed staff are not employees of government agencies.>

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The proposed project would benefit from coordination and integration with two primary areas of ongoing restoration efforts. First is in the area of Pacific herring stock related efforts. The second area is the Sound Ecosystem Assessment and related projects. As mentioned earlier, it is our hope that Trustee Council staff will facilitate communications will investigators involved in

these related ongoing research projects in order to maximize the benefits that can accrue from this proposed research.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

<Note: in accordance with instructions in the Invitation, this section is skipped as the proposed effort is not a continuation of FY 96 work>

PROPOSED PRINCIPAL INVESTIGATOR

Name:	Michael A. Downs, Ph.D.
Affiliation:	Impact Assessment, Inc.
Mailing address:	2160 Avenida de la Playa, Suite A La Jolla, CA 92037
Phone number:	(619) 459-0142
Fax number:	(619) 459-9461
E-mail address:	mdowns@cerfnet.com

PERSONNEL

Full resumes of the key personnel assigned for the proposed project are provided in Attachment 2 to this proposal. As per the instructions in the Invitation, this section summarizes the qualifications of the proposed Principal Investigator and provides a listing of the key personnel assigned to the project and their responsibilities. Please note that the three key personnel listed have established professional relationships, and have worked together on similar research projects for well over a decade. Also please note that although these individuals will be working out of different facilities for various portions of the research, IAI offices are interconnected electronically (through common hardware and communications software) to facilitate common research efforts. This system has proven efficient for us for many years.

Qualifications of Proposed Principal Investigator:

Michael Downs will serve as the Principal Investigator and Project Manager for this project. Dr. Downs received his Ph.D. in Anthropology from the University of California, San Diego and holds the position of Vice President, Impact Assessment, Inc. The focus of his career has been on issues of resource development and management and human-environmental relations. Dr. Downs served as project manager and a primary researcher/senior scientist on both of the recently completed Social Impact Assessments of groundfish allocation alternatives in the waters off of Alaska for the North Pacific Fishery Management Council. As a senior researcher on the Oiled Mayors *Exxon Valdez* study, Dr. Downs was the lead author of and bore primary responsibility for Interim Report #3 which focussed specifically on social and psychological impacts of the *Exxon Valdez* spill. He is a co-author of several articles focussing on spill impacts to individuals and communities. Other Alaska-based work includes having been a primary researcher and manager on numerous projects sponsored by the MMS Alaska Region, including a number with resource utilization oriented analysis. One such example of this work is the Northern Institutional Profile analysis, for which he was the primary author and overall project manager for a region-wide study that focussed to a large degree on the relationship of institutional change to a changing relationship to the regional resource base. He was also one of two primary researchers on the Affected Community Descriptions and Environmental Impact Statement for the Alaska Maritime National Wildlife Refuge for the US Fish and Wildlife Service, and is currently involved in IAI's work for the U.S. Forest Service, Alaska Region, in the Tongass National Forest (and is one of two key IAI researchers on a team selected to perform socioeconomic and subsistence analysis for the Chugach National Forest). As for other project management related work, Dr. Downs is currently the project manager of the Clark County Socioeconomic Impact Study, and he served as Program Manager on the MMS Coastal North Carolina Socioeconomic Study. Dr. Downs is the co-author of several ethnographic baseline and social impact assessment studies conducted by Impact Assessment. He was one of two primary investigators on the recently completed Social Assessment of the Kootenai National Forest. Recent teaching positions have included lectureships in Anthropology at both the University of California, San Diego and the University of San Diego. In sum, Dr. Downs brings a strong combination of research expertise and program/project management experience to this project.

List of Key Personnel and Their Responsibilities:

1. Michael A. Downs, Ph.D.

Michael Downs will serve as the Principal Investigator and Project Manager for the proposed project. He will be directly responsible for the overall conduct of the project, will serve as the point of contact for the Trustee Council and Lead Agency, and will attend the required meetings and workshops. Dr. Downs will also be directly involved with the all aspects of the project, including field interviews. Additionally, he will bear primary responsibility for the production of the analytic component of the project that focusses on implications of research findings for service restoration, and for the overall coordination of the draft and final project reports.

2. Michael S. Galginaitis, ABD

Michael Galginaitis will bear primary responsibility for the secondary and statistical data collection and analysis for the proposed project. He will be responsible for the assembly of the draft report based upon these data as well. Mr. Galginaitis will also bear primary responsibility for field data collection in communities of Homer, Kodiak, and Seward, and will assist Dr. Russell in the collection of field data in Cordova.

3. John C. Russell, Ph.D.

John Russell will bear primary responsibility for the primary data collection and analysis of the study effort. Dr. Russell will also bear primary responsibility for field data collection in the community of Cordova, and will assist in the collection of field data elsewhere, as scheduling requires. Additionally, he will have primary responsibility for the assembly of the draft report that is based upon the primary data components.

LITERATURE CITED

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1994 Sector Description and Preliminary Social Impact Assessment of the North Pacific Fishery Management Council Regulatory Changes in the Groundfish and Crab Fisheries of the Gulf of Alaska and Bering Sea/Aleutian Islands. Prepared for the North Pacific Fishery Management Council, Anchorage. October 21, 1994.

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1991a Community Profiles Developed for the Social Impact Assessment of the Inshore/Offshore Amendment Proposal. Prepared for the North Pacific Fishery Management Council, Anchorage. January 25, 1991.

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1991b Description of Social Environment and Consequences of Alternatives: Draft Social Impact Assessment of the Inshore/Offshore Amendment Proposal. Prepared for the North Pacific Fishery Management Council, Anchorage.

Johnson, Jeffery
1990 Selecting Ethnographic Informants. Newbury Park. Sage Publications.

Miles, M.B. and Huberman, A.M.
1994 Qualitative Data Analysis. Newbury Park. Sage Publications.

Attachment 1:
Summary of Corporate Capabilities and Experience, Record of Past Performance, and Facilities

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Specialists in Natural Resources Social Science
Social Assessments
Social Impact Assessment
Socioeconomic Analysis
Environmental Impact Statements

Branch Offices

Anchorage, Alaska
Emeryville and Sacramento, California

April, 1996

INTRODUCTION

In this attachment we provide an overview of Impact Assessment, Incorporated's capabilities and experience, a record of our past performance, and a summary of our organization and facilities. (Summaries of personnel qualifications are provided in a following attachment.) We believe the materials provided herein, taken in combination with our technical proposal and personnel qualifications, demonstrate: (1) an understanding of the problem, particularly the depth and currency of our Alaska fisheries experience and our knowledge of *Exxon Valdez* related issues; (2) the soundness of our technical approach, given our approach as laid out in the technical proposal and the parallels between this approach and those used for the successful completion of similar research; (3) the innovation and uniqueness we bring to this proposed project as a result of our thorough understanding of the dynamics of commercial fishing in the area; and, (4) the feasibility of the project, based in our clear understanding of the challenges involved in this type of research and our demonstrated success in meeting those challenges in past and ongoing projects.

Impact Assessment, Incorporated (IAI) was organized for the purpose of conducting studies of the social and economic impacts resulting directly or indirectly from natural resource management, development, and/or disruption. Over the years our experience has broadened considerably, but natural resource related analysis and planning has remained a strong focus of our work. We believe that our qualifications and experience make us one of the leading firms to conduct social assessments and subsistence, economic, and cultural studies of the actual and potential effects of resource management, development, regulatory change, and resource disruption in general, and for fisheries-related analysis in particular.

We bring a broad base of expertise to this work in geographic, topical, and analytic terms. We have a long corporate history of research and monitoring projects in Alaska, and with Alaska fisheries issues specifically. Our work addresses policy development, natural resources planning, regulatory compliance, community involvement and participation, and the full range of socioeconomic impacts related to natural resources management and development for communities, Native Americans, industry, and governments. We have worked with local, state, and federal agencies; and, we have familiarity with the spectrum of environmental laws and regulations that affect the management, use and harvesting of natural resources. We are experienced in the breadth of social science research methods, including the use of surveys, ethnographic techniques, economic modeling, and archival research.

We also understand the varying needs of applied research sponsors. IAI has successfully completed socioeconomic research for a range governmental agencies and other institutions including the North Pacific Fishery Management Council, U.S. Fish and Wildlife Service, the U.S. Forest Service, the Minerals Management Service, the Bureau of Land Management, and the National Park Service, among others.

In the interest of brevity, the following description of our experience has been structured to address the key technical qualifications we believe are necessary to successfully conduct

fisheries-related restoration monitoring and research from the perspective of lost or reduced services/socioeconomic impact. First, we provide a selection of socioeconomic studies we have completed to date. This is followed by a brief description of our organization and facilities. Brief biographical sketches (or full resumes) of core IAI staff (in addition to those provided as a separate attachment) and letters of commendation/ recommendation are available upon request. A copy of our full statement of qualifications is also available upon request.

Alaska Applied Fisheries Research

1995 IAI performed a Supplemental Social Impact Assessment for the North Pacific Fishery Management Council analysis of proposed changes in groundfish and crab regulatory schemes for the Gulf of Alaska and Bering Sea/Aleutian Islands fisheries focussing on several narrowly defined License Limitation management approach configurations. This research built upon the earlier, more general research performed under NPFMC #94-01 (1994) synopsized below. The analysis looked at the distribution of impacts across industry sectors and regions, and included communities spanning several regions. Clarence G. Pautzke, Executive Director, North Pacific Fishery Management Council, (907) 271-2809. Reference #95-02.

1993 - 1994 IAI performed a Social Impact Assessment for the North Pacific Fishery Management Council's (NPFMC) analysis of proposed changes in groundfish and crab regulatory schemes for the Gulf of Alaska and Bering Sea/Aleutian Islands fisheries. Proposed changes include establishment of Individual Fishing Quotas (IFQs) or License Limitation management approaches. This research required the analysis of existing secondary data, combined with the gathering and analysis of primary data, on fisheries participation and dependency by various harvest and processing industry sectors in both Alaska and the Pacific Northwest. Sector Profiles were produced for 12 industry segments, along with a Social Impact Analysis. Clarence G. Pautzke, Executive Director, North Pacific Fishery Management Council, (907) 271-2809. Reference #94-01.

1990-1991 IAI performed a Social Impact Assessment for the North Pacific Fishery Management Council's consideration of the Inshore/Offshore Amendment Proposal for commercial groundfish quota allocations in the Gulf of Alaska and the Bering Sea. This research required the compilation of community profiles to document existing utilization patterns of various user groups, and the differential influence of various resource use patterns on a number of coastal Alaska and Pacific Northwest communities. The profiling effort was followed by a social impact analysis of various inshore/offshore allocative alternatives. As a result of the process, of which this SIA was a part, NPFMC constructed a precedent-setting plan to divide harvest effort between inshore and offshore components of the fishery, a plan subsequently approved by the Secretary of Commerce. Steve Davis, Deputy Director, North Pacific Fishery Management Council, (907) 562-3339. Reference #90-46.

1982 A study of the Effects of a Proposed Federal Halibut Limited-Entry (Moratorium) for the North Pacific Fishery Management Council. IAI conducted a study in each of the villages of Kodiak island (including Kodiak itself) to assess the potential impact of proposed incorporation of halibut under various forms of fishery entry limitation.

1979-1982 A study of the Impact of Entry-Limitation Regulations on Indigenous Residents of Bristol Bay, Alaska for the National Science Foundation. During four summer months, two winter months and two spring months, a team of five researchers collected detailed interviews and biographies from local and Alaskan Native fishermen concerning their perception of social change in Bristol Bay and the relationship of this change to Alaska's Limited Entry Act of 1973. The study focussed primarily on social and economic effects of this management strategy on the rural Native fishermen of the region in the half-decade following initial implementation (1975-1980).

Other Renewable Resource Development, Regulation, and Management Socioeconomic Studies

1994 - 1995 IAI performed a comprehensive Social Assessment of the Kootenai National Forest for the U.S. Forest Service. This study examines existing social and economic conditions in counties surrounding the forest and describes and analyzes public evaluations of forest resources and their management. The study analyzes how different stakeholders and user groups (including Native Americans) evaluate the existing Forest Plan and its implementation as well as the use of Eco-Systems Management as a future management strategy. Technical Point of Contact, Mr. Dan Leavell (406) 293-6211; Ms. Zandra Dillion, Contracting Officer, Kootenai National Forest, (406) 293-4156. Reference contract 53-03J1-4-0099.

1994 - IAI is assisting the National Park Service in an Ethnographic Recording Project for socioeconomic variables in the Kenai Fjords National Park (KFNP), Alaska. This work involves review of existing National Park Service documents as well as the academic and applied literature on the area concerning historical and present uses of the Park. The main thrust of the project to document land use in KFNP through recorded interviews with Alaskan Natives, primarily in Port Graham and Nanwalek. The intent is to determine how much oral tradition and memory culture relating to the park exists and to plan for its documentation. Past subsistence activities are one aspect of this, within the context of overall use patterns. Ms. Joy C. Kucinski, Contracting Officer; Tim Cochrane, COAR, National Park Service, Alaska Region, (907) 257-2574. Reference Contract 1443CX970094028.

1994 - IAI is currently working on a component of the Swan Lake-Lake Tyee Transmission Line EIS project in Southeast Alaska. Foster-Wheeler Environmental (formerly Ebasco) is the prime contractor, with IAI as the

subcontractor responsible for describing subsistence use in the project area and analyzing potential effects upon subsistence users. The project area is primarily Forest Service land, so the project is very similar to our other Forest Service projects in the Tongass National Forest. Ellen Hall, Bellevue, is the project manager.

1993 - IAI is currently involved in the development of a comprehensive Environmental Impact Statement (EIS) assessing the potential human and environmental impacts of a Timber Sale in the Control Lake area of Prince of Wales Island in Southeast Alaska. IAI's primary responsibility in this project is the description and analysis of the potential socioeconomic effects of the timber sale upon communities likely to be affected by the sale. Subsistence is emphasized because of the special protection which the Alaska National Interest Lands Act gives to subsistence activities on Federal lands. Other socioeconomic issues related to the timber sale will be researched and analyzed to delineate the potential effects of the sale on all of the area's user groups and to contextualize "subsistence" as one component of a complex system, rather than as a separate entity isolated from other issues. U.S. Forest Service, Ketchikan, Alaska. Mr. Larry Lunde (Contracting Officer's Representative), U.S.D.A. Forest Service; Mr. Tom Stewart, Ebasco, Inc. (Prime Contractor), (206) 451-4601 (O), (206) 451-4691 (F). Reference Ebasco/Enserch #04463A.

1992 - IAI is currently involved in the development of a comprehensive EIS assessing the potential human and environmental impacts of a Timber Sale in the Labouchere Bay area of Prince of Wales Island in Southeast Alaska. IAI's primary responsibility is similar to that described for Control Lake. U.S. Forest Service, Ketchikan, Alaska. Mr. Larry Lunde (Contracting Officer's Representative), U.S.D.A. Forest Service, ; Mr. Jim Thrall/Kathleen Smayda, HARZA Northwest, Inc. (Prime Contractor), (206) 882-2455, (206) 883-7555 (F). Reference Contract 33-0109-2-00344.

1985-1986 A Comprehensive Conservation Plan for the U.S. Fish and Wildlife Service (FWS). This eighteen month project was designed to provide the FWS with three products. First, it provided in-depth descriptions of fifteen communities selected to represent all of Alaska's coastal communities affected by creation of the Alaska Maritime National Wildlife Refuge, ranging from Southeast Alaska, to the western Aleutians, to the North Slope. Second, it provided the FWS with socioeconomic input to their EIS concerning resource management alternatives. Finally, the study provided FWS with ANILCA Subsistence 810 evaluations of each of the Comprehensive Plan alternatives, as mandated by Congress. *Description of Affected Environment, Environmental Impact Statement and ANILCA 810 Evaluation of the Alaska Maritime National Wildlife Refuge, Comprehensive Conservation Plan.* U.S. Department of the Interior, FWS. Ms. Leslie Kerr, COR, (907) 442-3799, Planning Team Leader. Contract FWS 7-85-76.

1995 - Technical Analysis of Proposed Pacific Pipeline Project: Socioeconomic Component. This project involves a socioeconomic impact analysis of a proposed crude oil pipeline through the City of Los Angeles, from the perspective of the potentially impacted publics. This project will involve work with neighborhood and other local interest groups, and span a number of social, cultural, and ethic divisions. Mr. Gary Gero, Environmental Supervisor, Environmental Affairs Department, City of Los Angeles; (213) 580-1024. City Agreement No. C-91186.

1994 - 1995 IAI developed baseline information for use in the "Using Socioeconomic Information to Assess the Impacts of Surface Transportation in North Carolina Coastal Communities" project for the Center for Transportation and the Environment at the University of North Carolina at Chapel Hill. In this project IAI subcontracted to the Institute for Coastal and Marine Resources, East Carolina University. This project examined the socioeconomic impacts of the current transportation system in the Outer Banks area, along with potential changes that would derive from transportation system improvements. Primary issues revolved around balancing the area's multiple uses, including tourism, commercial fishing, and recreation, with the need to conserve fragile coastal resources. Dr. John S. Fisher, The Center for Transportation and the Environment, University of North Carolina at Chapel Hill, (919) 962-2211. Subcontracted to the Institute for Coastal and Marine Resources, East Carolina University, Greenville, North Carolina. Contact: Dr. John Maiolo; (919) 726-1693, (919) 726-1228 (F). Reference Contract 94-1742-03 (ECU).

1992-1993 IAI developed baseline information for the Coastal North Carolina Socioeconomic Study Program in conjunction with East Carolina University. This program provided the U.S. Department of the Interior with information to assist decisions related to oil drilling offshore North Carolina. The health of the economy, and the social structure of coastal regions of this state are closely linked to the health of the ocean environment. This study documented existing socioeconomic conditions in the region with a focus on the region's tourism and fishing industries. Published as OCS Study MMS 93-0052 (Executive Summary), MMS 93-0053 (County Studies), MMS 93-0054 (Community Studies), MMS 93-0055 (Pile Sort and Data Analysis), and MMS 93-0056 (Socioeconomic Monitoring Design and Methodology). Ms. Judy Wilson, Minerals Management Service, Atlantic Region, Contracting Officer's Technical Representative (703) 787-1075. Cooperative Agreement 14-35-0001-30671.

1989-1990 Subsistence Resource Harvest Patterns: Kaktovik. This study was designed to assess the effects of long-term oil development on subsistence use patterns in the North Slope community of Kaktovik, Alaska. The project involved personal interviews, mapping, and assessment of changes and the sources of those changes in subsistence patterns. OCS Study MMS 90-0039; Special Report No. 9. Ms.

Karen J. Gibson, Contracting Officer's Technical Representative (COTR), (907) 271-6613. Reference contract MM 14-35-0004-60147.

1989-1990 Subsistence Resource Harvest Patterns: Nuiqsut. This study was also designed to assess the effects of long-term oil development on subsistence use patterns, but in this case, for the North Slope community of Nuiqsut, Alaska. The project involved field interviews, mapping, and assessment of changes and the sources of those changes in subsistence patterns. OCS Study MMS 90-0038; Special Report No. 8. Ms. Karen J. Gibson, COTR, (907) 271-6613. Reference contract MM 14-35-0004-60146.

1988-1990 Northern Institutional Profile Analysis for the U.S. Department of the Interior, Minerals Management Service. This study was designed to assess the long-term sociocultural and socioeconomic effects of oil development on the North Slope. Individual studies on population, employment, formal and informal sociocultural institutions, economic profiles, fiscal policies, and infrastructure were conducted in all North Slope Borough communities including Kaktovik, Anaktuvuk Pass, Atkasuq, Nuiqsut, Barrow, Point Hope, Wainwright, and Point Lay, and the industrial enclave of Prudhoe Bay/Deadhorse. *Northern Institutional Profile Analysis: Chukchi Sea.* MMS Technical Report #141 (733 pp.). *Northern Institutional Profile Analysis: Beaufort Sea.* MMS Technical Report #142 (660 pp.). National Technical Information Service: Springfield, Virginia. Ms. Karen J. Gibson, COTR, (907) 271-6613. Reference contract MM 14-12-0001-30414.

1987-1990 Pt. Lay Case Study for the U.S. Department of the Interior, Minerals Management Service. This study involved nearly twelve months of data collection in the Alaskan communities of Pt. Lay, Pt. Hope, Barrow, and Nuiqsut, and the preparation of a comprehensive report of the Inupiat community of Pt. Lay, including analyses of demographics, public and private sector economic status, issues, and concerns, formal and informal institutions, and a general ethnographic characterization of the population and its relationship to neighboring populations. Six extended biographies were collected and submitted to provide a basis for the evaluation of the significance of the pending Chukchi Sea OCS oil lease on the socioeconomic and sociocultural systems in lease-affected communities. *Point Lay Case Study.* MMS Technical Report #139 (532 pp.). *Point Lay Biographies.* MMS Technical Report #140 (137 pp.). National Technical Information Service: Springfield, Virginia. Dr. Don Callaway, Contracting Officer's Representative (COR), (907) 271-6595. Reference contract MM 14-12-0001-30364.

1986-1988 A study entitled "Village Economics in Rural Alaska" for the U.S. Department of the Interior, Minerals Management Service. This work analyzed village economies in three rural Alaskan areas: Pribilof Islands, St. Lawrence Island, and the Yukon Delta. The twenty-one month project was designed to provide an in-depth empirical examination of the economic organization and functioning of the subsistence and marketing economies in rural Alaskan villages. The study, the first of its kind in Alaska, emphasized historical and current relationships of local

economies to wider state and national economies and the harvesting of renewable resources. *Village Economics in Rural Alaska.* MMS Technical Report #132 (326 pp.). National Technical Information Service: Springfield, Virginia. Contact Ms. Karen Gibson, (907) 271-6613. Reference contract MM 14-12-0001-30298.

1985-1988 A Sociocultural Monitoring Study of the North Slope and Aleutian-Pribilof Regions of Alaska for the U.S. Department of the Interior, Minerals Management Service. This sixteen month study was designed to test and reapply a sociocultural monitoring methodology to rural coastal communities expected to be affected by OCS oil tract leasing activities of the federal government. Project involved a total of five months of field data collection in the North Slope, Aleutian Islands, and Pribilof Islands. *Analysis of Aleut Institutional Response and Change: 1980-1985.* U.S. Department of the Interior, Minerals Management Service Technical Report #128 (309 pp.). National Technical Information Service: Springfield, Virginia. Karen Gibson, COR, (907) 271-6613. Reference contract MM 14-12-0001-30264.

1983-1984 Socioeconomic and Sociocultural Study of twenty-three Communities of Bristol Bay, Alaska for the U.S. Department of the Interior, Minerals Management Service. This sixteen month study required primary data collection in each of the Alaska Native communities of the region and the preparation of comprehensive regional and sub-regional economic and cultural analyses of each community's adaptations to accelerated development of offshore oil resources. *Sociocultural / Socioeconomic Organization of Bristol Bay: Regional and Subregional Analyses.* MMS Technical Report # 103 (528 pp). Contact Ms. Karen Gibson, (907) 271-6613, Reference contract MM 14-12-0001-30010.

1982-1983 Comprehensive Ethnographic Studies of the Communities of Unalaska and Cold Bay, Alaska for the U.S. Department of the Interior, Minerals Management Service. This twelve month study involved seven months of field data collection in the two principal study communities and short-term visits to the villages of Nikolski and Akutan. The project also involved a long-term follow-up study of the impact of oil development on the community of Valdez (through late 1983). In addition, several projection scenarios were prepared for the MMS depicting likely courses of change for these communities in the event of major oil development of the U.S. outer continental shelf. *Unalaska: Ethnographic Study and Impact Analysis.* U.S. Department of the Interior Minerals Management Service, Technical Report #92 (614 pp.). *Cold Bay: Ethnographic Study and Impact Analysis.* U.S. Department of the Interior Minerals Management Service, Technical Report #93, (468 pp.). Ms. Karen Gibson, COR, (907) 271-6613, Ms. Lynda DeRamus, Contracting Officer (CO), (703) 435-6415. Reference contracts MM 14-12-0001- 29069 and AA851-CT2-35.

1981-1982 A study of Social Change Among All Alaska Peninsula Communities for the U.S. Department of the Interior, Minerals Management Service. This twelve month project involved collection and analysis of primary field data from each of the

region's fishing communities and preparation of a non-OCS development scenario for each of the region's individual communities (Volume 1) and the region as a whole (Volume 2). These scenarios were to be used in the future to contrast with actual changes occurring as a result of oil development in the Shelikof Straits and Shumagin OCS lease sale areas. Volume I, *North Aleutian Shelf Non-OCS Forecast Analysis, Regional Level Analysis* (242 pp.); Volume II, *North Aleutian Shelf Non-OCS Forecast Analysis, Village Cluster and Community-Level Analysis* (276 pp.). U.S. Department of the Interior Bureau of Land Management, Technical Report #75. Mr. Robert Hansen, Contracting Officer, (703) 435-6415. Reference contract AA851-CT1-31.

Other Relevant Studies

1995 IAI assisted the City of Las Vegas and the Las Vegas Historic Preservation Commission in the process of establishing an "Old Las Vegas High School Neighborhood" Historic Preservation District. This work involved information dissemination to proposed district residents, as well as a multi-method survey and interview approach to gathering information on land owner and residents views and concerns with regard to the district and their properties. Ms. Virginia Hernandez, Historic Preservation Coordinator, City of Las Vegas Community Planning and Development Department; (702) 229-6011.

1990- IAI is currently engaged in a large and comprehensive socioeconomic impact study of the proposed high-level nuclear waste repository at the Yucca Mountain site in Nevada. The study, which represents an ongoing multi-disciplinary effort to assess and monitor social change resulting from the construction, operation and eventual closure of the repository, involves detailed analysis of many current human/technological issues pertinent to local government including: public perception of risk, transportation of high-level radioactive waste, and emergency preparedness and response. Mr. Dennis Bechtel, Coordinator, Clark County Nuclear Waste Division, Contract Authority.

1989-1990 Our study of the "Economic, Social, and Psychological Impacts of the *Exxon Valdez* Oil Spill" was conducted for the Oiled Mayors Subcommittee of the Alaska Conference of Mayors under a grant from the State of Alaska, Department of Community and Regional Affairs. This study was designed to provide a detailed assessment of the impacts of the oil spill and its cleanup on: (1) local government fiscal operations; (2) local business; and (3) local communities (including the psychological, social, and cultural consequences). Three interim reports and a final report describe these impacts in detail: *Interim Report #1: Analysis of Fiscal Impacts to Local Jurisdictions* (87 pp.); *Interim Report #2: Public and Private Sector Impacts of the Exxon Valdez Oil Spill* (163 pp.); *Interim Report #3: Social and Psychological Impacts of the Exxon Valdez Oil Spill* (312 pp.); *Final Report: Economic, Social, and Psychological Impact Assessment of*

the Exxon Valdez Oil Spill (178 pp.). Gordon Gould, Manager, City of Kodiak, Contracting Officer (CO), (907) 486-3224. Reference contract #AK-OSG 90-5.

ORGANIZATION

IAI was established to conduct applied social science research. IAI employs a small core group of individuals with demonstrated competence in technical, managerial, and/or administrative areas of specialization. The philosophy of the firm is to maintain this core group of carefully selected persons to serve as the nucleus for project work, and to supplement this group with technical specialists as needed to provide the client with the experts necessary to carry out the requirements of a given project. In this manner, IAI maintains an extremely low overhead multiplier while retaining the ability to assemble project teams having the best qualified experts (regionally, technically, etc.) in the country. This organizational strategy is an obvious advantage to the principal in terms of making the best individuals available at an economical rate while providing the additional value of a proven managerial/administrative infrastructure to monitor and control research teams.

IAI's project management team has a breadth of previous experience in managing the project activities of physical, biological, and social scientists, economists, engineers, environmental health specialists, physicians, planners, and others within the context of large multi-disciplinary efforts. This experience has provided a broad basis for understanding the issues, needs, interactions, and varied approaches to research problems and has served to develop an effective set of management practices and tools used to guide project activities.

FACILITIES

IAI's facilities are located in Anchorage, Alaska and La Jolla, Emeryville, and Sacramento, California. The facilities are fully computerized with multiple IBM 486s and 386s. In addition to desktop computers, IAI owns multiple portable computers in support of field research activities. Other equipment includes optical character readers; HP LaserJet printers; automatic facsimile (FAX) telecopiers; and other support equipment, such as a high speed photocopiers, and report binding machinery. In support of its GIS capabilities, IAI also owns and maintains a Sparkstation I and a Sparkstation II. GIS software includes ARC INFO 6.0, SUNVIEW, and ARCVIEW. IAI has developed an extensive library of IBM-compatible software, including all standard word processing, data management, statistical, graphics, spreadsheet, project management, disk conversion, file/disk management, desk-top publishing, and workgroup editing packages. IAI also has computer bulletin board systems which allow field researchers to communicate directly between both fixed facilities and field sites. In combination, these facilities provide IAI with a valuable multi-node "desk-top publishing" capability that ensures fast, efficient production of reports and other publications and the ability to maintain a hands-on technical and editorial quality control of all materials throughout the publication process.

All IAI facilities are interconnected electronically, through the use of common hardware and communications software. IAI employees working at different offices are in direct

communication, and frequently exchange electronic files and coordinate analytic efforts on an ongoing basis. This arrangement has proven efficient over the course of many years and allows us to contain project costs without sacrificing analytic quality.

Attachment 2:
Summary of Experience and Qualifications of Key Personnel

IMPACT ASSESSMENT, INCORPORATED

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(619) 459-0142 phone
(619) 459-9461 facsimile

Branch Offices

Anchorage, Alaska
Emeryville and Sacramento, California

April, 1996

INTRODUCTION

In this attachment we provide an overview of the experience and qualifications of the key personnel of Impact Assessment, Incorporated who will be assigned the proposed project. (An overview of our corporate capabilities and experience, a record of our past performance, and a summary of our organization and facilities is provided in a preceding attachment.) We believe the materials provided herein, taken in combination with our technical proposal and corporate qualifications, demonstrate in a number of ways our ability to carry out the proposed research and monitoring project.

The personnel assigned this work, Michael Downs, Michael Galginaitis, and John Russell, all have considerable and current experience with Alaska applied fisheries research. Further, all have previous *Exxon Valdez* related research experience. Each of these individuals is highly qualified to perform all aspects of the proposed project and, as discussed in the technical section of this proposal, each will be involved in all stages of the research and analysis.

As noted in the Personnel section of the technical proposal, Michael Downs will serve as the Principal Investigator and Project Manager for the proposed project. He will be directly responsible for the overall conduct of the project, will serve as the point of contact for the Trustee Council and Lead Agency, and will attend the required meetings and workshops. Dr. Downs will also be directly involved with the all aspects of the project, including field interviews. Additionally, he will bear primary responsibility for the production of the analytic component of the project that focusses on implications of research findings for service restoration, and for the overall coordination of the draft and final project reports. Michael Galginaitis will bear primary responsibility for the secondary and statistical data collection and analysis for the proposed project. He will be responsible for the assembly of the draft report based upon these data as well. Mr. Galginaitis will also bear primary responsibility for field data collection in communities of Homer, Kodiak, and Seward, and will assist Dr. Russell in the collection of field data in Cordova. John Russell will bear primary responsibility for the primary data collection and analysis of the study effort. Dr. Russell will also bear primary responsibility for field data collection in the community of Cordova, and will assist in the collection of field data elsewhere, as scheduling requires. Additionally, he will have primary responsibility for the assembly of the draft report that is based upon the primary data components.

Michael A. Downs, Ph.D.
Applied Anthropologist

Vice President
Impact Assessment, Inc.
2160 Avenida de la Playa, Suite A
La Jolla, California 92037
(619) 459-0142 ph; (619) 459-9461 fax

Date of Birth: May 25, 1955 at Detroit, Michigan

Home Address: 13293 Boomer Court; San Diego, California 92129
(619) 484-4204 ph; (619) 484-3790 fax

Personal: Married Sue Ellen Vezina July 11, 1987
Daughter Lauren Wislow Downs born April 25, 1990
Daughter Keri Mariah Downs born June 5, 1991

EDUCATION

Ph.D.	Anthropology	1985	University of California, San Diego
C.Phil.	Anthropology	1982	University of California, San Diego
M.A.	Anthropology	1981	University of California, San Diego
B.A.	Anthropology	1979	University of Michigan
B.A.	Psychology	1979	University of Michigan

HONORS AND FELLOWSHIPS

1984-1985	*Leon F. Goodman Fellow*, University of California, San Diego
1983-1984	*Graduate Studies Research Fellow*, University of California
1982-1983	*Dissertation Fellow*, University of California, San Diego
1980-1983	*California State Graduate Fellow*, University of California
1979-1980	*Regents Fellow*, University of California, San Diego
1979	*Graduate with High Distinction*, University of Michigan
1979	*Class Honors*, University of Michigan

TEACHING AND WORK EXPERIENCE

1988-present	*Vice President*, Impact Assessment, Inc.
1983-1988	*Associate Director*, Impact Assessment, Inc.
1986-1987	*Lecturer in Anthropology*, University of California, San Diego.

1986 *Lecturer in Anthropology*, University of San Diego.
1985 *Instructor in Anthropology*, San Diego Mesa College.
1984 *Lecturer in Anthropology*, University of San Diego.
1981-1983 *Research Associate*, Impact Assessment, Inc.
1980-1985 *Teaching Assistant*, Dept of Anthropology, University of California, San Diego.
1980-1982 *Research Assistant*, Department of Anthropology, UCSD.
1978-1979 *Research and Teaching Assistant*, Department of Anthropology, University of Michigan--Dearborn.

RESEARCH, PROJECT MANAGEMENT, AND FIELD EXPERIENCE

1981-present San Diego
Vice President, Impact Assessment, Inc. Position includes overall project management responsibilities, recruitment and management of research teams for domestic and foreign projects, research proposal and grant preparation, field research, research and management of secondary data sources, data analysis, and research report production.

1995-present San Diego/Los Angeles
Senior Social Scientist and Project Manager for Technical Analysis of Proposed Pacific Pipeline Project: Socioeconomic Component. This project involves a socioeconomic impact analysis of a proposed crude oil pipeline through the City of Los Angeles, from the perspective of the potentially impacted publics and includes an environmental justice analysis component. This project has involved work with neighborhood and other local interest groups, and span a number of social, cultural, and ethic divisions.

1996-present San Diego/Alaska
Field researcher, analyst, and writer on USFS, Alaska Region, Chugach National Forest project to provide socioeconomic and subsistence analysis of proposed salvage timber sales. (Selected as contractor, but no task orders issued to date.)

1995 San Diego/Anchorage
Analyst for Supplemental Social Impact Assessment for the North Pacific Fishery Management Council analysis of proposed changes in bottomfish and crab regulatory schemes for the Gulf of Alaska and Bering Sea/Aleutian Islands fisheries focussing on several narrowly defined License Limitation management approach configurations. This research builds upon the earlier, more general research on broad options. The analysis looks at the distribution of impacts across industry sectors and regions, and includes Alaska Native communities spanning several regions.

1995 San Diego/Las Vegas
Senior Social Scientist on contract to assist the City of Las Vegas and the Las Vegas Historic Preservation Commission in establishing an "Old Las Vegas High School Neighborhood" Historic Preservation District. This work involved information dissemination to proposed district residents, as well as a multi-method survey and interview approach to gathering information on land owner and residents views and concerns with regard to the district and their properties.

1994 - 1995 Montana/San Diego
Field researcher, analyst, and writer on Social Assessment of the Kootenai National Forest for the U.S. Forest Service. This work involved gathering public input through extensive interviews in multiple communities on the adequacy of existing Forest management plans, current Forest use by various user groups, and response to proposed changes for future management plans in Lincoln, Sanders, Flathead, Bonner, and Boundary Counties, Montana, and contextualizing this input through ethnographic description. Responsible for field research and analysis for Sanders County field sites.

1993-present Alaska/San Diego
Field researcher, analyst, and writer on United States Department of Agriculture Forest Service (USFS), Alaska Region, Control Lake Project Environmental Impact Statement. Research activities include subsistence and socioeconomic analysis of proposed timber sale options on Prince of Wales Island in the Tongass National Forest. Contract #53-0109-3-00369/E93-B0654.

1992-present Alaska/San Diego
Field researcher, analyst, and writer on USFS, Alaska Region, Lab Bay Project Environmental Impact Statement. Research activities include subsistence and socioeconomic analysis of proposed timber sale options on Prince of Wales Island in the Tongass National Forest. Contract #53-0109-2-00344.

1990-present Nevada/San Diego
Project Manager of the Socioeconomic Impact Assessment of the Proposed High-Level Nuclear Waste Repository at Yucca Mountain, Nevada. Project is being conducted for Clark County Nevada, at the direction of the Clark County Nuclear Waste Steering Committee which is composed of representatives of both the county and its constituent municipalities. Multidisciplinary project that involves economic-demographic/fiscal, transportation, and emergency management and planning as its major analytic components. Responsible for overall project management of both field and analytic project phases, with emphasis in emergency planning and management and sociocultural analyses.

1993-1994 Alaska/Washington/Oregon/San Diego
Field researcher, analyst, and writer on North Pacific Fishery Management Council project for the Social Impact Assessment of proposed changes in

bottomfish and crab regulatory schemes for the Gulf of Alaska and Bering Sea/Aleutian Islands fisheries, including Individual Fishing Quotas (IFQs) or License Limitation management approaches. This research required the analysis of existing secondary data combined with the gathering and analysis of primary data on fisheries participation and dependency by various harvest and processing industry sectors in both Alaska and the Pacific Northwest. Conducted field research in coastal communities in Alaska, Washington, and Oregon. Presented findings to NPFMC in April, 1995.

1992-1993 North Carolina/San Diego
Project Manager, field researcher, analyst, and writer on Minerals Management Service (MMS) project to provide socioeconomic baseline characterization for subsequent impact analysis of the effects of offshore oil exploration/development on a five county region of coastal North Carolina. Work was performed under a cooperative agreement with the Institute for Coastal and Marine Resources at East Carolina University.

1990-1991 Alaska/San Diego
Field researcher, analyst, and writer on North Pacific Fishery Management Council project for the Social Impact Assessment of the Inshore/Offshore Amendment Proposal (for commercial groundfish quota allocations). Conducted project field research in Sand Point and Dutch Harbor/Unalaska, Alaska and responsible for overall study coordination and management.

1989-1990 Alaska/San Diego
Field researcher, analyst, and writer on Oiled Mayors Subcommittee, Alaska Conference of Mayors, study of the Economic, Social, and Psychological Impact Assessment of the *Exxon Valdez* Oil Spill. Responsible, in part, for field studies and analysis coordination and was primary coordinator of the project's third interim report that focussed specifically on the social and psychological impacts of the spill. Conducted field research in the communities of Kenai, Seward, Soldotna, and Valdez. Final report completed November, 1990.

1988-1990 Alaska/San Diego
Field researcher, analyst, and first author on federal MMS Socio-Economic Studies Program (SESP) project to document institutional development and change on Alaska's North Slope. Coordinated eight village study, responsible for field research in Anaktuvuk Pass and Point Hope. Project completed in May, 1990 and published as MMS SESP Technical Reports No. 141 and 143, titled Northern Institutional Profile Analysis: Chukchi Sea and Northern Institutional Profile Analysis: Bering Sea.

1987-1989 Alaska/San Diego
Field researcher, analyst, and writer on MMS SESP project to prepare an ethnography of Point Lay, Alaska including comparative material from Point

Hope, Alaska. Primary field researcher for the Point Hope portion of the study. Project completed in November, 1989 and published as MMS SESP Technical Report No. 139, titled Point Lay Case Study.

1987-1988 Washington/San Diego
Field researcher, analyst, and writer on a State of Washington project entitled Assessment of the Socioeconomic Impacts of a Potential High-Level Nuclear Waste Repository at the Hanford Site, Washington. Served in the Management as well as the Socioeconomic Group for the study.

1986-1988 San Diego
Analyst and writer on MMS SESP project to describe and analyze village economies in rural Alaska through the intensive study of three selected Alaskan villages. Published as MMS SESP Technical Report #132, titled Village Economics in Rural Alaska.

1985-1987 Alaska/San Diego
Field researcher, analyst, and writer on project to refine a sociocultural monitoring methodology to assess impacts caused by offshore oil development in Alaskan coastal regions and subsequently apply it to the Aleutian-Pribilof region. Conducted field research in Atka and Unalaska, Alaska. Published as MMS SESP Technical Report #128, titled Aleut Institutional Response and Change 1980-1985.

1986 San Diego
Analyst and writer on monitoring study of sociocultural change in Nome, Alaska titled Institutional Change in Nome 1980-1986. Published as MMS SESP Technical Report #127.

1986 Alaska/San Diego
Co-author and editor of Aleut Institutional Response and Change, 1980-1985: Workshop Proceedings. Published as MMS SESP Technical Report #126.

1985-1986 Alaska/San Diego
Field researcher, analyst, and writer on U.S. Fish and Wildlife Service study of subsistence resource utilization impacts of the Alaska Maritime National Wildlife Refuge. Project included Description of Affected Environment, Environmental Impact Statement, and ANILCA 810 Evaluation. Published in-house by the USFWS under contract #14-16-0007-85-6535.

1983-1984 San Diego
Writer on Ethnographic Studies of the Bristol Bay Alaska Region. Assistant in the analysis and write-up of these materials. Study focused on interaction of fisheries and offshore oil and gas development. Published as MMS SESP Technical Report #103.

1983 Alaska
Field research for Doctoral Dissertation titled "Sociocultural Change and Ethnic Identity: The Effect of the Alaska Native Claims Settlement Act in Unalaska, Alaska." Unpublished Ph.D. Dissertation: University of California (1985).

1982-1983 Alaska/San Diego
Field researcher and writer on MMS Ethnographic Study of Unalaska, Alaska. Responsible for four months of field data collection and assistance in the analysis and write-up of these materials. Baseline study to document the community structure in the exploration phase of offshore oil development. Published as MMS SESP Technical Report #92.

1982 San Diego
Research Assistant to Prof. Marc J. Swartz, Dept. of Anthropology, Univ. of Calif., San Diego. Collected and analyzed data on cultural sharing among voluntary associational groups in San Diego.

1981-1982 San Diego
Researcher and writer on Bureau of Land Management Non-OCS Forecast Analysis of the North Aleutian Shelf offshore oil lease sale. Position involved collection and analysis of published, unpublished and field materials on communities of the southern Alaska Peninsula area. Published as BLM (later MMS SESP) Technical Report #75.

1980-1981 San Diego
Masters thesis research on the cross-cultural study of expressive behavior. Case study of the relationship between cultural change and expressive behavior change over three generations of Canadian Inuit. Unpublished MA Thesis: University of California.

1980-1981 San Diego
Research Assistant to Prof. Marc J. Swartz, Dept. of Anthropology, Univ. of Calif., San Diego. Analyzed field data on the impact of culture change on family structure, and differential individual and status group perception of change among the Swahili of Mombasa, Kenya.

JOURNAL ARTICLES

1996 Russell, John C., Michael A. Downs, John S. Petterson, and Lawrence A. Palinkas. Psychological and Social Impacts of the *Exxon Valdez* Oil Spill and Cleanup. In Proceedings of the *Exxon Valdez* Symposium, American Fisheries Society (in press).

1993 Palinkas, Lawrence A., Michael A. Downs, John S. Petterson, and John C. Russell. Social, Cultural, and Psychological Impacts of the *Exxon Valdez* Oil Spill. Human Organization, 52:1:1-13.

1993 Palinkas, Lawrence A., John S. Petterson, John C. Russell, and Michael A. Downs. Community Patterns of Psychiatric Disorder after the *Exxon Valdez* Oil Spill. American Journal of Psychiatry.

1992 Palinkas, Lawrence A., John C. Russell, Michael A. Downs, and John S. Petterson. Ethnic Differences in Stress, Coping, and Depressive Symptoms after the *Exxon Valdez* Oil Spill. Journal of Nervous and Mental Disease, 180:287-295.

CONSULTING EXPERIENCE

1992-1994 Alaska/San Diego
Provided research and analytic services, through Expert Support Services, regarding *Exxon Valdez* oil spill impact assessments.

Michael Galginaitis
Sociocultural Anthropologist

Research Associate/Site Manager
Impact Assessment, Inc
911 West 8th Avenue, Suite 402
Anchorage, Alaska 99501
(907) 272-6811 phone
(907) 272-9558 fax

Address: 1652 Sunrise Drive
Anchorage, Alaska 99508
(907) 279-7428

FORMAL EDUCATION

1975-present State University of New York at Binghamton
ABD 1978, Anthropology

1969-1973 The Johns Hopkins University
BA 1973, Social and Behavioral Sciences

HONORS AND AWARDS

1969-1973 Alfred P. Sloan Foundation Scholarship
1975-1980 Graduate and Teaching Assistantships, SUNY Binghamton

RESEARCH AND FIELD EXPERIENCE

01/95-04/95 Alaska
Proposal developer, primary analyst and author on a small add-on project to IAI's previous License Limitation study for the North Pacific Fishery Management Council. This is essentially the development of a reasonable brief assessment of the social effects upon fishing industry sectors of three specific alternatives for a license limitation plan. No new data were gathered for this project. Rather, it reworks previously collected data and statistical records. Clarence Pautzke, Executive Director, is the COAR.

11/94 - Alaska
Proposal developer, field worker, analyst, and author for IAI on the Swan Lake-Lake Tyee Transmission line EIS project. Foster-Wheeler Environmental (formerly Ebasco) is the prime contractor, with IAI as the subcontractor responsible for describing subsistence use in the project area and analyzing potential effects upon subsistence users. The project area is primarily Forest Service land, so the project is very similar to our other Forest Service projects. Ellen Hall, Bellevue, is the project manager.

10/94-03/96 Alaska
Proposal developer, field researcher, analyst, and author for the Kenai Fjords National Park Ethnographic Overview and Assessment, Phase I. This is a project to document land use in Kenai Fjords National Park through recorded interviews with Alaskan Natives, primarily in Port Graham and Nanwalek. The intention is to determine how much oral tradition and memory culture relating to the park exists and to plan for its documentation. Past subsistence activities are one aspect of this, within the context of overall use patterns (habitation, employment in the historical period, and so on). Sponsored by the National Park Service, Tim Cochrane serving as COAR.

10/94-03/95 Alaska
Proposal developer, field researcher, analyst, and writer for a pilot project investigating the acceptability of various safety devices to fishermen in Alaskan fisheries. The pilot study is to essentially develop the methodology to be used as well as a practical exercise to see if fishermen will cooperate and to determine if useful information can be developed. National Institute of Occupational Safety and Health (NIOSH) is the sponsor, Dr. George Conway serving as COAR.

12/93-10/94 Alaska/ lower-48
Field researcher, data analyst, and writer on North Pacific Fisheries Management Council project assessing the social impacts of alternative management plans for the groundfish fishery in the Bering Sea and Gulf of Alaska (License Limitation and Individual Fishing Quota Management Options).

05/93- Alaska
Primary researcher, analyst, and writer for the preliminary subsistence component of the Forest Service EIS for the Control Lake (Prince of Wales Island, Southeast Alaska) project. Ebasco Environmental is the prime contractor.

05/92- Alaska
Primary researcher, analyst, and writer for subsistence component of the Forest Service EIS for the Lab Bay (Prince of Wales Island, Southeast Alaska) project. Harza NW is the prime contractor. IAI also contributes to the analysis of other potential socioeconomic effects (in cooperation with Harza NW economists), and shares responsibility for the public participation process.

10/90- Alaska
Site Manager for Anchorage office, Impact Assessment, Inc. Responsible for everyday operation of office, liaison with Alaska organizations and institutions, and development and preparation of proposals.

1990-02/91 Alaska/lower-48
Field researcher, data analyst, and writer on North Pacific Fisheries Management Council project assessing the social impacts of alternative management plans for the groundfish fishery in the Bering Sea and Gulf of Alaska (Inshore/Offshore Regulatory Amendments).

1990 Alaska/San Diego
Field researcher, data analyst, and writer on federal MMS SESP project titled Subsistence-Harvest Areas, Part B (Nuiqsut) to document subsistence-harvest patterns in Nuiqsut, Alaska.

1990 Alaska/San Diego
Field researcher, data analyst, and writer on federal MMS SESP project titled Subsistence-Harvest Areas, Part C (Kaktovik) to document subsistence-harvest patterns in Kaktovik, Alaska.

1989-1990 Alaska/San Diego
Data analyst for village level trends for the study "Economic, Sociological, and Psychological Impacts of the *Exxon Valdez* Oil Spill."

1989 Alaska/San Diego
Field researcher and writer on federal Minerals Management Service (MMS) Socio-Economics Studies Program (SESP) project on Social Indicators to document community and household change in Alaska. Primary responsibility for the North Slope, with field research in Point Hope, Wainwright, Barrow, Nuiqsut, and Kaktovik.

1988-1990 Alaska/San Diego
Field researcher, data analyst, and writer on federal MMS SESP project titled Northern Institutional Profile Analysis to document institutional development and change on Alaska's North Slope. Conducted research in Point Hope, Point Lay, Wainwright, Barrow, Nuiqsut, and Kaktovik with primary project responsibilities for Point Lay, Wainwright, and Nuiqsut. Shared primary responsibility for Barrow.

1987-1989 Alaska/San Diego
Field researcher, data analyst, and writer on federal MMS SESP titled Point Lay Case Study to prepare an ethnography of Point Lay, Alaska, including comparative material from Point Hope, Alaska. Primary researcher for Point Lay,

secondary researcher for Point Hope. Additional interviews with key people in Barrow and Anchorage, archival work in Barrow and Fairbanks.

1987- San Diego/Anchorage
Research Associate for Impact Assessment, Inc. Position includes proposal and grant development and preparation, field and archival research, data analysis, and report preparation.

1985-1986 New York
Field worker for the Public Archaeological Facility, SUNY-Binghamton. Followed research design to recognize, recover, and document archaeological artifacts and features in various locations of New York State. Also training and supervision of less experienced workers.

1985 Alaska/Binghamton (NY)
Field researcher, data analyst, and writer on federal MMS SESP titled Aleut Institutional Response and Change 1980-1986 to refine a sociocultural monitoring methodology to assess impacts caused by offshore oil development in Alaskan coastal regions and to subsequently apply it to the Aleutian-Pribilof region. Primary responsibility for the North Slope (Nuiqsut) pretest of the methodology before the application to the Aleutian-Pribilof region.

1982-1984 Alaska/Binghamton
Field researcher, data analyst, and writer on federal MMS SESP titled Ethnographic Study and Monitoring Methodology of Contemporary Economic Growth, Socio-Cultural Change, and Community Development in Nuiqsut, Alaska to prepare an ethnography of Nuiqsut, Alaska and contribute to the development of a methodology to monitor change in Alaska.

1981-1982 Binghamton
Field worker for the Public Archaeological Facility, SUNY-Binghamton. Followed research design to recognize, recover, and document archaeological artifacts and features in various locations of New York State.

1977 Afton/Bainbridge/Binghamton
Field researcher and graduate advisor for an NSF funded student-initiated research project titles Social Impact Assessment: Methods and Practice to assess the effects of the construction of Interstate-88 on selected communities in New York State. Responsible for public relations, interviewing, participant observation, documentary research, and progress report writing.

1973-1975 Jamestown (ND)
Social Insurance Representative for the Social Security Administration in the Jamestown, North Dakota, branch office. Interviewed claimants, assisted

beneficiaries, served as liaison with the North Dakota Mental Hospital at Jamestown.

PUBLICATIONS

Galginaitis, Michael; Claudia Chang; Kathleen M. MacQueen; Albert A. Dekin, Jr.; and David Zipkin

1984 Ethnographic Study and Monitoring Methodology of Contemporary Economic Growth, Socio-Cultural Change and Community Development in Nuiqsut, Alaska. Social and Economic Studies Program Technical Report No. 96. Alaska OCS Region, Minerals Management Service: Anchorage.

Impact Assessment, Inc. (Galginaitis sole or first author)

n.d. Subsistence Resource Inventory Report: Control Lake Timber Sale. Draft, in preparation for the U.S. Forest Service, Ketchikan office, Alaska.

n.d. Draft "Subsistence" section for Draft Environmental Impact Statement, Control Lake Timber Sale. USDA, U.S. Forest Service, Ketchikan office, Alaska.

n.d. Draft "Subsistence" section for Draft Environmental Impact Statement, Lab Bay Timber Sale. USDA, U.S. Forest Service, Ketchikan office, Alaska.

1993 Subsistence Resource Inventory and Environmental Consequences Report: Lab Bay Timber Sale. USDA, U.S. Forest Service, Ketchikan office, Alaska.

1990 Subsistence Resource Harvest Patterns: Nuiqsut. Social and Economic Studies Program Special Report No. 8. Alaska OCS Region, Minerals Management Service: Anchorage.

1990 Subsistence Resource Harvest Patterns: Kaktovik. Social and Economic Studies Program Special Report No. 9. Alaska OCS Region, Minerals Management Service: Anchorage.

1989 Point Lay Case Study. Social and Economic Studies Program Technical Report No. 139. Alaska OCS Region, Minerals Management Service: Anchorage.

1985 Summary: Nuiqsut field investigation, November 1985 in Workshop Proceedings: Monitoring Sociocultural and Institutional Change in the Aleutian-Pribilof Region. Alaska OCS Sociocultural Studies Program Technical Report No. 126. Alaska OCS Region, Minerals Management Service: Anchorage.

Impact Assessment, Inc. (Galginaitis one of several primary authors)

1994 Supplemental Social Impact Assessment of the North Pacific Fishery Management Council Specified License Limitation Options for the North Pacific Groundfish and Crab Fisheries, Revision 1.1. Submitted to the North Pacific Fishery Management Council.

1994 Sector Description and Preliminary Social Impact Assessment of the North Pacific Fishery Management Council Regulatory Changes in the Groundfish and Crab Fisheries of the Gulf of Alaska and Bering Sea/Aleutian Islands. Submitted to the North Pacific Fishery Management Council.

1991 Community Profiles Developed for the Social Impact Assessment of the Inshore/Offshore Amendment Proposal. Submitted to the North Pacific Fishery Management Council.

1990 Northern Institutional Profile Analysis: Chukchi Sea. Social and Economic Studies Program Technical Report No. 141. Alaska OCS Region, Minerals Management Service: Anchorage.

1990 Northern Institutional Profile Analysis: Beaufort Sea. Social and Economic Studies Program Technical Report No. 142. Alaska OCS Region, Minerals Management Service: Anchorage.

PAPERS PRESENTED

1994 Subsistence Deer Harvest Patterns for Residents of Klawock, Alaska: An Empirical Case and Speculative Implications. Presented at the Alaska Anthropological Association meetings in Juneau, Alaska (04/02/94). Based on the Control Lake/Lab Bay subsistence work for the Forest Service.

TEACHING EXPERIENCE

Primitive Religion
Introduction to Anthropology
Anthropology Through Film
Anthropology Through Science Fiction

John C. Russell, Ph.D.
Impact Assessment, Inc.
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Placerville, CA 95667
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office (916) 622-8179

EDUCATION

1979 Ph.D. in Cultural and Psychological Anthropology University of California, San Diego.

1976 Candidate in Philosophy in Anthropology, University of California, San Diego.

1973 Master of Arts in Anthropology University of California, San Diego

1972 Bachelor of Arts with High Honors in Anthropology University of California, San Diego.

SPECIALIZED TRAINING

Post-Doctoral Training and Research in Cultural Psychiatry and Medical Anthropology, School of Medicine, Department of Psychiatry, University of Hawaii, Manoa

Training in Psychological Testing, School of Medicine, Department of Psychiatry, University of California San Diego

Training in Psychiatry, Including In-Patient, Out-Patient, Consultation Liaison, and Emergency Room Services

CURRENT POSITION

1989 - Vice-President for Research and Senior Research Scientist, Impact Assessment, Incorporated La Jolla, California

RESEARCH EXPERIENCE

1994-1995 Principal Investigator and Project Manager for research regarding the social impacts of Forest Management Plans for the Kootenai National Forest, Montana. Designed and conducted multi-method data collection including key-person interviews, participant observation, review of historical records, Forest Service Archives, and secondary source materials. Analysis focused on the relationship of

social context to public assessments of natural resources in two Montana counties and evaluation of their management by the Forest Service.

1993- Participated in the study design and data collection research regarding the social impacts of proposed fishery management strategies for groundfish and crab species in the Bering Sea and Gulf of Alaska regions. Had primary responsibility for conducting key-person interviews and focus groups with individuals from all levels of the fishing industry for Kodiak, Island and for the factory trawler fleet in Seattle.

1990-1995 Director for the sociocultural research program for IAI's study of the socioeconomic impacts related to locating a high-level nuclear waste repository at Yucca Mountain, Nevada. Designed and implemented the studies of possible transportation impacts and designed and implemented studies to assess the perceptions of risk among urban and rural residents in Clark County, Nevada. Designed, implemented, and analyzed a survey of residents regarding their evaluations of risk-related issues; conducted key-person interviews, and designed and analyzed structured elicitation methods to collect cultural data regarding risk perceptions and evaluations of environmental resources at risk.

1992-93 Participated in the design and implementation of research regarding the socioeconomic baseline conditions in rural coastal counties of North Carolina potentially affected by development of offshore gas and oil. Developed formal elicitation protocols for assessing environmental resources at risk and conducted key-person interviews with government officials, business leaders, and community representatives.

1989-93 Project Manager for Research regarding the social, psychological, and economic impacts of the *Exxon Valdez* oil spill and cleanup. Designed and implemented a survey of about 800 households affected by the oil spill to assess the relationship between exposure to the spill and social disruption and psychological conditions (PTSD, Depression, Anxiety). Designed and implemented key-person interviews with officials of local government affected by the oil spill. Developed procedures to collect government records and archives to assess any spill-related damages. Developed and conducted key-person interviews with community leaders, fishermen, and other affected by the oil spill. Assisted with developed of procedures to assess private and public sector economic and fiscal impacts.

1987-88 Manager of Field Studies for research regarding socioeconomic impacts of locating a high level nuclear waste repository at the Hanford Nuclear Reservation, Richland, Washington. Coordinated field data collection among a team of multidisciplinary researchers investigating social, economic, and risk-related issues concerning the Hanford site. Conducted key-person interviews with local government officials, residents, and community leaders. Conducted archival

research with records of the local historical society and in local government archives.

1984-87 Project Manager for a state-wide program investigating the relationship between environmental factors and birth outcomes. Participated in the overall design of the scientific and administrative structure of the program. Hired and constructed training programs for research and administrative staff, established personnel policies and procedures, constructed and managed an annual budget of 5.3 million dollars, and managed the implementation of data collection and quality control procedures for in 52 California counties. Participated in the design of special study questionnaires to investigate clusters of birth defects and coordinated the activities of staff epidemiologists, biostatisticans, medical archivists, biologists, and physicians. Managed the organization of resources and coordination of staff activities for more than 30 special studies of suspected clusters of birth defects in California.

1987 As Director of Environmental and Epidemiological Studies at the Health Officers Association of California, developed and implemented the first program to investigate childhood lead poisoning in California. Hired and managed the staff, and assisted in the design and implementation of a survey of California residents regarding child exposure to lead sources. Also, assisted in the design and implementation of studies to investigate the relationship between adverse reproductive outcomes and residence near Superfund toxic sites in the Santa Clara Valley, California; the public health implications of agricultural drainage water contamination at the Kesterson Wildlife Refuge in the Central Valley of California, and studies of the development and implementation of management systems and program performance standards in local health departments in California.

1983-84 Principal Investigator and Project Manager for a social and cultural study of the Division of Child Psychiatry at the Neuropsychiatric Institute, University of California, Los Angeles. The study used survey, key-person interviews, direct observation methods, participant observation, and review of archival materials to investigate the relationships among management style, organizational structure, and delivery of patient care by the 500 person staff. Provided consultation to the Chief of the Division regarding management issues in patient care and staff management.

1980-83 As Research Anthropologists in the Departments of Psychiatry and Family Practice at the University of California, Davis. Had primary responsibility for implementing ethnographic and survey methods to investigate the social organization and nature of social support in rural California ranching, farming, and timer communities. Conducted 18 months of continuous field work in Shasta, Lassen, Colusa, and Mendocino Counties. Methodologies used included participant-observation, key-person interviews, formal elicitation techniques,

surveys, review of historical archives, and oral history interviews. The study developed the relationships among rural culture and social organization, family relationships, and the management of psychosocial distress. The results of this study were used to develop a training program for psychiatry and family residents to treat rural patients more effectively.

1979-80 As a Post-Doctoral Fellow in Psychiatry and Medical Anthropology, conducted a 10 month study of the social and cultural factors affecting the post-war adjustment problems of Vietnam combat veterans. The research analyzed clinical and life-history data to examine relationships among social organization, cultural ideals, and post-war social experiences that affected the post-war adjustment of combat veterans. Under clinical supervision, conducted individual and group therapy sessions. Participated in clinical review of patients and contributed an anthropological perspective regarding patient care issues.

1976-78 Ph.D. dissertation research (18 months) in a Gaelic speaking community in western Ireland. The research investigated the social organization and cultural of rural Irish communities and specifically the relationships among family interaction, personality development, and religious belief and practices.

1976 Research concerning the social organization and shamanistic practices of a Himalayan tribal people in Nepal (dissertation research interrupted by illness).

1974 Research concerning the religious beliefs and reincarnation behaviors of Tibetan and Indian peoples in Nepal and India with professor Ian Stevenson, Department of Psychiatry, University of Virginia.

SELECTED PUBLICATIONS, REPORTS, AND PRESENTATIONS

1995 Invited Presentation for the Montana Community for the Humanities, University of Montana: Changing Direction in the Articulation of Culture and Social Organization of Timber-Dependent Communities in Northwestern Montana.

1995 Social Assessment of the Kootenai National Forest. Principal Author of a Final Report prepared for the U.S. Forest Service, Libby, Montana.

1995 Russell, John, et al. Social Disruption and Psychological Impacts of the *Exxon Valdez* Oil Spill. Journal of Fisheries Research (in press).

1994 Final Report, Social Impact Assessment of the North Pacific Groundfish Fishery in Alaska, Washington, and Oregon. (Contributing Author)

1994 Sociocultural Assessment of Risk-Related Impacts Related to the Proposed High-Level Nuclear Waster Repository Yucca, Mountain, Nevada. (Principal Author).

1993 Russell, John, Downs, Michael, and Palinkas, Lawrence. The Social and Psychological Impacts of the *Exxon Valdez* Oil Spill. Principal Author of a Manuscript prepared for litigation related to the *Exxon Valdez* oil spill.

1993 Palinkas, LA, Downs, MA, Petterson, JS, and Russell, J. Social, Cultural, and Psychological Impacts of the *Exxon Valdez* Oil Spill. Human Organization. 52:1:1-13.

1993 Palinkas, LA, Petterson, JS, Russell, J, and Downs, MA. Community Patterns of Psychiatric Disorder after the *Exxon Valdez* Oil Spill. American Journal of Psychiatry. Accepted for Publication.

1992 Palinkas, LA, Russell, J, Downs, MA, and Petterson, JS. Ethnic Differences in Stress, Coping, and Depressive Symptoms after the *Exxon Valdez* Oil Spill. Journal of Nervous and Mental Disease, 180:287-295.

1992 The Culture of Chaos and the *Exxon Valdez* Oil Spill. Presentation at the Annual Meetings of the American Anthropological Association.

1992 Final Systems Development Report for the Clark County Socioeconomic Impact Assessment of the Proposed High Level Nuclear Waste Repository at Yucca, Mountain. Technical Report Submitted to the Clark County Nuclear Waste Division, Clark County, Nevada. (Contributing Author)

1991 Final Base Case Analysis for the Clark County Socioeconomic Impact Assessment of the Proposed High Level Nuclear Waste Repository at Yucca, Mountain. Technical Report Submitted to Clark County Nuclear Waste Division, Clark County, Nevada. (Contributing Author)

1991 Ethnic Issues in Post-Traumatic Stress Disorder Following the *Exxon Valdez* Oil Spill. Presentation at the Annual Meetings of the Society for Applied Anthropology.

1991 Implications for Social Scientists for the Investigation of Traumatic Events: The Case of the *Exxon Valdez* Oil Spill. Presentation at the Annual Meetings of the American Anthropological Association.

1990 Cultural Issues in Sociocultural and Psychological Impacts Following the *Exxon Valdez* Oil Spill. Presentation at the Annual Meetings of the American Anthropological Association.

1990 Community Disruption Following the *Exxon Valdez* Oil Spill and Cleanup. Presentation at the Annual Meetings of the American Association for the Advancement of Science, Arctic Division.

1990 Final Report: The Economic, Social, and Psychological Impacts of the *Exxon Valdez* Oil Spill. Technical Report Submitted to the Oiled Mayors, A Sub-Committee of the Alaska Conference of Mayors. (Principal Author).

1990 Interim Report: The Social and Psychological Impacts of the *Exxon Valdez* Oil Spill. Technical Report Submitted to the Oiled Mayors, A Sub-Committee of the Alaska Conference of Mayors. (Contributing Author).

1990 Interim Report: Public and Private Sector Impacts of the *Exxon Valdez* Oil Spill. Technical Report Submitted to the Oiled Mayors, A Sub-Committee of the Alaska Conference of Mayors. (Contributing Author).

1990 Northern Institutional Profile Analysis: Chukchi Sea and Northern Institutional Profile Analysis: Bering Sea. Technical Report for the Minerals Management Service, Department of Interior. (Contributing Author).

1988 Studying Clusters of Birth Defects in California. A Report for the California Department of Health Services.

1988 Program Update, Special Studies of Birth Defects in California. A Report for the California Department of Health Services.

1987 Implementation of the California Birth Defects Monitoring Program. A Report for the California Department of Health Services.

1985 Cooperative Negotiations: Improving Program Performance in Local Health Departments in California. Report Prepared for the California Department of Health Services.

1984 An Ethnographic Report on Areas of Organizational Dysfunction in an Academic Medical Center. Report submitted to the University of California Los Angeles School of Medicine, Division of Child Psychiatry.

1984 Family Experience and Folk Catholicism in Rural Ireland. The Journal of Psychoanalytic Anthropology.

1983 Responsibilities of Anthropologists in Psychiatric Clinical Settings. Human Organization. Winter.

1983 The Ethnography of Northeastern California Ranching Communities: The Implications For Social Support Systems. A Final Report from the University of California Davis to the National Institute of Mental Health.

1982 Social Organization and Mental Health. Invited Presentation, University of California, Davis, School of Medicine Psychiatry Residency Training Program.

1982 Clinical Implications of Care-Giving to Rural Residents. Invited Presentation, University of California, Davis School of Medicine, Residency Training Program.

1981 "You Have to be Cruel to be Kind": Emotional Styles in Rural Irish Farm Families. Paper presented at the Annual Meetings of the American Anthropological Association.

1980 The Couch in the Field: Comments on Clinical Anthropology." Medical Anthropology Newsletter. November, 1980.

1980 Discontinuities Between Self-Concept and Social Identity Among Vietnam Combat Veterans. Paper presented at the Annual Meetings of the American Anthropological Association, Washington, D.C.

1979 A Psychocultural Interpretation of Irish Catholic Penitential Pilgrimage. Paper prepared for the Annual Meetings of the American Anthropological Association, Cincinnati, Ohio.

1979 In The Shadows of Saints: Aspects of Family and Religion in a Rural Irish Gaeltacht. Ph.D. dissertation, University of California, San Diego.

1978 Strangers and Neighbors: Dimensions of Moral Community in Rural Ireland. Paper presented at the Annual Meetings of the American Anthropological Association, Los Angeles.

CONSULTING POSITIONS

1992-93 Consultant, Expert Support Services Concerning Psychosocial, Municipal and other impacts related to the *Exxon Valdez* oil spill and cleanup.

1987 Consultant to Impact Assessment, Incorporated concerning management of field studies for the study of impacts related to locating a high-level nuclear waste repository at the Hanford Site, Richland, Washington.

1987 Consultant, to the March of Dimes for preparation of proposals and research and management proposals.

1984 Consultant to the Health Officers Association for preparation of research and management proposals.

EMPLOYMENT

1989 - Vice-President for Research and Senior Research Scientist, Impact Assessment, Incorporated, La Jolla, California.

1988-89 Program Manager, California Birth Defects Monitoring Program; Assistant Director For Environmental and Epidemiological Studies

1987-88 Private Consulting

1985-87 Director for Environmental and Epidemiological Studies. Health Officers Association.

1983-84 Principle Public Administration Analyst, Department of Child Psychiatry, Neuropsychiatric Institute, University of California, Los Angeles.

1981-83 Research Anthropologist, Departments of Psychiatry and Family Practice, School of Medicine, University of California, Davis.

1979-80 Post-Doctoral Research Fellow in Psychiatry and Anthropology, Department of Psychiatry, University of Hawaii, Manoa.

TEACHING EXPERIENCE

1981-83 Seminar series for Family Practice Residents concerning psychosocial factors in the delivery of health care in rural California.

Lectures on concepts of culture and socio-cultural factors affecting health and illness. Independent Study in Psychological Anthropology for graduate students, School of Medicine, University of California, Davis.

1980 Introduction to Culture and Psychiatry in the Psychiatry Clerkship for Medical Students, University of Hawaii.

1978-79 Instructor in English Composition, University of California San Diego.

1978 Instructor in Anthropology for courses in Introduction to Cultural Anthropology, Thomond College, Limerick, Ireland.

PROFESSIONAL ASSOCIATIONS

American Anthropological Association
Society for Urban Anthropology
Society for Cultural Anthropology
Society for Psychological Anthropology
Society for Medical Anthropology
Society for Applied Anthropology (Fellow)
National Association for the Practice of Anthropology
American Association for the Advancement of Science

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

Budget Category:	Authorized FFY 1996	Proposed FFY 1997						
Personnel		$203.0						
Travel		$13.8						
Contractual		$2.8						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$219.6	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Indirect		$0.0						
Project Total	$0.0	$219.6						
Full-time Equivalents (FTE)		16.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

Personnel hours includes 120 hours for peer-review publication preparation; Personnel rates include indirect costs.

Contractual costs include $1000 for publication of the final report. This is based on estimates obtained for 32 copies of a 200 page double-sided report, perfect bound and 4 single-sided unbound, camera-ready copies.

Travel and personnel costs reflect the attendence of the PI at two restoration workshops as well as one technical review session. We have treated these all as FY97 expenditures, although one of the workshops will actually occur during FY98. If this needs to be changed, we will do so. It was done for the purposes of simplicity, as this would be the ONLY continuing expense for this project, which is otherwise totally confined to FY97. Also, note that travel costs do not include travel to professional meetings to present the findings, other than for Trustee Council sponsored events.

Personnel costs reflect the division of repsonsibilities discussed in the proposal. It is anticipated that these could shift somewhat, dependent upon other projects. While each of the proposed researchers has a unique combination of skills and expertise, each is capable of all tasks required for this project and could substitute for any of the others. Any shift in personnel hours will be accomplished within the budget and would not increase costs.

1997

Prepared: 04/15/96

Project Number: 97 _ _
Project Title: Restoration of Commercial Fishing Services: The Social Ecology of the Herring Fishery in PWS
Name: Impact Assessment, Inc.

FORM 4A
Non-Trustee
SUMMARY

4/11/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FFY 1997
Michael S. Galginaitis	Field Researcher/Analyst		6.0	10.1	0.0	60.6
Michael A. Downs, Ph.D.	Project Manager		5.3	12.6	0.0	75.6
John C. Russell, Ph.D.	Field Researcher/Analyst		4.7	12.6	0.0	66.8
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		16.0	35.3	0.0	
					Personnel Total	$203.0

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FFY 1997
San Diego - Anchorage, 2 workshops 1 tech. review		0.5	3	13	0.1	2.8
San Diego - Anchorage, field work no per diem, not end pt.		0.5	4	0		2.0
Anchorage - Juneau CFEC coordination		0.4	1	3	0.1	0.7
Anchorage - Kodiak fieldwork		0.2	2	6	0.1	1.0
Anchorage - Cordova fieldwork		0.2	4	56	0.1	6.4
Anchorage - Seward (car) fieldwork		0.0	1	3	0.1	0.3
Anchorage - Homer (car) fieldwork		0.0	2	6	0.1	0.6
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$13.8

1997

Prepared: 04/15/96

Project Number: 97 _ _
Project Title: Restoration of Commercial Fishing Services: The Social Ecology of the Herring Fishery in PWS
Name: Impact Assessment, Inc.

FORM 4B
Personnel
& Travel
DETAIL

4/11/96

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

Contractual Costs:	Proposed
Description	FFY 1997
Rental Car, 2 weeks (Homer/Seward fieldwork)	0.3
Rental Car, Cordova fieldwork (4 weeks, not entire field period)	1.0
CFEC data (confidential requiring that CFEC do the preliminary work)	0.5
Final report (printing, binding, mailing -- see comment on summary form)	1.0
Contractual Total	$2.8

Commodities Costs:	Proposed
Description	FFY 1997
None (included in "indirect costs")	
Commodities Total	$0.0

1997

Prepared: 04/15/96

Project Number: 97 _ _
Project Title: Restoration of Commercial Fishing Services: The Social Ecology of the Herring Fishery in PWS
Name: Impact Assessment, Inc.

FORM 4B
Contractual & Commodities DETAIL

4/11/96

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

New Equipment Purchases:	Number	Unit	Proposed
Description	of Units	Price	FFY 1997
None			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$0.0

Existing Equipment Usage:	Number	
Description	of Units	
IAI property only		
Desk Computers	4	
Laptop Computers	3	

1997

Prepared: 04/15/96

Project Number: 97 _ _
Project Title: Restoration of Commercial Fishing Services: The Social Ecololgy of the Herring Fishery in PWS
Name: Impact Assessment, Inc.

FORM 4B
Equipment
DETAIL

4/11/96

A Genetic Study to Aid in Restoration of Murres, Guillemots and Murrelets to the Gulf of Alaska; Submitted Under the BAA

Project Number:	97169-BAA
Restoration Category:	Research (new)
Proposer:	Queen's University (V.L. Friesen) & DOI (J.F. Piatt)
Lead Trustee Agency:	
Cooperating Agencies:	
Alaska SeaLife Center:	
Duration:	1st year, 4-year project
Cost FY 97:	$141.7
Cost FY 98:	$133.9
Cost FY 99:	$131.9
Cost FY00:	$17.1
Geographic Area:	Gulf of Alaska and neighboring areas
Injured Resource:	common murre, pigeon guillemot, marbled and Kittlitz's murrelets

ABSTRACT

Populations of common murres, pigeon guillemots, and marbled and Kittlitz's murrelets from the Gulf of Alaska are failing to recover from the *Exxon Valdez* Oil Spill. We propose to use state-of-the-art genetic techniques to aid in their restoration by 1) determining the geographic limits and structure of populations, i.e. the extent to which colonies are genetically isolated or comprise metapopulations, 2) detecting cryptic species and subspecies, 3) identifying sources and sinks, 4) providing genetic markers for the identification of breeding populations of birds killed by the Spill, 5) identifying appropriate reference or 'control' sites for monitoring or reintroductions, and 6) determining the role of inbreeding and small effective population sizes in restricting recovery.

INTRODUCTION

Common murres (*Uria aalge)*, pigeon guillemots (*Cepphus columba*), marbled murrelets (*Brachyramphus marmoratus*) and Kittlitz's murrelets (*B. brevirostris*) apparently are not recovering from the the *Exxon Valdez* Oil Spill. An understanding of the geographic structure and dynamics of their populations is critical for their restoration. Although the term *population* commonly is used to refer to any group of organisms, it is defined biologically as a group of organisms that share a common gene pool due to interbreeding. A population may consist of several localized subpopulations, such as colonies of seabirds. If gene flow among colonies is low, either because levels of dispersal are low (Cairns and Elliot 1987) or because immigrants have low fitness, populations will comprise colonies; if dispersal is more widespread, then populations may include several colonies within a region. For example, colonies of thick-billed murres (*Uria lomvia*) within the North Atlantic appear to constitute a single panmictic population that is genetically isolated from colonies in the North Pacific (Birt-Friesen et al. 1992). Some species, such as many gulls and cormorants, appear to comprise 'metapopulations' - networks of subpopulations that disappear naturally and are recolonized by immigrants from other sites over time periods ranging from a few generations to tens of thousands of years. Generally, subpopulations of a metapopulation are geographically isolated but exchange migrants on either a regular or intermitant basis (Levins 1969). In some species, individual subpopulations may constitute 'sources' or 'sinks': subpopulations in optimal sites have high productivities and low mortalities, and act as net exporters or 'sources' of breeders for other sites; sink populations occur in suboptimal habitats and have low productivities, so require immigration to maintain their numbers (Pulliam 1994). For example, the colony of ancient murrelets (*Synthliboramphus antiquus*) on Reef Island may act as a source of immigrants maintaining the colony at Limestone Island, where predation by raccoons and rats is high (A.J. Gaston, pers. comm.).

Information about the geographic structure and dynamics populations is needed for restoration for several reasons.

Definition of the geographic limits and genetic structure of populations.-Genetic data enable identification of the extent to which colonies represent genetically isolated populations. If colonies of murres, murrelets and guillemots that were affected by the *Exxon Valdez* Oil Spill are essentially panmictic and/or constitute metapopulations, they should recover without assistance within a number of generations. For example, double-crested cormorants (*Phalacrocorax auritus)* have recolonized many sites from which they were extirpated by pesticides in the 1950-1960s. However, if colonies constitute numerous localized populations, they probably will not naturally recolonize sites affected by the Spill, and will require human assistance for recovery. For example, common murres have failed to repopulate colonies in southern Quebec from which they were extirpated by egging and shooting in the late 1800s and early 1900s (e.g. Tuck 1961). Genetic isolation of colonies may explain why common murres are not recovering from the Spill.

Identification of population uniqueness and cryptic species.-A colony's uniqueness (e.g. its endemicity or genetic distinctiveness) may be used to priorize restoration efforts. Most importantly, genetic data enable the identification of cryptic species - populations that are similar in appearance but that represent separate, non-interbreeding species. For example, genetic comparisons revealed that North American and Asiatic subspecies of the marbled murrelet actually represent reproductively distinct species that have been genetically isolated for 5-6 million years (Friesen et al. accepted). These two taxa therefore must be managed independently.

Preliminary data also suggest that Kittlitz's murrelets from Kachemak Bay are highly divergent from those from Attu Island, and that the two populations may represent cryptic subspecies or species.

Identification of sources and sinks.-Genetic data can provide measurements of rates of immigration into and emigration out of colonies, and thus enable identification of sources and sinks. If colonies affected by the Spill represent sources, then their restoration will be critical. For example, protection of the ancient murrelet colony on Reef Island may be essential to the longevity of the local population of murrelets. If a colony represents a sink, its restoration may be a waste of resources and may actually prevent recovery of the overall population.

Environmental impact assessment.-Genetic data provide markers that enable identification of breeding populations of birds killed by the Spill. Many seabirds caught in the *Exxon Valdez* Oil Spill were migrating: the 'affected' zone, or the populations that were affected by the Spill and require restoration effort, may be geographically distant from the actual Spill zone. Identification of the breeding sources of these birds will clarify the impacts of the Spill. This is especially important because several local populations appeared to be declining before the accident, and the relative importance of the Spill versus other environmental effects (such as prey availability) on population decline and recovery is unclear.

Environmental monitoring.-Genetic data enable identification of appropriate reference or 'control' sites from which to obtain baseline data for monitoring, restoration and modeling, e.g. to determine if a seabird colony has recovered 'normal' functioning. Demographic parameters may be very different for genetically divergent populations, even if they occur in ecologically similar or geographically proximate areas.

Captive breeding and reintroductions.-Genetic delineation of populations also is essential for captive breeding and translocations, to prevent both inbreeding and introductions of genetically incompatible or inappropriate individuals. For example, after a captive breeding program was designed to restore the dusky seaside sparrow (*Ammodramus maritimus nigresens*) by hybridizing the last remaining males with females of the morphologically similar Scott's seaside sparrow (*A. m. peninsulae*), genetic analyses indicated that Scott's seaside sparrow was not the most closely related subspecies to the dusky seaside sparrow and therefore not the most appropriate choice for captive breeding (Avise and Nelson 1989).

Restoration of genetic variation.-Genetic information is important to determine the extent to which inbreeding is inhibiting population recovery. As a population declines, its genetic resources become depleted (Allendorf and Leary 1986, Gilpen and Soulé 1986). Initially this depletion involves loss of rare variants (alleles) from the population, but ultimately it includes loss of individual variation (heterozygosity) due to increased inbreeding. Low heterozygosity often is associated with low fitness due to a decrease in such factors as survival, growth, reproductive success and disease resistence (e.g. O'Brien & Evermann 1988, Vrijenhoek 1994). For example, low reproductive success of cheetahs has been attributed to low genetic variation resulting from population bottlenecks and inbreeding (O'Brien & Evermann 1988). Populations that are declining due to inbreeding may recover with the introduction of small numbers of individuals from neighboring sites.

Estimation of effective population size.-Several lines of evidence suggest that if a population declines below an effective size of approximately 50 individuals, it may enter an extinction vortex in which inbreeding, deleterious alleles and stochastic effects combine synergistically to accelerate extinction (Gilpin and Soulé 1986). The *effective size* of a population is the number of individuals that actually contribute to the gene pool of the population, and may be one or two

orders of magnitude lower than the census size due to unequal breeding success and population bottlenecks. For example, the North Atlantic population of thick-billed murres consists of approximately 2.5 million breeding pairs (Nettleship and Evans 1985), but appears to have an effective size of only ~15,000 females (Friesen et al. submitted). Genetic data enable estimation of the effective population size (Nei and Li 1979). Introduction of small numbers of individuals from neighboring sites may increase the effective size of a population and reverse or prevent an extinction vortex.

Methodology

Generation of the population genetic information necessary for restoration of most species of birds breeding at high latitudes, such as the seabirds affected by the Spill, requires highly sensitive molecular markers. Although gene flow and population genetic structure can be approximated from demographics (e.g. Rockwell and Barrowclough 1987), generation of these data involves long-term banding studies and is extremely labour-intensive, especially for species with secretive nesting habits, such as marbled and Kittlitz's murrelets. Furthermore, estimates of genetic divergence from demographic data tend to miss occassional mass migrations, which may be important sources of gene flow in seabirds (e.g. Nettleship and Evans 1985). Traditional molecular methods such as protein electrophoresis also are not suitable for measuring genetic subdivision in populations that breed at high latitudes due to low levels of variability (Evans 1987). Although DNA fingerprinting can reveal high levels of variability, it is expensive, laborious and time-consuming, and exhibits levels of homoplasy (genetic 'noise') too high for comparisons of populations.

Recent innovations in molecular genetics, especially the polymerase chain reaction (PCR, or DNA amplification) provide several advantages over previous methods of genetic analysis. Most importantly for the present purposes, they enable DNA sequences to be compared directly among individuals from different populations (e.g. Kocher et al. 1989, Birt-Friesen et al. 1992, Quinn 1992, Wenink et al. 1994). Furthermore, they allows researchers to focus ther attention on genes with high levels of variability, such as mitochondrial DNA or nuclear introns. Unfortunately, most existing PCR-based protocols are expensive and laborious (e.g. nucleotide sequencing), are not entirely reproducible (e.g. analyses of randomly amplified polymorphic DNA), or require extensive ground-work for each new taxon (e.g. analyses of microsatellite DNA). However, two other innovations, the analysis of single-stranded conformational polymorphisms (SSCPs) and denaturing gradient gel electrophoresis (DGGE; Lessa & Applebaum 1993), are solving these problems. Both techniques provide rapid and inexpensive methods of detecting even single mutations in small fragments (250-600 base pairs) of amplified DNA, and enable large numbers of samples (up to 48) to be screened simultaneously for allelic variation. These techniques are especially useful for assays of nuclear genes since alternate alleles for heterozygous individuals are easily identified. Use of SSCPs or DGGEs in conjunction with targeted amplification of highly variable genes is a powerful new approach that combines the strengths of classical protein electrophoresis with those of cutting-edge DNA-based techniques:

1) virtually any gene can be surveyed, including genes of special interest such as those involved in disease resistence;
2) assays are rapid and relatively inexpensive;
3) large numbers of genes can be surveyed, enabling accurate estimation of genetic variation;
4) almost any mutation is detected in the genes amplified;
5) the exact nature of variation can be investigated by sequence analysis if desired, enabling

complicating factors such as natural selection to be investigated;
6) statistical methods previously developed for proteins, as well as more recent approaches for sequence data, can be used;
7) protocols can be transfered easily among species and laboratories; and
8) assays can be performed on old or degraded samples, blood, or museum specimens - thus animals do not need to be killed.

Past efforts and results

Previous studies of relatively slowly evolving genes (allozymes and the mitochondrial cytochrome *b* gene) indicated that Atlantic and Pacific populations of both common and thick-billed murres are genetically distinct (Birt-Friesen et al. 1992, Friesen et al. submitted). Differentiation among Atlantic populations of thick-billed murres was weak, but Atlantic colonies of common murres exhibited clinal variation in cytochrome *b* genotype frequencies. Sample sizes within the Pacific were very small and restricted to the Bering Sea, but preliminary results indicated that colonies differ in allele frequencies, and thus may represent genetically isolated populations (V.L.F. unpubl. data). Previous studies of geographic variation in marbled murrelets, also using allozymes and cytochrome *b*, indicated that the Asian and North American subspecies represent cryptic species that have been genetically isolated for 5-6 million years and that must be managed independently (Friesen et al. accepted). Preliminary results of this study also indicated significant differentiation among North American populations of murrelets, suggesting that they do not represent a single population. Furthermore, preliminary analysis of three Kittlitz's murrelets from Kachemak Bay and four from Attu Island revealed that these populations are highly divergent and may represent cryptic subspecies or even species: further genetic analyses are critical for the conservation of this species.

Currently, V.L.F., Dr. Tim Birt (Curator of Birds at Metro Toronto Zoo and Adjunct Professor of Biology at Queen's University) and other members of our research group are developing protocols for assaying variation in more rapidly evolving genes, including introns of nuclear genes (e.g. genes of the major histocompatability complex, which are involved in disease resistence), the mitochondrial control region (which evolves up to ten times faster than cytochrome *b*), and microsatellite loci. With the aid of funding from the World Wildlife Fund and the Environmental Innovations Program of Public Works and Government Services Canada, we are developing protocols for analysis of variation in 20 nuclear genes through the use of SSCPs and DGGE, and applying them to a conservation study of marbled murrelets from throughout the North Pacific. To date (since August 1, 1995) we have developed protocols for eight genes (aldolase, α-enolase, lamin, lactate dehydrogenase, an MHC class I locus, an MHC class II locus, ornithine decarboxylase, and vimentin), and screened 48 samples for variation at four genes (aldolase, α-enolase, lamin, and the MHC class II locus). Results indicate that this approach will meet our expectations of a highly sensitive and versatile tool for conservation purposes: 90-100% of mutations are detected (Hayashi 1991, Friesen et al., accepted), levels of variability are high (e.g. eight alleles each have been detected in the α-enolase and MHC class II genes in 48 murrelets - a number equivalent to the highest levels of variability detected using protein electrophoresis), 24-48 samples can be screened on a single gel, and primers amplify products in most species tested (from seabirds through passerines and reptiles to mammals). Preliminary results confirm the genetic distinctiveness of Asian and North American forms of the marbled murelet, as well as the existence of genetic differences among local populations of

murrelets. In addition, we have almost completed surveys of variation in the mitochondrial control region (a notoriously difficult gene to analyze in birds) among populations of guillemots (*Cepphus* spp.) from throughout the Northern Hemisphere (e.g. Kidd and Friesen, 1996), and have begun a survey of control region variation within a colony of thick-billed murres (Ibarguchi et al., in progress). We also are developing protocols for analysis of microsatellite loci in murrelets (Congdon et al., in progress) and murres (Ibarguchi et al., in progress).

Proposed project

In the present project, we propose to conduct a genetic analysis of common murres, pigeon guillemots, and marbled and Kittlitz's murrelets from the Spill area and neighboring sites. Specifically, we propose 1) to determine the geographic limits and structure of populations, i.e. the extent to which colonies are genetically isolated or comprise metapopulations, 2) to identify cryptic species and subspecies, 3) to identify sources and sinks, 4) to provide genetic markers for the identification of breeding populations of birds killed by the Spill, 5) to identify appropriate reference or 'control' sites for monitoring or reintroductions, and 6) to determine the role of inbreeding and small effective population sizes in restricting recovery of the target species.

The present proposal has two main components. Firstly, murres, guillemots and murrelets from the Spill area and neighboring sites will be compared for variation in genes with high mutation rates. Secondly, whereas most studies underway in VLF's lab focus on regional variation in seabirds, variation at a local level is anticipated to be less pronounced; accurate measurement of gene flow and genetic differentiation among neighboring colonies therefore will require greater sensitivity, and will necessitate analysis of a larger number of genes. Thus, to accelerate achievement of the first objective, we propose to develop amplification primers and protocols for 10 new genes to be screened in the target species. This will require continuation of work that already is routine in the lab. The entire project is expected to require 3 1/2 years for completion.

NEED FOR THE PROJECT

A. Statement of Problem

Seabirds of the family Alcidae (auks, guillemots, murrelets, auklets and puffins) are highly vulnerable to marine oil pollution due to the large amount of time they spend resting on the ocean surface, as well as their dependence on marine fish and invertebrates for food. Many species of alcids suffered heavy mortality associated with the *Exxon Valdez* Spill; for example, the estimated mortality for common murres was in the hundred of thousands. Although guillemots and murrelets were declining prior to the Spill, the accident probably increased their rate of decline. Numbers of common murres, pigeon guillemots and marbled murrelets apparently are not recovering; the state of recovery of Kittlitz's murrelets is unknown. The reasons for the failure of these species to recover (as well as for the prespill declines) are unclear, but may be due to availability and quality of prey (currently being investigated through the APEX Predator Experiment and Nearshore Verterbate Predator Project), and/or genetic problems such as genetic isolation of colonies or low genetic variability. We propose to conduct a genetic analysis to aid in the restoration of these species.

B. Rationale/Link to Restoration

The proposed investigation will aid recovery in six ways.
1) It will provide a measure of gene flow and genetic divergence among colonies both within the Spill area and between the Spill area and neighboring sites, and thus it will indicate the extent to which colonies are genetically isolated or comprise metapopulations. This will enable determination of the extent to which a lack of natural gene flow is inhibiting recovery, and thus the need for active restoration.
2) It will identify cryptic species or subspecies, an especially likely possiblility for Kittlitz's murrelets. This will help to priorize restoration efforts.
3) By providing measures of immigration into and emigration out of colonies, it will identify sources and sinks. This will help to direct restoration efforts to the most productive colonies.
4) It will provide genetic markers for the identification of breeding populations of birds killed by the Spill. This will enable determination of the 'affected' zone, and the relative importance of the Spill versus other environmental effects on the decline and recovery of different colonies.
5) The study will help to identify appropriate reference or 'control' sites for monitoring or reintroductions, by delineating the geographic limits of populations.
6) By providing a measure of genetic variability and inbreeding within populations, it will indicate the role of inbreeding depression and small effective population sizes in restricting recovery of the target species. This will indicate the importance of reintroductions for restoration.

C. Location

This project will require collection of blood, feather and/or tissue samples from birds breeding thoughout the Pacific basin, mostly in Alaska (Table 1). As much as possible, tissue will be obtained from museum specimens, and blood and blood feathers ('pin' or growing feathers) will be obtained from chicks or adults during banding. Birds being collected for ongoing diet studies in Alaska (J.F.P.) also will be used as a source of tissue. In years 1 and 2 of the project, emphasis will be placed on obtaining samples from Alaska (Gulf of Alaska, Bering Sea, Aleutian Islands, Chukchi Sea). In year 3, efforts will expand to include the Sea of Okhotsk, Japan, and the southern United States, with assistance from colleagues in those areas.

Results of the project will aid in the restoration of populations of murres, murrelets and guillemots throughout the Spill area. Specifically, this study will 1) indicate the extent to which colonies require active restoration or will recover naturally, 2) enable priorization of restoration effort by identification of source and unique colonies, 3) provide population-specific markers to determine the 'affected' zone of the Spill, 4) suggest appropriate control sites for monitoring, 5) indicate the need for reintroductions to counter inbreeding depression, and 6) identify appropriate sources for reintroductions.

The study also will have several spin-off benefits. For example, genetic data for marbled murrelets, which presently are threatened by logging, oil pollution and gill nets throughout the North Pacific, will aid in accurate measurement of the extent of genetic differentiation and gene flow throughout the range. Amplification primers and screening protocols developed in the present project also will have broad utility in conservation. For example, they will be useful for

management of the thick-billed murre, which is the object of hunting and egging by indigenous people throughout the Arctic. If developed properly, protocols also will be useful for conservation of endangered and economically important species of mammals and fish.

COMMUNITY INVOLVEMENT

Unfortunately, the bulk of the work involved in the proposed project must be conducted by highly trained personnel in a specially equipped research laboratory. However, once population-specific genetic markers have been identified, university students and technicians from local communities may be employed by the Alaska Sealife Center for the screening of carcasses recovered from the Spill. If available, a local student interested in graduate work in conservation genetics may be hired by V.L.F. We will attempt to obtain tissue samples from seabirds harvested for subsistence purposes when possible. Sample collections may require chartering local vessels and paying for assistance from local experts, hunters or vessel operators (see **Methods**). Information about the age of colonies, which is needed for interpretation of genetic results, will be sought from traditional knowledge. Project objectives and interm results will be communicated to local residents through popular reports in the Trustee Council newsletter.

PROJECT DESIGN

A. Objectives

The primary purpose of this project is to conduct a genetic comparison of common murres, pigeon guillemots, and marbled and Kittlitz's murrelets from the area of the *Exxon Valdez* Oil Spill and neighboring sites. We have six main objectives for each species:

1) To measure gene flow and genetic divergence among colonies both within the Spill area and between the Spill area and neighboring sites.
2) To identify cryptic species or subspecies.
3) To identify source and sink colonies.
4) To provide genetic markers for the identification of breeding populations of birds killed by the Spill.
5) To identify appropriate reference or 'control' sites for monitoring or reintroductions.
6) To measure coefficients of inbreeding and effective population sizes.

A secondary purpose, to accelerate achievement of the first, is to develop amplification primers and screening protocols for the analysis of genetic variation in 10 new nuclear genes.

B. Methods

Protocol development

Accurate measurement of gene flow and genetic differentiation among populations is a function of the numbers of samples, sites and genes that are surveyed. Thus in the first part of this project, we will develop universal PCR primers, refine protocols for detection of genetic variation, and assess the general utility of primers for each of approximately 10 nuclear genes in addition to the

20 currently being analyzed in V.L.F.'s lab. Protocol development will be conducted by a post-doctoral fellow, and is estimated to require one year for completion. Development will follow a general procedure that has proven successful for previous genes and that involves three steps: 1) primer design, 2) protocol optimization, and 3) primer assessment.

1) Published nucleotide sequences for a variety of vertebrates (including at least one bird species) for 10 genes will be retrieved from the GenBank and EMBL sequence databases. Primers will be designed to anneal to conserved sequences within exons (which are functionally constrained and therefore highly conserved), so that they amplify introns (which are essentially unconstrained and therefore highly variable both among and within species). Primers thus will be analogous to the 'universal' mitochondrial primers of Kocher et al. (1989).

2) Protocol optimization will involve amplification of DNA from three individuals of each of the four target species. Samples will be amplified using standard protocols (e.g. Kocher et al. 1989), quality of the products will be assessed on agarose gels, and minor alterations (e.g. changes in annealing temperature or addition of adjunct reagents) will be made to the amplification profiles. These steps will be repeated until clean amplifications of the target gene are produced. Not all primer pairs are expected to produce useful amplifications even after several cycles of optimization; such genes will be dropped from further analyses.

3) Once amplification protocols have been refined, 12 individuals from each of the four target species will be amplified in the presence of ^{33}P, and SSCPs will be analyzed using standard protocols (Lessa and Applebaum 1993; Friesen et al. accepted). SSCP protocols for the 48 samples then will be optimized through adjustments of such variables as electrophoresis temperature, acrylamide concentration, and salt concentration. If resolution of DNA on SSCP gels is insufficient for reliable scoring, protocols for DGGE gels will be refined through a similar procedure.

Population surveys

In the second component of this project, we will conduct large-scale surveys of genetic variation in murres, guillemots and murrelets from throughout the North Pacific. Sites from outside the Spill area are necessary to define the geographic limits of the breeding populations.

Common Murres.- Comprehensive assessment of genetic differentiation and gene flow among populations of common murres will require analysis of samples from at least 30 individuals from each of 15 sites (Table 1).

Marbled Murrelets.- Much of the desired information for marbled murrelets already is being collected by V.L.F. under a contract from the Canadian goverment. Assessment of genetic differentiation and gene flow and identification of genetic markers for murrelets breeding within the Spill area will require collection and analysis of samples from four additional sites (Table 1).

Kittlitz's Murrelets.- Kittlitz's murrelets are rare and notoriously secretive in their nesting sites. Samples of these birds therefore are extremely difficult to obtain. We will analyze any samples that we can obtain from anywhere in their range either through collections for dietary analyses or from incidental catches in gill nets or oil slicks. We anticipate obtaining approximately 50 samples.

Pigeon Guillemots.- A large-scale survey of genetic variation in guillemot mitochondrial DNA already is underway in V.L.F's laboratory (e.g. Kidd and Friesen 1996). Measurement of genetic differentiation and gene flow and identification of genetic markers for guillemots breeding within the Spill area will require analysis of variation in nuclear genes in at least 30 samples from each of 12 sites (Table 1).

Many of the necessary baseline samples already have been collected through the assistance of Vern Byrd and Dave Roseneau (Alaska Maritime National Wildlife Refuge), Jay Pitocchelli, Tom van Pelt and Lindsey Hayes (National Biological Service, Anchorage), Alex Pritchard (University of Alaska), Jan Hodder (Oregon Institute of Marine Biology) and Kathy Martin (Canadian Wildlife Service). Other samples are available from tissue collections at the University of Alaska Museum and the Burke Museum (University of Washington). Funding is required to complete collections of samples, which to date have been obtained opportunistically during other research projects. To fill gaps in numbers and distributions, a concerted effort will be required to collect blood or specimens at key geographic sites (Table 1). This may sometimes require air travel to sites of interest, chartering local vessels, and paying for assistance from local experts, hunters or vessel operators. Permits for collection of seabirds are required from the U.S. Fish and Wildlife Service, the State of Alaska (ADF&G) and the Animal Care Committee of Queen's University, and will be obtained by J.F.P. and V.L.F. prior to collections.

Screening will be conducted by the post-doctoral fellow and two technicians as samples become available and as primers and protocols are developed. Previous work suggests that each person can process approximately 4500 samples per year; analysis of 30 loci for each of approximately1220 samples (with the exception of murrelets already being analyzed by V.L.F.) is expected to require approximately 7 1/2 person-years. Data will be analyzed using standard methods developed for analysis of data from protein electrophoresis and sequencing (e.g. Swofford & Selander 1981; Nei 1987): inbreeding coefficients will be calculated as estimators of genetic variabilities; genetic differentiation will be calculated using Wright's *F* statistics; historical gene flow among colonies will be estimated using Slatkin's (1985) method of private alleles and Hedrick's (1971, 1975) *U* statistic. Results of these analyses will indicate cryptic species and subspecies, sources and sinks, colony-specific markers for impact assessment, and appropriate control sites for monitoring.

Finally, representatives of each allele detected in the population surveys will be sequenced to identify effects of selection (Simonsen et al. 1995), to measure contemporary gene flow using the method of coalescence (Slatkin and Maddison 1989), and to estimate effective population sizes (Nei and Li 1979). Alleles will be isolated for sequencing by separation on SSCP gels and amplification from gel-slices. The time required for sequencing will vary among genes depending on the number of alleles: based on the amount of variation being detected in introns in marbled murrelets (V.L.F. unpubl. data), an average of 8 alleles are anticipated per gene for each species. Evolutionary relationships among alleles will be determined using standard methods of phylogenetic analysis (e.g. parsimony analysis on PAUP, Swofford and Begle 1993); possible effects of selection will be identified using correlational analyses (e.g. Abernethy 1994, Simonsen et al. 1995).

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Collections of blood and tissue will be coordinated with other agencies (museums, wildlife agencies, etc.) by V.L.F. and J.F.P. Vessel charters will be arranged with the Alaska Maritime National Wildlife Refuge and with private boat operators throughout the study area. No additional contracts or cooperating agencies are required to complete this project. Genetic analyses are enabled in part by previous support from the Natural Sciences and Engineering

Research Council (Research Grant held by V.L.F) and the Environmental Innovations Program of Public Works and Government Services Canada (Contract held by V.L.F and T.P. Birt). In 1995 V.L.F. submitted an application to the Lindbergh Foundation for $10,850 towards the salary for a post-doctoral fellow for one year to begin a genetic study of common murres in the North Pacific; if this application is successful, $10,850 may be subtracted from the total funding requested from *Exxon* for FY97.

SCHEDULE

A. Measurable Project Tasks for FY 97

Oct. 1 '96 - Dec. 31 '96:	Post-doctoral fellow develops amplification primers and protocols for first three new loci Technicians screen available samples from murres and guillemots for five loci previously developed in VLF's lab
Jan. 97:	PIs attend Annual Restoration Workshop
Jan. 1 '97 - Mar. 30 '97:	Post-doctoral fellow develops protocols for three new genes Technicians screen available samples from murres and guillemots for five more loci
Jan. 1 '97 - Apr. 30 '97:	PIs arrange logistics for sample collections
Apr. 1 '97 - Jun. 30 '97:	Post-doctoral fellow develops protocols for three new genes Technicians screen available samples from murres and guillemots for five more loci
May 1 '97 - Aug. 30 '97:	Blood, feather and tissue samples collected from sites in Alaska
Jul. '97:	VLF and post-doctoral fellow attend conferences
Jul. 1 '97 - Sept. 31 '97:	Post-doctoral fellow develops protocols for final four new genes Technicians screen available samples from murres and guillemots for five more loci

B. Project Milestones and Endpoints

Oct. 1 '96:	Post-doctoral fellow begins developement of protocols for ten new genes, and technicians begin screening available samples for 20 genes developed under the EIP contract
Jan. '97:	PIs attend Annual Restoration Workshop
Jul. '97:	VLF and post-doctoral fellow attend conferences
Aug. 31 '97:	Field collections for '97 completed (some Alaskan sites).
Sept. 30 '97:	Post-doctoral fellow completes developement of protocols for ten new genes Technicians complete screening of previously available samples from murres and guillemots for 20 genes
Oct. 1 '97:	Post-doctoral fellow begins screening murrelet samples for variation in 10 new genes Technicians begin screening old samples for ten new genes, and begin screening samples collected in 1997 for 30 genes

Jan. '98:	PIs attend Annual Restoration Workshop
Apr. 15 '98:	VLF completes annual report for FY 97
Jul. '98:	VLF and post-doctoral fellow attend conferences
Aug. 31 '98:	Field collections for '98 completed (remaining Alaskan sites).
Sept. 30 '98:	Post-doctoral fellow and technicians complete screening of samples collected from murres and guillemots up to Apr. 1 '98 for 30 genes
Jan. '99:	PIs attend Annual Restoration Workshop
Apr. 15 '99:	VLF completes annual report for FY 98
Jul. '99:	VLF and post-doctoral fellow attend conferences
Aug. 31 '99:	Sample collections for '99 completed (sites outside Alaska)
Sept. 30 '99:	Post-doctoral fellow and technicians complete screening of all samples for variation
Jan. '00:	PIs attend Annual Restoration Workshop
Mar. 31 '00:	VLF and postdoctoral fellow complete data analysis (including all analyses outlined in **Objectives**) and manuscripts
Apr. 15 '00:	VLF completes final report

C. Completion Date

Data collection and analysis will be completed for all species by the end of FY 99; final reports and manuscripts summarizing results of the completed projects for each species will be prepared during FY 00.

PUBLICATIONS AND REPORTS

Approximately three publications, each reporting the sequence and utility (amplification protocols, allele sequences, variablities within the target species, potential uses in other species) of primers for three to four nuclear introns, will be submitted to *Molecular Ecology* Primer Notes in FY 97. These publications will form the basis of the annual report for FY97. Primer sequences and protocols for all 30 loci developed under the EIP contract and *EVOS* project will be summarized in a handbook, to be submitted to Queen's University Press following completion of FY97. Four major publications also will be prepared for publication following completion of the project in FY00; each will report estimates of genetic variability, genetic structure and gene flow for one of the target species. These papers will form the basis for the final report, and will be submitted to international peer-reviewed journals such as *Evolution*, *Molecular Ecology*, or *Auk*, as well as to managers involved with restoration.

PROFESSIONAL CONFERENCES

Interim results from FY97 will be presented as contributed papers by the principal investigators and/or post-doctoral fellow at the annual meetings of the Society for the Study of Conservation and the American Ornithological Union in July, 1997 (locations to be announced). Interim and final results in subsequent years will be presented at the Annual Restoration Workshops, as well

as at international scientific conferences such as the annual meetings of the Pacific Seabird Group, the American Ornithological Union, the Cooper Ornithological Union, and/or the Society for the Study of Conservation, as well as at the International Ornithological Congress to be held in South Africa in 1998.

NORMAL AGENCY MANAGEMENT

Not applicable.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

Collection of samples will be coordinated with ongoing studies of seabird feeding ecology in Alaska conducted by the National Biological Service (J.F.P.) and the U.S. Fish and Wildlife Service (Alaska Maritime National Wildlife Refuge). Tissues and skeletons obtained from seabirds will be archived at the American Museum of Natural History (New York), and tissues also will be collected for use in onging studies of seabird trophic relationships using stable isotope ratios (K. Hobson, Canadian Wildlife Service, Saskatoon). Genetic markers identified in the present project may be used by personnel at the Alaska Sealife Center to identify breeding populations of carcasses recovered from the Spill. This project is made possible by a previous contract for Can$106,000 awarded to VLF and Dr. Tim Birt by the Environmental Innovations Program of Public Works and Government Services Canada, which enables the development of primers and protocols for 20 nuclear introns and their application to the conservation of marbled murrelets. The present project also is made possible through the donation of tissue samples from murres, murrelets and guillemots by field researchers in Canada and the United States (see **Methods** - ***Population surveys***); these samples are worth an estimated $10,500.

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PERSONNEL

Principal investigator - Dr. Vicki Friesen (Assistant Professor of Biology, Queen's University, Kingston, Ontario) completed undergraduate and graduate work in 1992 on the ecology and genetics of seabirds in the North Atlantic. Her doctoral project involved a molecular study of population differentiation and evolution in common and thick-billed murres. She is an author on 19 publications in peer-reviewed scientific journals, including papers on behavioral ecology, genetics and evolution of various vertebrates, primarily seabirds. On-going projects in her research lab include population genetic and phylogenetic studies of murres, murrelets, guillemots, auklets, shags, storm-petrels, ptarmigan and parrots. She will be responsible for supervising the laboratory component of the project, and writing interim and final reports and manuscripts for publication; she will contribute to laboratory work as necessary to keep the project on schedule. Her curriculum vitae is appended.

Principal investigator - Dr. John F. Piatt (Research Biologist GS-13, Alaska Science Center, National Biological Service, Anchorage, AK) obtained a Ph.D. in Marine Biology from Memorial University of Newfoundland in 1987. His dissertation involved seabird-forage fish interactions. Since 1987, he has studied seabirds both at colonies and at sea in the Gulf of Alaska, Aleutian Islands, and Bering and Chukchi seas. His is an author on 45 peer-reviewed scientific publications about seabirds, fish, marine mammals, and effects of oil pollution on marine birds. He will act as the liason between V.L.F., the *EVOS* Trustees and other agencies in Alaska, coordinate collection of samples, and assist with writing of reports and manuscripts for publication.

Post-doctoral fellow (3 years) - Dr. Brad Congdon completed his Ph.D. at the University of Queensland in Australia in 1992. His dissertation involved a genetic comparison of populations of mosquitofish. He subsequently established and ran a molecular genetics lab at the Cooperative Center for Tropical Pest Management at the University of Brisbane. Currently he is working with V.L.F. on the population genetics of murrelets, and with Dr. Peter Boag (Department of Biology, Queen's University) on extra-pair paternity in swallows. He is an author on eight peer-reviewed publications. He will be responsible for development of amplification primers and protocols (estimated to require ~1 year for completion), and screening marbled and Kittlitz's murrelets for genetic variation (estimated to require ~1.5 years and ~0.5 years, respectively).

Technician I (3 years) - Mr. Shane Doran received a B.Sc. [honours] from Queen's University in 1995. His thesis involved the population genetics of blue-eyed shags. Currently he is working part-time for V.L.F. on the population genetics of murrelets. He will be responsible for population screening for common murres (estimated to require ~2 1/2 years for completion) as well as for management duties necessary for successful completion of the project (e.g. ordering supplies, maintaining radioisotope records, preparing DNA extractions, etc).

Technican II (3 years - vacant) - This person will be responsible for population screening for pigeon guillemots (estimated to require ~2.5 years for completion), as well as for sample collections and assisting the post-doctoral fellow with routine laboratory tasks. Ms. Monica Kidd will be completing her M.Sc. thesis under V.L.F. on population genetics of guillemots in 1996, and may be available for this position. Alternatively, it may be filled by two graduate students.

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Swofford, D. L., and R. B. Selander. 1981. BIOSYS-1: a Fortran program for the comprehensive analysis of electrophoretic data in population genetics and systematics. Journal of Heredity 72:281-283.

Tuck, L.M. 1961. The murres. Can. Wildl. Serv. Monogr. No. 1.

Vrijenhoek, R.C. 1994. Genetic diversity and fitness in small populations. Pp. 37-53 *in* V. Loeschcke, J. Tomuik and S.K. Jain (eds.), Conservation Genetics. Birkhäuser, Boston.

Wenink, P.W., A.J. Baker and M.G.J. Tilanus. 1994. Mitochondrial control region sequences in two shorebird species, the turnstone and dunlin, and their utility in population genetic studies. Mol. Biol. Evol. 11: 22-31.

Table 1. Sites, numbers of samples available, and numbers of samples needed for genetic analyses of murres, murrelets and guillemots.

Site	Avail-able	Needed
COMMON MURRE		
California (Farallon Islands)	0	30
Washington (Clallam)	12	8
N. Vancouver Island	40	0
Southeastern Alaska	0	30
Prince William Sound (Cordova)	23	7
Middleton Island	0	30
Upper Cook Inlet (Kachemak Bay, Chisik I.)	22	8
Lower Cook Inlet (Barren Is.)	19	11
Alaska Peninsula (Semidi, Midun Is.)	18	12
Eastern Aleutians (Aiktak I.)	14	16
Western Aleutians (Attu, Agattu & Buldir Is.)	23	7
Bering Sea (Pribilof, St. Matthew, St. Lawrence Is.)	0	30
Chukchi Sea (Capes Lisburne & Thompson)	33	0
Sea of Okhotsk (Talan I., Magadanskaya)	5	25
Japan (Teuri I.)	0	30
MARBLED MURRELET		
California	12	18
Oregon	12	18
Washington	18	12
British Columbia (Queen Charlotte Is.)	30	0
Southeastern Alaska (Lemesurier I.)	20	10
Prince William Sound (Unakwik Fjord)	15	15
Cook Inlet (Kachemak Bay)	10	20
Kodiak Island	2	18
Mitrofania Bay	14	16
Shumagin Islands (Koniuji Is., Belofski B., Yakutat P.)	14	16
Central Aleutians (Adak I.)	0	30
Western Aleutians (Attu I.)	9	21

Table 1, cont'd.

Site	Available	Needed
KITTLITZ'S MURRELET		
Prince William Sound	2	*
Kachemak Bay	4	*
Western Aleutians (Attu I.)	5	*
PIGEON GUILLEMOT		
California (Farallon Is.)	20	10
Oregon	25	5
British Columbia (Queen Charlotte Is.)	0	30
Southeast Alaska (Glacier Bay)	0	30
Prince William Sound (Jackpot & Naked Is.)	30	0
Cook Inlet (Kachemak Bay)	8	22
Kodiak Island	0	30
Alaska Peninsula (Semidi and Shumagin Is.)	7	23
Western Aleutians (Attu, Agattu Is.)	0	30
Kuril Is.	0	30
Bering Sea (Pribilof, St. Lawrence Is.)	0	30
Chukchi Sea (Capes Thompson and Lisburne)	0	30

*Samples will be obtained from Kittlitz's murrelets opportunistically.

NOTE: Every effort will be made to obtain samples non-destructively to minimize the need for collections, e.g. as feathers or blood samples collected during banding, or from museum specimens.

NOTES ON COMMODITIES COSTS

Consumables and disposibles

Post-Doctoral Fellow

Primer design - Two 30-mer PCR primers will be required for each gene. Primer synthesis at the Queen's University Core Facility costs $3/base, or $180 per gene.

Protocol Refinement - Protocol refinement for each gene will involve a cycle of three steps: amplifications of DNA from 12 test samples, electrophoretic analysis of PCR products in an agarose gel, and modification of amplification profiles. Based on previous experience, an average of ten cycles are anticipated per gene. Amplifications cost $0.44/sample, and agarose gels (12 samples/gel) cost $1.60, for a total of $69 per gene.

- Amplification of 48 samples with incorporation of ^{33}P-dATP for analysis of SSCPs will cost $0.90/sample, for a total of $43. Refinement of SSCP protocols is expected to require a mean of six gels @ $27/gel for a total of $162.

Sequence Analysis of Alleles - An average of 8 alleles is anticipated for each species for each gene (see Methods). Two sequencing reactions will be required for each allele at a cost of $4.30 per reaction, for a total of $69 for each species. Four sequencing gels will be required for each species, at a cost of $11/gel for a total of $44. Thus, sequencing will cost a total of $452 per gene for all four species.

Thus, protocol development and sequencing for each gene will cost a total of $906. Protocols will be developed for 10 genes, for a total of $9060. Previous experience indicates that approximately $250 will be required for miscellaneous items such as disposable gloves, bench paper, and pipette tips, for a total of **$9310** for consumables and disposables for the post-doctoral fellow.

Technicians

Each technician will screen DNA from approximately 225 samples for each of 20 genes. Each sample costs $0.90/gene for amplifications with incorporation of ^{33}P-dATP, and $0.55/sample for SSCP gels. Thus each technician will require $6525 for reagents for population screening. Approximately $250/yr will be needed for gloves etc, for an annual cost of **$6775** each.

Victoria Louise Friesen

Curriculum Vitae - 10 April 1996

Education

7/1992-6/1994	-Postdoctoral Fellow, Ornithology -Royal Ontario Museum and University of Toronto -"A phylogenetic analysis of the family Alcidae"
5/1987-6/1992	-Doctor of Philosophy, Biopsychology -Memorial University of Newfoundland, St. John's, Newfoundland -"Population differentiation and evolution within thick-billed (*Uria lomvia*) and common (*U. aalge*) murres"
4/1984-2/1987	-Master of Science, Biopsychology -Memorial University of Newfoundland, St. John's, Newfoundland -"Parental energy expenditures and activity budgets of northern gannets (*Sula bassanus*)"
9/1980-4/1984	-Bachelor of Science (first class honours), Biology -University of Prince Edward Island, Charlottetown, Prince Edward Island

Scholarships and Awards (last five years)

1994	-NSERC Women's Faculty Award -Queen's University
1992	-NSERC Postdoctoral Fellowship -University of Toronto and Royal Ontario Museum

Manuscripts and Grant Proposals Reviewed For

-Auk
-Canadian Journal of Zoology
-Canadian Society for Endangered Birds
-Canadian Wildlife Service Special Publications
-Condor
-Ecology
-Evolution
-Marine Ecology Progress Series
-National Science Foundation
-Proceeding of the XXth International Ornithological Congress
-Wilson Bulletin

Research Grants and Contracts (last five years)

11/94	-Advisory Research Council Research Grant -$5,000 -V.L.FRIESEN -"Equipment for development of a molecular genetic technique for studies in ecology and evolution"
08/95-03/97	-Environmental Innovation Program, Public Works and Government Services Canada Contract -$106,000 -V. L. FRIESEN and T. P. Birt -"Development of an innovative molecular technique for the conservation of genetic variation in endangered birds"
06/95	-George Cedric Metcalf Charitable Foundation, Research Donation -$3,000 -V. L. FRIESEN and T. P. Birt -"Development of an innovative genetic technique to aid in the conservation of endangered birds"
05/95	-Advisory Research Council Research Grant -$5,000 -V. L. FRIESEN -"Development of an innovative genetic technique to aid in studies of ecology and evolution"
04/95	-NSERC Equipment Grant -$22,000 -C. G. Eckert, V. L. FRIESEN, W. C. Leggett, K. E. Wynne-Edwards, B. L. Tufts and P. T. Boag -"Ultracold freezers for molecular and physiological ecology"
11/94	-Advisory Research Council Research Grant -$5,000 -V.L.FRIESEN -"Population differentiation and speciation in guillemots"
11/94-10/97	-NSERC Collaborative Projects Grant -$108,059 -P.T. Boag, H.L. Gibbs, P.J. Weatherhead, M.C. Clarke, V.L. FRIESEN, R.D. Montgomerie, R.J. Robertson and L.M. Ratcliffe -"Second generation DNA profiling of wildlife species"

04/94-03/97	-NSERC Research Grant -$35,000 -V.L. FRIESEN -"Mechanisms of population differentiation and speciation in seabirds"
04/94-03/95	-Endangered Species Recovery Fund (World Wildlife Fund) -$12,000 -V.L. FRIESEN and A.J. Baker -"Conservation genetics of marbled murrelets"
1992	-Chapman Fund Research Grant -$1,500 -V.L. FRIESEN -"Population divergence and speciation in gannets

Refereed Papers

FRIESEN, V.L., J.F. Piatt and A.J. Baker. Accepted. Evidence from cytochrome *b* sequences and allozymes for a 'new' species of alcid, the long-billed murrelet (*Brachyramphus perdix*). *Condor.*

FRIESEN, V.L., W.A. Montevecchi, R.T. Barrett and W.S. Davidson. 1996. Molecular evidence for kin groups in the absence of large-scale genetic differentiation in a migratory bird. *Evolution*, in press.

FRIESEN, V.L., A.J. Baker and J.F. Piatt. Phylogenetic relationships within the Alcidae (Charadriiformes: Aves) inferred using total molecular evidence. *Mol. Biol. Evol.* 13: 359-367.

Birt, T.P., V.L. FRIESEN, J.M. Green and W.S. Davidson. Mitochondrial DNA variation in Newfoundland and Norwegian populations of Atlantic capelin, *Mallotus villosus*, detected using two techniques. *Mol. Ecol.* 4: 771-776.

FRIESEN, V.L., R.T. Barrett, W.A. Montevecchi and W.S. Davidson. 1993. Molecular identification of a backcross between a female common murre/thick-billed murre hybrid and a male common murre. *Can. J. Zool.* 71: 1474-1477.

FRIESEN, V.L., W.A. Montevecchi and W.S. Davidson. 1993. Cytochrome *b* nucleotide sequence variation among the Atlantic Alcidae. *Hereditas* 119: 245-252..

BIRT-FRIESEN, V.L., W.A. Montevecchi, A.J. Gaston and W.S. Davidson. 1992. Genetic structure of thick-billed murre (*Uria lomvia*) populations examined using direct sequence analysis of amplified DNA. *Evolution* 67: 267-272.

Birt, T.P., V.L. FRIESEN, J.M. Green, W.A. Montevecchi and W.S. Davidson. 1992. Cytochrome *b* variation in parrots. *Hereditas* 117: 67-72.

Montevecchi, W.A., V.L. BIRT-FRIESEN and D.K. Cairns. 1992. Reproductive energetics and prey harvest of Leach's storm-petrels in the northwest Atlantic. *Ecology* 73: 823-832.

Cairns, D.K., W.A. Montevecchi, V.L. BIRT-FRIESEN and S.A. Macko. 1990. Energy expenditures, activity budgets, and prey harvest of breeding common murres. *St. Av. Biol.* 14: 84-92.

BIRT-FRIESEN, V.L., W.A. Montevecchi, D.K. Cairns and S.A. Macko. 1989. Activity-specific metabolic rates of free-living northern gannets and other seabirds. *Ecology* 70: 357-367.

Davidson, W.S., S.E. Bartlett, T.P. Birt, V.L. BIRT and J.M. Green. 1989. Identification and purification of serum albumin from rainbow trout (*Salmo gairdneri*). *Comp. Biochem. Physiol.* 93B: 5-9.

Davidson, W.S., V.L. BIRT, T.P. Birt and J.M. Green. 1988. Palmitate-binding, serum albumin-like proteins in salmonids. *FEBS Letters* 233: 299-302.

Montevecchi, W.A., V.L. BIRT and D.K. Cairns. 1988. Dietary changes of seabirds associated with local fisheries failures. *Biol. Oceanogr.* 5: 153-161.

Montevecchi, W.A., D.K. Cairns and V.L. BIRT. 1988. Migration of post-smolt Atlantic salmon, *Salmo salar*, off northeastern Newfoundland, as inferred by tag recoveries in a seabird colony. *Can. J. Fish. Aquat. Sci.* 45: 568-571.

BIRT, V.L., T.P. Birt, D. Goulet, D.K. Cairns and W.A. Montevecchi. 1987. Ashmole's halo: direct evidence for prey depletion by a seabird. *Mar. Ecol. Prog. Ser.* 40: 205-208.

BIRT, V.L. and D.K. Cairns. 1987. Kleptoparasitic interaction of arctic skuas *Stercorarius parasiticus* and black guillemots *Cepphus grylle* in northeastern Hudson Bay, Canada. *Ibis* 29: 190-196.

Cairns, D.K., K.A. Bredin and V.L. BIRT. 1987. A tunnel for hidden access to blinds at high latitude seabird colonies. *J. Field Ornithol.* 58: 69-72.

Cairns, D.K., K.A. Bredin, V.L. BIRT and W.A. Montevecchi. 1987. Electronic activity recorders for aquatic wildlife. *J. Wildl. Manag.* 51: 395-399.

Papers Submitted or In Preparation

FRIESEN, V.L., W.A. Montevecchi, A.J. Baker, A.J. Gaston, R.T. Barrett and W.S. Davidson. Mitochondrial sequence variation suggests differences in historical biogeographies of two congeneric seabirds. Submitted to *Mol. Ecol.*

FRIESEN, V.L. and D.J. Anderson. Phylogeny and evolution of the Sulidae: A test of alternative modes of speciation. In prep. for *Mol. Phyl. Evol.*

FRIESEN, V.L., J.F. Piatt and A.J. Baker. Molecular insights into the evolution of the Alcidae. In prep. for *Mol. Phyl. Evol.*

FRIESEN, V.L., D.K. Cairns, W.A. Montevecchi and S.A. Macko. Parental time and energy budgets of northern gannets (*Sula bassana*). In prep. for *Physiol. Zool.*

Montevecchi, W.A., R.E. Ricklefs and V.L. FRIESEN. Organic composition and condition of nestling and fledgling northern gannets. In prep. for *Can. J. Zool.*.

Scientific Presentations

FRIESEN, V.L. 1995. Molecular evidence for kin groups within a colony of thick-billed murres. Proc. Jt. Conf. Colon. Waterbird Soc. Pac. Seabird Gr.

FRIESEN, V.L., H. Jones and D.J. Anderson. 1995. Phylogeny and evolution of the Sulidae. Proc. Jt. Conf. Colon. Waterbird Soc. Pac. Seabird Gr.

Kidd, M.G. and V.L. FRIESEN. 1995. A guillemot intraspecific phylogeny: inferring population history from patterns of geographic variation in *Cepphus* mitochondrial control regions. Proc. Jt. Conf. Colon. Waterbird Soc. Pac. Seabird Gr.

FRIESEN, V.L., A.J. Baker and J.F.Piatt. 1995. Conservation genetics of marbled murrelets. *22nd Meet. Pacif. Seabird Gr.* Oral presentation.

FRIESEN, V.L., A.J. Baker and J.F. Piatt. 1994. Molecular insights into modes of speciation in the Alcidae. *XXI Internal. Ornithol. Congr.* Symposium presentation.

FRIESEN, V.L., A.J. Baker and J.F. Piatt. 1994. Molecular evidence for a 'new' species of alcid, the long-billed murrelet. *XXI Internal. Ornithol. Congr.* Poster presentation.

FRIESEN, V.L., A. J. Baker and J.F. Piatt. 1994. A molecular investigation of evolutionary relationships within the Alcidae. *21st Ann. Meet. Pacif. Seabird Gr.* Opening presentation.

FRIESEN, V.L., W.A. Montevecchi and W.S. Davidson. 1994. Population genetics and conservation of rare seabirds. *21st Ann. Meet. Pacif. Seabird Gr.* Invited presentation.

BIRT-FRIESEN, V.L., A.J. Baker and J.F. Piatt. 1993. A phylogenetic analysis of the Alcidae. *111th Meet. Am. Ornithol. Union.* Oral presentation.

FRIESEN, V.L., W.A. Montevecchi, A.J. Baker and W.S. Davidson. 1993. Population differentiation and phylogeography in two species of murres (genus *Uria*). *32nd Ann. Meet. Can. Soc. Zool.*
Oral presentation.

FRIESEN, V.L., W.A. Montevecchi and W.S. Davidson. 1993. Genetic substructuring within a colony of thick-billed murres. *1st Jnt. Meet. Wilson Ornithol. Soc. Can. Soc. Ornithol.* Oral presentation.

FRIESEN, V.L. and A.J. Baker. 1992. Utility of mitochondrial DNA sequencing in conservation biology. *54th Midwest Fish Wildl. Confer.* Invited presentation.

BIRT-FRIESEN, V.L., W.A. Montevecchi and W.S. Davidson. 1990. Multi-level analyses of genetic affinities within the genus *Sula. XX Internatl. Ornithol. Congr.* Oral presentation.

BIRT-FRIESEN, V.L., W.A. Montevecchi, A.J. Gaston and W.S. Davidson. 1990. Inter-colony genetic comparison of thick-billed murres (*Uria lomvia*) using the polymerase chain reaction. *Col. Waterbird. Soc. Ann. Meet.* Invited presentation.

Montevecchi, W.A., V.L. BIRT-FRIESEN and D.K. Cairns. 1990. Avian energetics and bioindication in the northwestern Atlantic. *Col. Waterbird Soc. Ann. Meet.* Invited presentation.

BIRT-FRIESEN, V.L., W.A. Montevecchi and W.S. Davidson. 1989. Development of molecular genetic techniques to probe the population structure of thick-billed murres in the North Atlantic. *Pop. Biol. Conserv. Mar. Birds Workshop.* Oral presentation.

BIRT, V.L., W.A. Montevecchi & W.S. Davidson. Aug. 1988. Novel DNA probes for seabird population genetics studies. *XIX Internatl. Congr. Genet. Genome* 30, *Suppl.* 1: 371. Poster.

BIRT, V.L., T.P. Birt, D. Goulet, D.K. Cairns & W.A. Montevecchi. March 1986. Ashmole's halo: direct evidence for prey depletion by a seabird. *Pop. Biol. Conserv. Mar. Birds, Proc., Pac. Seabird Gr. Bull.* 13: 100. Oral presentation.

BIRT, V.L., D.K. Cairns, S.A. Macko & W.A. Montevecchi. March 1986. Energetics if free-ranging northern gannets during the breeding season. *Pop. Biol. Conserv. Mar. Birds, Proc., Pac. Seabird Gr. Bull.* 13:102. Oral presentation.

FRIESEN, V.L., D.K. Cairns, S.A. Macko & W.A. Montevecchi. June 1986. Parental energy expenditures of free-ranging northern gannets and common murres. *XIX Internatl. Ornithol. Congr.* Poster.

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997						
Personnel		$78.0						
Travel		$31.7						
Contractual		$0.0						
Commodities		$22.9						
Equipment		$8.6	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$141.2	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Indirect		$0.5						
Project Total	$0.0	$141.7	$133.9	$131.9	$17.1			
Full-time Equivalents (FTE)		36.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

All estimates assume a U.S./Canadian exchange rate of 0.74.

Indirect costs include page charges (approximately $250), and costs for Xeroxing, telephone calls, shipping samples, permits, etc (approx. $250).

1997

Prepared: 9 April 1996

Project Number: 97169-BAA
Project Title: A genetic study to aid in restoration of murres, guillemots and murrelets to the Gulf of Alaska
Name: Queen's University (V.L. Friesen) and DOI (J.F. Piatt)

FORM 4A
Non-Trustee
SUMMARY

4/10/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FFY 1997
Dr. B. Congdon	Post-doctoral fellow		12.0	2.5	0.0	30.0
Mr. S. Doran	Technician I		12.0	2.0	0.0	24.0
vacant	Technician II		12.0	2.0	0.0	24.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		36.0	6.5	0.0	
					Personnel Total	$78.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
Ship rental (JFP)	4.0	7			28.0
Restoration workshop (VLF)	0.7	1	4	0.1	1.1
Conservation Society meeting (post-doc)	0.7	1	6	0.1	1.3
American Ornithologists' Union meeting (VLF)	0.7	1	6	0.1	1.3
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$31.7

1997

Project Number:
Project Title: A genetic study to aid in the restoration of murres, guillemots and murrelets to the Gulf of Alaska
Name: Queen's University (V.L. Friesen) and DOI (J.F. Piatt)

FORM 4B
Personnel
& Travel
DETAIL

Prepared: 9 April 1996

4/10/96

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

Contractual Costs:	Proposed
Description	FFY 1997
None	
Contractual Total	$0.0

Commodities Costs:	Proposed
Description	FFY 1997
CONSUMABLE AND DISPOSIBLES - SEE P. 12 OF PROPOSAL FOR DETAILS	9.3
Post-doctoral fellow	6.8
Technician I	6.8
Technician II	
	1.3
AQUISITION OF SPECIMENS FROM THE BURKE MUSEUM	
Commodities Total	$24.2

1997

Project Number:
Project Title: A genetic study to aid in restoration of murres, guillemots and murrelets to the Gulf of Alaska
Name: Queen's University (V.L. Friesen) and DOI (J.F. Piatt)

FORM 4B
Contractual & Commodities DETAIL

Prepared: 9 April 1996

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
Thermal Cycler (MJ-R PTC-100-60)	1	5.9	5.9
Temperature Regulator	1	1.8	1.8
SSCP Appartus	1	0.9	0.9
			0.0
NOTE: This project is made possible by the existence of equipment valued in excess of			0.0
$50,000 within VLF's DNA research laboratory at Queen's University			0.0
The requested equipment is required to handle additional demand on apparatus associated			0.0
with the proposed project			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**		$8.6

Existing Equipment Usage: Description	Number of Units	

1997

Project Number:
Project Title: A genetic study to aid in restoration of murres, guillemots and murrelets to the Gulf of Alaska
Name: Queen's University (V.L. Friesen) and DOI (J.F. Piatt)

FORM 4B
Equipment
DETAIL

Prepared: 9 April 1996

4/10/96

Isotope Ratio Studies of Marine Mammals in Prince William Sound

Project Number:	97170
Restoration Category:	Research
Proposer:	Dr. Donald M. Schell, Institute of Marine Science/School of Fisheries and Ocean Sciences-University of Alaska Fairbanks
Lead Trustee Agency:	Alaska Department of Fish and Game (ADF&G)
Cooperating Agencies:	
Alaska SeaLife Center:	
Duration:	Three years
Cost FY 97:	$133,879
Cost FY 98:	$110,000
Cost FY 99:	
Cost FY 00:	
Cost FY 01:	
Cost FY 02:	
Geographic Area:	Prince William Sound/Gulf of Alaska
Injured Resource/Service:	Harbor seals, nearshore ecosystem species, seabirds

ABSTRACT

This project uses natural stable isotope ratios to assess trophic structure and food webs in Prince William Sound (PWS) and contributes to the studies by the ADF&G personnel to determine the reasons for the decline of harbor seal populations. Through a mix of captive animal studies, comparison of isotope ratios in archived and current marine mammal tissues and their potential prey species in the PWS, insight into environmental changes causing the decline may be possible. In addition, by providing analytical services for mass spectrometry of it contributes to the SEA program being conducted by the PWS Science Center and the Inst. of Marine Science, UAF, to describe the food chains supporting commercial fishes impacted by the Exxon Valdez Oil Spill.

INTRODUCTION

Our work over the past three years has provided a rapidly growing data base with which our studies of harbor seals are beginning to coalesce into a coherent picture of ecosystem interactions in Prince William Sound. Stable isotope tracers have provided a means of following advection into the sound from offshore and of identifying geographic separations in the food webs supporting some of the injured species, primarily sea otters, harbor seals and sea birds. Our methods and procedures continue as proposed in FY96 and are included in this proposal for convenience of the reader. An accompanying Annual Progress Report details the accomplishments to date and the preliminary findings.

Over the past two decades, isotope ratio analysis has emerged as a powerful tool in ecosystem research both on the process scale and as a validation technique for large-scale ecosystem models (Michener and Schell, 1994). In relevant applications to this study, Schell et al (1989a) described a geographic gradient in isotope ratios in biota across the Alaskan Beaufort Sea and the Bering-Chukchi seas and showed that this gradient could be applied to describing bowhead whale natural history. The isotopic gradient arises from the primary producers in the ecosystem and is passed up food chains to label consumers clear up to the top predators. Saupe et al. (1989) describes the parallel shifts in $\delta^{13}C$ in euphausiids and copepods across this region and Schell et al (1989b, 1992) discussed the effects of the gradient in forming oscillations in isotope ratios in whale baleen. Hobson and Welch (1992) used isotope ratios to describe the trophic relationships of birds and mammals to the available prey species in the Canadian Arctic. Further extension to benthos by Dunton et al (1991) and to fishes (Vinette, 1992) has confirmed that the isotopic trends are evident across the entire food web.

In contrast to the primarily geographic control on carbon isotope ratios, nitrogen isotope ratios are influenced by trophic level. Vinette (1992) has shown that the $\delta^{15}N$ of euphausiids and copepods in the continental shelf regions of the Bering, Chukchi and Beaufort seas are statistically indistinguishable. Within a given region, when pelagic and benthic species of known feeding habits are compared, a predictable enrichment in ^{15}N occurs of about 3.3‰ per trophic level increase. By assembling the trophic spectrum of species within an ecosystem it is possible to ascribe trophic status within the ecosystem. Hobson and Welch (1992) were able to use $\delta^{15}N$ values in the Barrow Strait - Lancaster Sound region to identify the roles of arctic cod (*Boreogadus saida*) and other prey species to top consumers. Higher trophic levels showed little change in $\delta^{13}C$ but varied by an average of 3.8‰ between levels. Recently, Sease et al (1993) showed preliminary data that confirmed that sea lions occupy a high trophic status in North Pacific food webs and reflect a geographic gradient between Prince William Sound and the Washington coast.

Our recent work in the Bering Sea and in the Prince William Sound and Gulf of Alaska has shown that pronounced geographic gradients in isotope ratios exist in both $\delta^{13}C$ and $\delta^{15}N$ across the shelf break. This discovery and the acquistion of sufficient data to enable contour mapping of isotope label regimes, are now being used to interpret the isotope ratio patterns found in the Bering Sea sea lions. This is requiring the development of statistical approaches and will be a focus of the FY97 work.

The trophic changes that may have occurred in the populations of harbor seals is also proving interesting. Samples of tissues from pre-decline seals have been compared with post-decline seals and very little difference is apparent. Only a limited number of seals have been compared to date and this work is continuing.

Trophic energetics of individual seals can be assessed by the changes in isotope ratios along the lengths of the vibrissae. Whereas an individual animal may show little temporal change in trophic status as indicated by $\delta^{15}N$ values or regional feeding as evidenced by carbon isotope ratios along the length of vibrissae, there have been remarkable differences from one animal to the next in the few individuals examined to date. This study expands upon our growing data base to provide a similar assessment of the trophic energetics of harbor seals in Prince William Sound and to assist other EVOS studies by providing isotope ratio analysis and interpretation for their studies.

Preliminary Findings

Funding for this work resumed in February 1995 (no interim funds from Oct. 94 were allocated) and as a result only preliminary findings are available at this time. We have completed the first major suite of prey species isotope ratio analyses and collected a wide spectrum of marine mammal samples from native harvests and through strandings and collections being conducted by the ADF&G. These samples have been analyzed and we are now synthesizing the data in context with the lower trophic data collected by Tom Kline of the Prince William Sound Science Center.

A major requirement in using the isotope ratios along the vibrissae of seals as temporal markers is that the growth rates be known. We are currently conducting calibration experiments in cooperation with the chief veterinarian of the Mystic Marine Life Aquarium (MMA), Mystic Connecticut. The personnel of MMA and the principal investigator have kindly agreed upon protocols for undertaking experiments on captive sea lions and harbor seals aimed at determination of whisker growth rates, diet fractionation factors arising from differing types of prey species, and seasonal cycles in isotope ratios arising from physiological effects. In addition, as part of a synergistic study on Bering Sea marine mammals, we have also conducted the first set of measurements of whisker growth rates on juvenile sea lions being raised at the Vancouver Aquarium in cooperation with Dr. Andrew Trites of the University of British Columbia.

NEED FOR THE PROJECT

A. Statement of Problem

Harbor seals were undergoing an unexplained decline in numbers before the oil spill and the decline was further accelerated by the disaster. Since that time the population has not recovered and is still at a low level although now perhaps finally stabilized. No definitive cause and effect relationships have been found for the decline or failure to recover. This project uses stable

isotope ratios as natural tracers to test hypotheses regarding shifts in diet or trophic status in the past decade as underlying reasons for the decline.

A second need for this project is to provide isotope ratio analyses for this study and other restoration projects needing isotope abundance information. We anticipate receiving a total of approximately 8000-10,000 samples for isotope ratio analysis in the coming year.

B. Rationale/Link to Restoration

Carbon isotope ratios serve as conservative tracers of energy supply between trophic levels (phytoplankton to zooplankton to fishes to top consumers). Seals, cetaceans, birds, etc., acquire the isotope ratios in proportion to the amount of food derived from each differing source. This, in turn, is reflected in the composition of body tissues and in keratinous tissues (claws, feathers, baleen, whiskers) as a temporal record when multiple sources of food are consumed over time and space. This allows the discerning of important habitats and food resources in animals that seasonally migrate or undergo periods of hyper- and hypotrophy.

Nitrogen isotope ratios reflect both the food sources and the trophic status of that animal. As nitrogen in food is consumed and assimilated by a consumer, the heavy isotope is enriched by approximately 3‰ with accompanying loss of the lighter isotope through excretion. The enrichment occurs with each trophic step and thus allows the construction of conceptual models and food webs and the assignment of relative trophic status to species for which dietary data are sparse. The data obtained from these measurements are unique in that they trace materials actually assimilated and thus can be used for more accurate ecosystem modeling.

The availability of macrozooplankton forage for salmon, herring, and their predators varies in space and time because of changes in the physico-chemical processes in Prince William Sound. In the SEA context, the latter is known as the Lake/River processes (SEA hypothesis number 2). When macrozooplankton are not available, macrozooplankton consumers are forced to switch prey, the Predator/prey relationships (SEA hypothesis number 3) shift in time and space. These shifts represent fundamental changes in the way the PWS ecosystem produces commercial species (i.e. herring and salmon). A better understanding, particularly a quantitative understanding, is a prerequisite to determining protocols for restoration and recovery of these species.

It can be postulated that the natural stable isotope abundances of PWS biota will shift because of changes in trophic level, food web structure, and primary productivity in the context of the SEA hypotheses, thus providing an independent tool to verify, quantify and model ecosystem processes. The tracer nature of the approach will enable the integration of ecosystem components. It will enable us to monitor both "top down" (predation) and "bottom-up" (food supply) controls on herring and salmon production.

C.. Summary of Major Hypotheses and Objectives

The major hypothesis to be tested is that:

The isotope ratios of harbor seals are derived from prey taken from the Prince William Sound ecosystem. Changes in the trophic structure of the food webs arising from either the oil spill or natural cycles will be evident through changes in isotope ratios in potential prey and seals.

The objectives of this study are divided into three elements:

1. A research component on marine mammals focusing on the trophic energetics and ecosystem dynamics of harbor seals conducted by Dr. Schell, PI, in cooperation with ADF&G personnel working as part of the marine mammal program. An additional effort using captive animals to calibrate the response to changing isotopic composition in diet and to determine vibrissae growth rates will also be undertaken. This will entail the analysis of approximately 3000-4000 samples for carbon and nitrogen isotope ratios, a major increase over last year reflecting the very successful collection of samples from over 100 seals.

2. A research component focusing on lower trophic levels having direct application to the testing of hypotheses regarding fisheries resources. This work will be conducted in cooperation with Dr. T. Kline of the Prince William Sound Science Center and is described in detail in his Detailed Project Description. Our own work on this aspect will entail analysis of over 1000 samples collected in the vicinity of marine mammal haulouts and feeding areas. It will also include samples from outside of PWS to provide information of potential shifts in isotope ratios arising from migrations. Dr. Kline estimates the need for analysis of approximately 2000 samples. Experience from 1995 - 96 indicates that this is a minimum number. Analytical costs for these latter samples are included in the separate proposal by Dr. Kline.

3. A service/research component supplying analytical services for carbon and nitrogen isotope ratios to other PI's involved with EVOS studies. This effort will entail consultation and analysis of selected samples to build upon the data base and to integrate the food web studies into a cohesive picture of the trophic dynamics. This task is anticipated to require approximately 20% of the analytical and research effort and has been embraced enthusiastically by other research components. We already have samples from 9 sea otters and collections of sea birds and prey are currently underway.

   The ancillary work from other participants will be coordinated through the UAF Stable Isotope Facility and will consist of approximately 1000 samples. If there appears to be more than 1000 external samples collected, the PI will prioritize samples in consultation with the investigators. All work will be performed cooperatively and the data shared as outlined in the Detailed Project Descriptions of the cooperating studies.

COMMUNITY INVOLVEMENT

The community involvement in this project is essential in that a large fraction of the samples will be provided via native harvests of marine mammals. Kate Wynne, of the UAF and USFWS, has collected seal whiskers and tissues for this study in the past and we anticipate this assistance will continue.

PROJECT DESIGN

A. Objectives

The objectives to be completed during the period of this proposal are essentially the same as in our FY96 proposal and include:

1. Collect samples of harbor seal vibrissae through continued cooperative work with the ADF&G in Prince William Sound;

2. Collect samples of harbor seal prey species including forage fishes, salmon and herring in the vicinity of major haul-outs and high population densities. Samples of seal tissues will be collected from native hunters. These samples will be obtained through assistance by ADF&G personnel monitoring harvests and the samples of forage fishes through the efforts of T. Kline.

3. Perform stable isotope ratio analyses on tissues and organisms collected during the sampling program. Through the use of **carbon** isotope data on taxa collected over geographical regions, the presence/absence of **isotopic gradients** useful in sorting out habitat dependencies will be determined.

4. Assist other research programs in the Prince William Sound ecosystem study by conducting stable isotope ratio analyses on samples provided and aid the interpretation of results. This effort will require approximately 20% of the analytical and research effort.

5. Through the use of **nitrogen** isotope ratios in collected taxa, assign **trophic status** to species in each region. Compare trophic status with predictive models based on conceptual food webs.

6. Determine temporal changes in harbor seal trophic status and food dependencies by comparing isotope ratios along the lengths of vibrissae with prey availability and their isotope ratios. Through the use of captive animals being fed known diets, establish the relationships between whisker growth rate and temporal changes and the fractionation factors between the $\delta^{13}C$ and $\delta^{15}N$ values of diet and consumer.

7. Compare the isotope-ratio derived food web models to predictions by the Òlake-riverÓ hypothesis and others being tested by the SEA project as an independent means of validation.

B. Methods

The primary work will be divided into the sampling program and the subsequent analytical and synthesis tasks. Sampling of tissues for stable isotope analysis has been described for both bulk tissues (muscle, blubber) and temporally variable tissues (whiskers, claws, etc.) (Schell, et al. 1989; Michener and Schell, 1994).

1. Analytical — Vibrissae from seals either from Prince William Sound or captive animals are noted as to location in the face. The whisker is then segmented at 2.5 mm intervals with a razor and the subsamples placed in vials for later grinding and mass spectrometry. The subsamples obtained are dried and powdered for homogeneity and the isotope ratios of carbon and nitrogen determined with a Europa 20/20 mass spectrometer system. The sample is flash combusted at high temperature and the nitrogen and carbon dioxide gases separated and purified by gas chromatography. These are subsequently led into the mass spectrometer by capillary and the isotope ratios determined. The analytical replicability for the entire sampling process is better than ± 0.05°/oo for both $\delta^{13}C$ and $\delta^{15}N$.

2. Sampling — The acquisition of samples for isotope analysis will be conducted through several channels. Forage fish, pollock and other commercial species will be obtained through cooperative programs with the National Marine Fisheries Service, the Alaska Dept. of Fish and Game, and from the Prince William Sound Science Center. As part of the cooperative effort with Dr. Kline, samples will be recorded and the analyses run on a coordinated suite of specimens collected over the geographic regions of the Sound and over the seasons. This will allow "within taxa" comparisons to determination shifts in trophic levels and discrimination of the effects of geographic shifts of isotope ratios in primary producers.

   Samples of marine mammals, birds, etc., have been and will be obtained from archived materials, strandings, native harvests and, in some cases, collection in the field. This effort will be closely coordinated with the US Fish and Wildlife Service, ADF&G, and the EVOS-sponsored efforts having field programs. Our experience in 1994 has already produced a wide variety of samples and there is reason to anticipate that 1995 will be even more productive as the requests for materials are communicated to field researchers. The small amounts of sample required for isotopic analyses mean that little effort for preservation or transport is required.

   The application of isotope ratio work with marine mammals is relatively new and the technique is still in a process of calibration. We have been offered the opportunity to conduct captive animal experiments at the Memorial University of Newfoundland and the Mystic Aquarium in Connecticut using harp seals and harbor seals. We plan to conduct

measurements of whisker growth rates and correlation experiments between seals and diets of known composition. Seal vibrissae will be marked and growth rates measured over the seasonal cycles to determine if physiological effects are translated into differing isotope ratios. This work will comprise only a limited amount of the total effort but will be essential given this relatively new field of application. This work will be conducted by Ph. D. student Amy Hirons as part of her dissertation program. This project will support travel costs to Memorial University to establish experiment protocols and to acquire data and information from cooperating investigators.

Tissues samples for analysis from cooperating investigators will be supplied to the P.I. in the form of dry powdered material to expedite handling and analysis. If samples must be prepared by the personnel in the PI's laboratory, a charge for preparation will be made to the investigator or a reduced number of samples will be run depending upon the difficulties involved. Similarly, glass fiber filtered samples will be charged at double the normal sample rate because of the accelerated destruction of the combustion furnace tubes from the melted glass particles. Since almost all sample materials are dried tissues, no significant problems are anticipated in this respect.

3. Synthesis of data— The plots of isotope ratios of carbon and nitrogen along the lengths of vibrissae from harbor seals are known to show oscillations in isotope ratios in response to dietary changes over the season (Schell, 1993-4 data). As new data with supporting natural history information are acquired, the values at specific intervals will be compared with potential prey for likely matches. These will be compared with observational data and known feeding habits. From this information, sampling can be constrained to the most probable food sources and further directed analyses performed to confirm or deny conceptual food web structure. In cooperation with ADF&G personnel, the stable isotope data will also be compared with fatty acid compositions in seal blubber to determine if other proxies for dietary components can be established.

Additional synthesis efforts will be made in conjunction with modeling projects associated with the SEA program. The data we acquire is very valuable in that it is an independent means of validating food web and energy flow models to top consumers. If isotopic data are in conflict with that projected from the model calculations, it is usually the model that is off the mark. Although a complex ecosystem such as Prince William Sound with strong interactions between land and sea can give rise to varied isotopic abundances in the biotic components, the strong integrating effects that occur in building the "whole body" are very amenable to stable isotope tracers.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

None

D. Location

The research effort will be conducted in Prince William Sound with contrasting data obtained from samples from the Kodiak Island area and in the coastal Gulf of Alaska near Cordova. Comparative work involving prey items and marine mammals from outside Prince William Sound will be made on cruises of opportunity in the Gulf of Alaska. Calibration experiments on whisker growth rates and diet/stable isotope ratio changes will be undertaken using captive harbor seals at research facilities in St. John's Newfoundland and at the Mystic Aquarium, Mystic Connecticut. The benefits of this project will be realized throughout the PWS and will be applicable to other areas of the state.

SCHEDULE

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

1 Oct. 96 - Feb. 1997:	Prepare and analyze isotope ratio samples collected in 1994-1996
December 1996	Collect vibrissae from isotopically labeled seals and sea lions
15 Feb. - 31 March 1997:	Synthesis and coordination for sampling in 1997, Annual report on FY97 (and prior) work
Apr. 1997 - Aug. 1997:	Field work and sampling, captive animal experiments
Aug. 1997 - Sep. 1997:	Analysis of samples Data synthesis, identification of gaps Manuscript preparation

B. Project Milestones and Endpoints

The milestones in this project are a blend of definitive goals and a continuing research process that will extend to the end of the funding period. Specific goals will be attained as follows:

Captive animal studies of vibrissae growth rates and dietary effects on stable isotope ratios — Now underway and completion anticipated in spring 1997.

Field collections of prey species over the geographic region, collections of whiskers and tissues from harbor seals — Currently underway. Will continue through FY97 but will be more directed toward the end of the study as we fill data gaps.

Stable isotope analyses — The laboratory work associated with the preparation of samples and the isotope ratio analyses will continue throughout the duration of this project but will become more focused as the end approaches. The major collection and data base construction will occur during FY97.

Modeling and synthesis of results — This will occur over the entire project in an iterative process with the emphasis building in FY97 and continuing until the conclusion of the project.

Assistance to other investigators — This aspect is now underway and will continue throughout the project. It is anticipated that the maximum interaction will occur during FY97. Synthesis and interpretation of isotope ratio data will be ongoing.

Project milestones and reporting periods:

Oct. 1996 - Feb. 1997:	Analysis of 1996 field season samples Preparation of journal manuscripts
Mar. 1997 - Apr. 1997:	Preparation for field, continue analyses Annual Report
Apr. 1997 - Aug. 1997:	Field work, continued analytical work
Sep. 1997 - Dec. 1997:	Analytical work, synthesis and completion of captive animal expts.
Jan. 1998 - Mar. 1998:	Final report, synthesis meetings, manuscript preparation

C. Completion Date

The sampling and analytical aspects of this project are anticipated to be complete in 1998. The service aspects of the mass spectrometry for isotope ratios may continue beyond that date if demand warrants.

PUBLICATIONS AND REPORTS

Results of this project will be made available via the following:

Annual Reports: These reports will detail progress and preliminary findings and notable achievements. These are anticipated for the ends of FY96 and FY97.

Final Report: A Final Report will be provided. Technical results in these reports will be shared with EVOS collaborators. Thus they will be apprised of the development of the stable isotope methodology and the interpretation of the results. The PI will provide expertise in interpretation of isotope results in other projects for which the isotope techniques are only a minor portion of the scientific effort. The final reports of the PI will assist others in that they will provide independent means for validation of trophic models and energy flow descriptions of the Prince William Sound ecosystem.

Peer-reviewed publications: Over the course of this study peer-reviewed publications will be generated for the open literature based upon the scientific findings. These publications will generated by the PI as first author publications where the primary focus is on the findings

produced by the isotopic techniques or as second author publications when the isotope work is a minor part of the scientific results.

Papers at scientific society meetings: We request support for travel to appropriate scientific meetings for dissemination of results and interaction with colleagues. It is anticipated that the Society for Marine Mammalogy or the American Society for Limnology and Oceanography meetings will be attended by the PI and graduate student Amy Hirons.

Public Lectures: Interaction with the public will arise through formal and informal presentations of results. Synthesis meetings designed to explain the findings of ecosystem studies will be presented at meetings coordinated by the EVOS program and open to the public. Informal presentation of results will occur through interaction with interested members of the public, press and scientific community. Classroom instruction will also involve integration of findings into the presentation of educational material.

PROFESSIONAL CONFERENCES

The results of this project are to be presented at the joint American Society of Limnology and Oceanography/American Geophysical Union meeting in Sante Fe, January 1997. Funds are designated for partial support of this travel for the P.I. and Ph. D. student Amy Hirons.

NORMAL AGENCY MANAGEMENT

Not applicable.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

1. Resources and Services — This study focuses on harbor seals, sea birds and the cetaceans of Prince William Sound. Although the major effort is concerned with harbor seals, other marine mammal tissues will be collected in cooperation with those agencies handling or collecting those species. The principal cooperating agency personnel are Kathy Frost and co-workers with the ADF&G with whom a wide variety of sampling efforts have already been undertaken and are continuing in 1995. Dr. Michael Castellini and Brian Fadely have also provided invaluable help by accessing whiskers from seals in their tagging program.

2. Relations to Other Damage Assessment Work— This study is closely coordinated with the modeling efforts and the pelagic food web studies being undertaken by the Prince William Sound Science Center personnel. Dr. Kline is responsible for most pelagic collections of food base organisms and is sharing these data to help construct the food web models. Dr. Schell is responsible for the marine mammal aspects and will collect additional forage species as required by his project (for example, samples of herring,

capelin, sand lance, etc., in regions of high marine mammal density or active feeding). Stable isotope data provide an excellent means for validating models and testing food web linkages. This aspect of the work will be cooperative with many components of the SEA project.

We are very fortunate to be simultaneously involved in an isotope study on marine mammals in the Bering Sea. This project, which is supported by the North Pacific Universities Consortium and the Coastal Marine Institute, will provide a valuable amount of complementary data and assist in gathering insight as to the mechanisms involved in the marine mammal population declines.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

The sampling and use protocols for the sampling and experimentation on vertebrates in the 1995 proposal were reviewed and approved by the University of Alaska Institutional Animal Care and Use Committee. This assurance is valid for this proposal and will be reviewed for renewal in FY97.

PROPOSED PRINCIPAL INVESTIGATOR, IF KNOWN

Name	Dr. Donald M. Schell
Affiliation	Professor, Institute of Marine Science
Mailing address	School of Fisheries and Ocean Sciences P.O. Box 757220 University of Alaska Fairbanks Fairbanks, AK 99775-7220
Phone number	(907) 474-7115
Fax number	(907) 474-7204
E-mail address	ffdms1@ims.alaska.edu

PERSONNEL

Dr. D.M. Schell has been involved in stable isotope studies for over 25 years. His work has involved both natural abundance tracer studies and enrichment experiments. His work on bowhead whales and geographic gradients in stable isotope ratios has been published and subjected to rigorous reviews. The findings have been upheld and have provided insight into bowhead whale natural history that was unattainable by other techniques.

As PI, Dr. D.M. Schell will oversee the Quality Assurance/Quality Control aspects of this project. We have established protocols for sampling and our working standards are cross-calibrated with other nationally recognized laboratories. Primary standards are from the National Technical Standards Service. Our mass spectrometer technician has been well-trained and has over eight years experience on three mass spectrometers.

Dr. Schell oversees the Stable Isotope Ratio Mass Spectrometry Facility on the UAF campus. This consists of three working instruments which are dedicated to specific elements as demand requires. A Europa automated continuous flow system will be used for most samples but back-up analytical capability is available. Machine operations are the responsibility of Norma Haubenstock, technician, who has over eight years experience in the laboratory. We have budgeted additional funds for an assistant to prepare samples, load and operate the automated system and to aid in data processing and archiving for all users.

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1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997	LONG RANGE FUNDING REQUIREMENTS					
			Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Personnel	$6.3	$0.0						
Travel	$0.0	$0.0						
Contractual	$133.8	$133.9						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0						
Subtotal	$140.1	$133.9						
General Administration	$10.3	$9.4						
Project Total	$150.4	$143.3	$130.0	$0.0	$0.0	$0.0	$0.0	
Full-time Equivalents (FTE)		0.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:

1997

Project Number: 97170
Project Title: Isotope Ratio Studies of Marine Mammals in PWS
Agency: AK Dept. of Fish & Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

Prepared:

4/15/96

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

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		0.0	0.0	0.0	
					Personnel Total	$0.0

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$0.0

1997

Prepared:

Project Number: 97170
Project Title: Isotope Ratio Studies of Marine Mammals in PWS
Agency: AK Dept. of Fish & Game

FORM 3B
Personnel
& Travel
DETAIL

4/15/96

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

Contractual Costs:	Proposed
Description	FFY 1997
RSA with the University of Alaska	133.9
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$133.9

Commodities Costs:	Proposed
Description	FFY 1997
Commodities Total	$0.0

1997

Prepared:

Project Number: 97170
Project Title: Isotope Ratio Studies of Marine Mammals in PWS
Agency: AK Dept. of Fish & Game

FORM 3B
Contractual & Commodities DETAIL

4/15/96

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

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

Existing Equipment Usage: Description	Number of Units	Inventory Agency

1997

Project Number: 97170
Project Title: Isotope Ratio Studies of Marine Mammals in PWS
Agency: AK Dept. of Fish & Game

FORM 3B
Equipment
DETAIL

Prepared: 4/15/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Budget Category:	Authorized FFY 1996	Proposed FFY 1997						
Personnel	$83.7	$83.3						
Travel	$11.2	$11.0						
Contractual	$5.2	$5.7						
Commodities	$6.9	$7.1						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$107.0	$107.1	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
Indirect	$26.8	$26.8						
Project Total	$133.8	$133.9	$110.0	$0.0	$0.0	$0.0	$0.0	
Full-time Equivalents (FTE)		15.7						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

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

1997

Prepared:

Project Number: 97170
Project Title: Isotope Ratio Studies of Marine Mammals in PWS
Name: D. M. Schell

FORM 4A
Non-Trustee
SUMMARY

4/15/96

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

Personnel Costs:			Months	Monthly		Proposed
Name	Position Description		Budgeted	Costs	Overtime	FFY 1997
D. M. Schell	Principle Investigator		3.0	11.0		33.0
N. Haubenstock	Technician		4.7	4.4		20.7
B. Barnett	Lab Assistant		8.0	3.7		29.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		15.7	19.1	0.0	
					Personnel Total	$83.3

Travel Costs:		Ticket	Round	Total	Daily	Proposed
Description		Price	Trips	Days	Per Diem	FFY 1997
R/T National mleeting		0.8	2	10	0.1	2.6
R/T Fairbanks Mystic, Connecticut		0.8	1	4	0.1	1.2
R/T Fairbanks Cordova		0.6	4	32	0.1	5.6
R/T Fairbanks Anchorage		0.4	2	8	0.1	1.6
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
					Travel Total	$11.0

1997

Prepared:

Project Number: 97170
Project Title: Isotope Ratio Studies of Marine Mammals in PWS
Name: D. M. Schell

FORM 4B
Personnel
& Travel
DETAIL

4/15/96

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

Contractual Costs:	Proposed
Description	FFY 1997
Communications	0.9
Maintenance, mass spectrometry factory service	4.0
Shipping, expediting, Cordova-Fairbanks	0.8
Contractual Total	$5.7

Commodities Costs:	Proposed
Description	FFY 1997
Mass spectrometry gases, glassware	3.5
Chemicals, lab glassware, expendables	1.4
Data management software	0.9
Field gear, ring nets, shipping containers	1.3
Commodities Total	$7.1

1997

Prepared:

Project Number: 97170
Project Title: Isotope Ratio Studies of Marine Mammals in PWS
Name: D. M. Schell

FORM 4B
Contractual & Commodities DETAIL

4/15/96

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

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

Existing Equipment Usage:	Number of Units	
Description		

1997

Project Number: 97170
Project Title: Isotope Ratio Studies of Marine Mammals in PWS
Name: D. M. Schell

FORM 4B
Equipment
DETAIL

Prepared: 4/15/96

Project Title: Alaska Department of Fish and Game Mariculture Technical Center Operational Funding

Project Number:	97171
Restoration Category:	Research
Proposer:	Alaska Department of Fish and Game
Lead Trustee Agency:	
Cooperating Agencies:	
Alaska SeaLife Center:	
Duration:	1st year, 5-year project
Cost FY 97:	$271.8
Cost FY 98:	$219.7
Cost FY 99:	$225.1
Cost FY 00:	$230.5
Cost FY 01:	$236.0
Geographic Area:	Seward
Injured Resource/Service:	Clams\Subsistence

ABSTRACT

Operate a facility where bivalve shellfish and aquatic plant research can take place. The ability of the Mariculture Technical Center to hold large culture phytoplankton and to rear large numbers of bivalve shellfish will be unique within the State of Alaska. This capability will open new avenues for research and research funding beneficial to the restoration of subsistence shellfish resources, lost or diminished as a result of the *Exxon Valdez* oil spill.

INTRODUCTION

In 1993, because of growing concern over subsistence resources or services lost or diminished as a result of the *Exxon Valdez* oil spill, the Alaska Legislature appropriated *Exxon Valdez* oil spill criminal settlement funds for the development of a shellfish hatchery and technical center. The Mariculture Technical Center (MTC) and Shellfish Hatchery (SH) began as two separate projects requested by two separate entities, the Alaska Department of Fish and Game (ADF&G) and the Chugach Regional Resources Commission (CRRC), respectively. They were combined into one project during the legislative appropriation process. The legislature (Section 5 of HCS CSSB 183(FIN)) required that the ADF&G develop the MTC/SH in a location on the lower Kenai Peninsula. A site feasibility study, completed in October of 1994, identified Seward as the best location for the facility. Facility design was completed in January, 1996. Invitations to bid facility construction were accepted in March of 1996. Construction of the MTC/SH is expected to begin in May of 1996 with a scheduled completion date of January, 1997. The facility is scheduled for beneficial occupancy in November, 1996.

The project will be located on a 1.8 acre area within the campus of the University of Alaska, Institute of Marine Science (IMS) in Seward, Alaska. The University has a 100 year lease for the property from the municipality of Seward. A sublease agreement between the Alaska Department of Fish and Game and the University was negotiated in 1995.

The MTC and SH will be housed in one pre-engineered single story metal building of rectangular shape on a 6-inch concrete slab foundation with a gross square footage of 10,920. A sloped roof (18 feet to peak) will be used to drain snow and rain away from building entrances. Ceiling height will be 12 feet. The site is adjacent to Resurrection Bay so the building will be designed to withstand wind driven salt spray from the exterior. Framing members will be hot-dipped galvanized for the humid air created by heated hatchery process saltwater on the interior. High quality finishes are required on both the exterior and the interior finishes.

Space utilization in the building will be as follows:

Mariculture Technical Center

Wet Labs (2)	860 sq ft
Office and Restrooms	520 sq ft
Hall	170 sq ft
TOTAL	1550 sq ft

Each lab will have complete infrastructure facilities (heated and ambient seawater, heated and ambient freshwater, drains, etc.) to perform pilot scale research on a variety of anticipated shellfish species. Lab space will be sufficient to produce food for shellfish independently in each lab.

Shellfish Hatchery (Use and Area-square feet)

Hatchery Tank Room	6330 (one production module shared with MTC)
Mechanical Room	840 (common to SH and MTC)
Office, Restrooms, Hall	810
Shop	520 (shared with MTC)
Algae Culture Lab	520
Dry Lab	200 (shared with MTC)
Electrical Room	150 (common to SH and MTC)
TOTAL	9370

The hatchery production is planned on the basis of producing 20 million spat to a size of 2 to 4 mm each year. The hatchery will have multi-species rearing capabilities and allow for genetic isolation between species in distinct modules of the hatchery.

Overall the facility will provide sound, reliable water supply and drain systems for the anticipated activities of both the MTC and SH. In general, flow through water demands at this facility will be low, ranging from 25 to 55 gpm for seawater and 1 to 10 gpm for freshwater. During batch tank filling operations the demand will increase to a maximum of 150 gpm seawater and 50 gpm freshwater.

The seawater supply system will consist of an eight inch HDPE underwater pipeline extended from an existing sea wall to a depth of minus 250 feet in Resurrection Bay. A six inch pipe will extend from the sea wall to the supply pumps in the mechanical room. The underwater pipeline will be laid along the bottom of the bay, and will be held in place with concrete anchors at 15 foot centers. A section of perforated eight inch pipe will serve as the intake structure at the end of the pipeline. The primary seawater supply pumps (two-10 hp self priming pumps) will manifold off a common suction header. The pumps will feed directly into a bank of three high rate sand filters for particle removal down to approximately 30 microns. After filtration the ambient seawater distribution system branches off to points of use. The remainder of the filtered water is routed through primary and secondary heat exchangers to provide 20° to 25° C heated seawater. The primary heat exchanger will recover up to 65% on the heat energy contained in the process waste water. The secondary heat exchanger will utilize an oil fired boiler to meet heated water demand. Total seawater heating will typically range from 500,000 to 2,000,000 Btuh with a peak demand of 2,500,000 Btuh under worst case conditions.

Freshwater will be used as necessary to control salinity in the algae production tanks and MTC lab experiments. The Alaska Sealife Center is developing a freshwater artesian spring near the SH/MTC site and will provide a stub out for a 50 gpm freshwater supply to this facility. As a backup, there will be a connection from the potable water system to provide up to 25 gpm of freshwater. A small carbon filter will be required to dechlorinate the potable water prior to use.

Process water drains from the shellfish tankage will be collected in floor trenches and routed to a

buried precast concrete energy recovery sump. A variable frequency energy recovery pump will force the drain water through the primary heat exchanger. A continuous level transmitter mounted in the sump will modulate the pump speed to automatically maintain optimum energy recovery flows. The effluent will then flow directly back to Resurrection Bay via an 8 inch drain extended from the seawall to a depth of minus 40 feet.

The building will provide a flexible space that can be converted to a variety of configurations without major modifications. Many of the functions provided will be shared by the MTC and SH (such as main water supply and main drain systems, mechanical/shop space, and dry lab). The facility is designed so that operations of neither the MTC nor SH will adversely affect the other.

The State of Alaska owns the MTC/SH, but a private entity will operate the SH component of the facility, under contract to ADF&G. The CRRC is interested in operating the shellfish hatchery, but state purchasing laws prevent ADF&G from contracting directly with CRRC. The State can enter into sole source contracting arrangements with established Economic Development Districts (EDD), so the ADF&G is working with the Kenai Peninsula Borough EDD and CRRC to facilitate an operating contract for the shellfish hatchery. A final agreement has not been signed to date.

If Trustee Council funding is approved, ADF&G will operate and maintain the MTC component of the project. The primary tasks for the first year (FY 97) will be the development of wet lab(s) space into fully functional shellfish research facilities capable of independent algal production, assisting the shellfish hatchery operator with the preliminary shake down of shared mechanical and process water delivery systems, and soliciting and reviewing research proposals. Although specific research projects have yet to identified, it is likely the MTC staff will dedicate a considerable amount of time to in-house research and development projects designed to assist the hatchery operator with initial seed production efforts.

NEED FOR THE PROJECT

A. Statement of Problem

No existing facilities in Alaska adequately address known and anticipated needs for laboratory-based research for the long-term restoration of bivalve shellfish (the Council's rationale for approving funding for the construction of the Alaska SeaLife Center for restoration of marine mammals, marine birds, and fish is similar: no existing facilities in Alaska satisfactorily serve research needs). ADF&G is building a MTC that could address these research needs, but recent budget cuts prevent the Department from full participation in the operation of the facility.

Alaska's strict shellfish import restrictions only allow the import of oyster spat less than 20 mm in length, native to or originating from the Pacific coast of North America. Agencies and/or aquatic farmers interested in developing new aquaculture species must therefore culture native species. Research and development is necessary to identify and develop broodstocks of these native species, and establish hatchery techniques to enable seed production. The result of this

research can be applied to restoration of subsistence shellfish resources, lost or diminished as a result of the *Exxon Valdez* oil spill (or future oil spills) by providing the hatchery technology required to culture native bivalve species for use in replenishing damaged marine environments, and to provide the opportunity for economic restoration through new business opportunities.

B. Rationale/Link to Restoration

This project will allow ADF&G to actively manage laboratory facilities for bivalve shellfish research. The facility can be used as a rehabilitation tool by providing the hatchery technology required to culture indigenous bivalve species for use in replenishing damaged marine environments as well as supplying seedstock to aquatic farms in the spill affected areas. New opportunities for bivalve shellfish research associated with restoration of subsistence shellfish resources, lost or diminished as a result of the *Exxon Valdez* oil spill will be created by providing laboratories and a production module with process water systems capable of water temperature and salinity manipulation, and large culture phytoplankton production.

C. Location

The MTC/SH will be located at Seward. The benefits of the research and development projects conducted at the facility could produce Alaska-wide impacts.

COMMUNITY INVOLVEMENT

The Kenai Peninsula Borough Economic Development District and the City of Seward have been active partners in the development of the MTC/SH. Native villages and residents in the spill affected area will benefit from technology developed at the MTC. State of Alaska procurement policies and procedures will be used when securing services, equipment, or supplies needed to operate the MTC. Employee hiring will be in accordance with State of Alaska Personnel Rules.

PROJECT DESIGN

A. Objectives

1. Operate the Mariculture Technical Center (MTC) component of the MTC/SH facility in Seward, scheduled for completion in January, 1996. Operate the facility with Council approved funding for a period of five years. Pursue additional technical development funding from private sources and public agencies to sustain the project beyond five years.

B. Methods

MTC staff will outfit and develop the physical components of the MTC. Staff will identify research priorities and pursue project funding. Shakedown research will be conducted during

year one. Specific research projects will be identified and conducted in years two through five.

SCHEDULE

A. Measurable Project Tasks for FY 97

Oct.:	Hire two full time staff, relocate to Seward, monitor the final phases of MTC/SH construction
Oct.- ongoing:	project administration (accounting, budgeting, reporting, personnel actions, etc.)
Nov.- Dec.:	ADF&G determines the MTC/SH construction work has been substantially completed to allow ADF&G to assume beneficial occupancy of the facility
Dec.- ongoing	assist (through research and development) SH contract operator with initial clam seed production effort
Dec.- Jan.:	operate/test building mechanical and process water delivery systems
Jan.- Feb.:	set up MTC office, establish communication links (phone, e-mail, etc.)
Jan.- Feb.:	purchase materials and equipment for the labs and the MTC office
Feb.- Apr.:	set up MTC labs for independent algal production including; fabrication and installation of process water plumbing, installation of algae culture system, operation and testing of systems
Feb.- Apr.:	meet with the ad hoc steering committee (formed the spring of 1995) to form policy and discuss procedures for accepting/prioritizing MTC research proposals, develop bench fee schedule
Mar.- ongoing:	on the job, apprenticeship, and/or workshop algae/larvae culture training
Apr.- ongoing:	solicit research proposals, apply for additional development funding
May- ongoing:	review research proposals, prioritize and assign projects
June- ongoing:	conduct/monitor accepted projects

B. Project Milestones and Endpoints

Objective 1

October, 1996 to September, 2001:	Operate the Mariculture Technical Center (MTC) component of the MTC/SH facility in Seward (specific research projects to be conducted in the facility have yet to identified, therefore detailed milestones and endpoints are unknown at this time).

C. Completion Date

FY 2001

PUBLICATIONS AND REPORTS

(Specific research projects to be conducted in the facility have yet to identified, therefore details of project specific manuscripts are unknown at this time.)

April 15, 1998	FY 97 annual report due. Report will discuss overall MTC program progress to date, present individual project details/results, and make recommendations regarding future work.
April 15, 1999	FY 98 annual report due. Report will discuss overall MTC program progress to date, present individual project details/results, and make recommendations regarding future work.
April 15, 2000	FY 99 annual report due. Report will discuss overall MTC program progress to date, present individual project details/results, and make recommendations regarding future work.
April 15, 2001	FY 00 annual report due. Report will discuss overall MTC program progress to date, present individual project details/results, and make recommendations regarding future work.
April 15, 2002	Final report due.

NORMAL AGENCY MANAGEMENT

When the MTC concept was first developed in 1991, it was to have been operated by the ADF&G. Budget cuts, in excess of 25% the last two years, have forced the department to eliminate entire divisions and programs. The ADF&G is currently concentrating on core management and statutory functions, making new programs such as the MTC operation impossible to pay for with general fund appropriations (MTC operation is not required by statute or regulation). If Trustee Council funds are not approved, ADF&G will attempt to contract out the operation of the MTC. Without ADF&G's direct involvement in the facility, bivalve shellfish research projects will most likely be regional in nature with emphasis on commercially valuable species. The intent of the original appropriation (to aid in the restoration of subsistence resources or services, lost or diminished as a result of the *Exxon Valdez* oil spill) will not be completely fulfilled.

The progress of CRRC's clam restoration project (#96131) will likely be affected. The SH will have to dedicate a considerable amount of effort, space, and funds to research and development rather than production that it would not have if ADF&G were operating the MTC. Also, CRRC will be solely responsible for the initial operation and testing of new mechanical and process water delivery systems for the entire facility.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

CRRC is in the second year of a five year Trustee Council funded clam restoration project (#96131). CRRC currently does not produce sufficient seed to accomplish project goals at their

Qutekcak Shellfish Hatchery in Seward. This facility was intended to operate for a limited period of time until a new and permanent hatchery could be built. In order meet the project's future seedstock planting goals, CRRC requires a larger hatchery with expanded production capability. The staff of the Qutekcak Hatchery have successfully conditioned, spawned, set and raised small quantities of the native littleneck *Protothaca staminea.* Large scale littleneck clam seedstock production strategies must still be developed. As part of this project, the hatchery will also attempt to produce cockle *Clinocardium nuttalli* seed. The cockles are a new shellfish aquaculture species. Research and development is necessary to identify and develop broodstocks for this species and establish hatchery techniques to enable seed production. CRRC will be the probable operator of the SH, therefore, it is likely the MTC will dedicate a considerable amount of time to in-house research and development projects designed to assist CRRC with initial clam seed production efforts.

MTC base operation funding for future years would provide for some specific project funding, but ADF&G will pursue additional development funding from sources such as:

- Alaska Science and Technology Foundation
- Western Regional Aquaculture Consortium
- USDA
- National Marine Fisheries Service

Grant funds from a number of these sources are very likely if ADF&G operates the MTC.

The project will be located on property occupied by the University of Alaska, Seward Marine Center. Part of the mission of the University's Marine Advisory Program is to conduct shellfish research. The phytoplankton culture and shellfish rearing capabilities of the MTC/SH will open new opportunities for research and research funding to University scientists. The MTC/SH will open an area of shellfish research that is not present at the IMS, Seward Marine Center and this will provide the potential for joint research projects between the two facilities.

PERSONNEL

Tom Rutz
9175 James Blvd
Juneau, Alaska 99801
(907) 465-6146

Employment:
1993- Present: Assistant Mariculture Coordinator, Alaska Department of Fish and Game, Juneau, AK. Reviewed and issued aquatic farm and shellfish hatchery permits to comply with statutory and regulatory responsibilities of the Department. Assisted the public and private sectors with technical questions regarding aquatic farming and worked with the aquatic farm industry on ongoing projects as well as identifying, prioritizing, and developing new applied shellfish research projects.

1983-1993: Assistant Hatchery Manager (Elmendorf Hatchery), Alaska Department of Fish and Game, Anchorage, AK. Assumed responsibility for the day to day operation of a large production fish hatchery.

1983: Assistant Hatchery Manager (Snettisham Hatchery), Alaska Department of Fish and Game, Juneau, AK. Assumed responsibility for the day to day operation of a large production fish hatchery.

1979-1983: Fish Culturist (Hidden Falls Hatchery), Alaska Department of Fish and Game, Sitka, AK. Maintained cultured king and chum salmon population.

1979: Fish Culturist (Snettisham Hatchery), Alaska Department of Fish and Game, Juneau, AK. Maintained cultured king and chum salmon population.

1973-74: Teeple Service Station, Greene, IA. Auto mechanic.

1970-1973: United States Marine Corps, Counter Mortar Radar Technician. Maintained and repaired ground radar sets and miscellaneous electronic gear.

Education:
B.Sc. Fisheries, University of Alaska, Juneau, 1978

James O. Cochran
Alaska Department of Fish and Game
P.O. Box 25526
Juneau, AK 99802
(907)465-6150

Employment:

1990 - present: Mariculture Coordinator, Alaska Department of Fish and Game, Commercial Fisheries Management and Development Division. Administer the aquatic farming program for the division and the department. Provide technical assistance to aquatic farms. Coordinate mariculture and related efforts with other divisions and agencies.

1988 - 1990: Senior Fish Culturist, ADF&G, FRED Division. Provided technical and logistic assistance to all state and private salmon hatcheries in southeast Alaska. Project manager for a multi-million dollar expansion of Hidden Falls Hatchery.

1981 - 1988: Hatchery Manager, Hidden Falls Hatchery, ADF&G, FRED Division. Managed all aspects of a large, multi-species, remote salmon hatchery located on Baranof Island near Sitka, AK. Chum salmon and chinook salmon were cultured at the facility.

1981: Operations Manager, Prince William Sound Aquaculture Corporation. Managed all operational aspects of the corporation including a large salmon hatchery, a limnology program, and logistic support. I also provided technical assistance for hatchery and corporate personnel and board of directors.

1978 - 1981: Hatchery Manager, Hidden Falls Hatchery (see above for job description).

1977 - 1978: Chief Fish Culturist, North American Salmon Research Center, St. Andrews, New Brunswick, Canada. I managed all fishery and operations related aspects of a large genetics research hatchery. Duties included identification, prioritization, and coordination of projects.

1974 - 1977: Fish Biologist, US Fish and Wildlife Service, Berlin National Fish Hatchery, Berlin, New Hampshire. I began as an entry level fishery biologist at a large, multi-species salmon and trout hatchery. I was senior hatchery biologist upon my departure in 1977. Primary duties included all aspects of hatchery operations, disease identification and treatment, and logistic support for the facility.

Education:
B.Sc. Wildlife Research, Colorado State University, Fort Collins, CO. 1971.
M.Sc. Fishery Biology, Colorado State University, Fort Collins, CO. 1973.

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

Budget Category:	Authorized FFY 1996	Proposed FFY 1997						
Personnel		$129.6						
Travel		$11.6						
Contractual		$27.3						
Commodities		$33.5						
Equipment		$48.4	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$0.0	$250.4	Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
General Administration		$21.4						
Project Total	$0.0	$271.8	$219.7	$225.1	$230.5	$236.0		
Full-time Equivalents (FTE)		2.0						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments:
- Project cost associated with report writing and workshop attendance in FY97 is estimated to be $4.1 thousand (15 person days at Range 18).
- MTC base operation funding for future years would provide for some specific project funding, but ADF&G will pursue additional development funding from sources such as:

Alaska Science and Technology Foundation
Western Regional Aquaculture Consortium
USDA
National Marine Fisheries Service

Grant funds from a number of these sources are very likely if ADF&G operates the MTC, but specific funds from other granting agencies have not been identified for FY 97.
- No general fund budget appropriations are anticipated by ADF&G for MTC operation for the duration of this project.

1997

Prepared: 4/2/96

Project Number:
Project Title: Alaska Department of Fish and Game Mariculture Technical Center Operational Funding
Agency: Alaska Department of Fish and Game

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/4/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
vacant	Technical Center Facility Manager	18/F	12.0	5.7	0.0	68.4
vacant	Technical Center Asst Facility Manager	16/F	12.0	5.1	0.0	61.2
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
						0.0
	Subtotal		24.0	10.8	0.0	
					Personnel Total	$129.6

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
workshops in Anchorage for principal investigator			6	0.1	0.6
supply and purchasing trips to Kenai/Soldotna and Anchorage			24	0.1	2.4
department administrative and/or policy meetings in Juneau, Anchorage	0.5	1	4	0.1	0.9
apprenticeship training in Puget Sound area shellfish hatchery	0.5	1	30	0.1	3.5
air charters (related to nursery projects)	1.0	3	3	0.1	3.3
Washington Sea Grant Pacific Northwest Shellfish Growers Conference	0.5	1	4	0.1	0.9
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$11.6

1997

Prepared: 4/2 /96

Project Number:
Project Title: Alaska Department of Fish and Game Mariculture Technical Center Operational Funding
Agency: Alaska Department of Fish and Game

FORM 3B
Personnel
& Travel
DETAIL

4/4/96

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

Contractual Costs:	Proposed
Description	FFY 1997
utilities (electricity, garbage, water, sewer, telephone, communication links)	10.7
snow removal	1.5
tool and equipment rental	2.5
shared fuel costs with shellfish hatchery operator (building heat and process water heating)	9.6
freight and postage	1.0
baseline process water samples (especially dissolved organics and heavy metals)	2.0
When a non-trustee organization is used, the form 4A is required. **Contractual Total**	$27.3

Commodities Costs:	Proposed
Description	FFY 1997
office (fax machine, phones, paper, pens, pencils, printer/copier/fax cartridges, misc)	2.2
janitorial, safety (paper towels, lab wipes, soap, cleaning supplies, brooms, brushes, first aid kits, eye wash stations, misc clothing)	1.0
stock labratory chemicals and algae nutrient solution components	2.4
shop tools and stock items (fasteners, lumber, metal stock, resins, glue, PVC pipe stock, nitex screen, electrical connectors, misc)	12.0
labware (water quality test equipment, instruments, glassware, lamps, burners, slides, counting cells, micrometers, calipers, misc)	4.1
algae culture flasks and lab air distibution system	3.3
lab water distribution system (small pumps, PVC pipe/fittings/valves, headbox alarms, filters, heaters, misc)	4.5
algae culture lighting system components (flourescent lights/ballasts, mounts, rack, misc.)	4.0
Commodities Total	$33.5

1997

Prepared: 4/2/96

Project Number:
Project Title: Alaska Department of Fish and Game Mariculture Technical Center Operational Funding
Agency: Alaska Department of Fish and Game

FORM 3B
Contractual & Commodities
DETAIL

4/4/96

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

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
office equipment (2 computers, 1 printer, software, 2 bookshelves, 2 cabinets, 2 chairs, 2 tables, 1 copier)	1	13.5	13.5
lab equipment (2 microscopes, 2 dissecting scopes)	1	5.0	5.0
water quality test equipment (1 DO meter, 1 pH meter, 1 turbidmeter, 1 saturometer, 1 colorimeter w/filters)	1	6.1	6.1
water quality test equipment (salinometers)	2	0.6	1.2
50 gal. Kalwal algae rearing tanks and fittings	8	0.2	1.6
larvae rearing tanks (misc sizes) and fittings	1	5.0	5.0
shared floor mounted autoclave (with hatchery operator) for algae carboy sterilization	1	4.0	4.0
bench top autoclaves for labs	2	1.0	2.0
anlalytical balance	1	3.0	3.0
UV sterilizers for incoming process water	2	1.5	3.0
upwell/downwell nursery rearing boxes	4	1.0	4.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$48.4

Existing Equipment Usage: This is a new facility/project. Description	Number of Units	Inventory Agency

1997

Prepared: 4/2/96

Project Number:
Project Title: Alaska Department of Fish and Game Mariculture Technical Center Operational Funding
Agency: Alaska Department of Fish and Game

FORM 3B
Equipment
DETAIL

4/4/96

Cutthroat Trout and Dolly Varden Recovery in Prince William Sound

Project Number:	97172
Restoration Category:	Monitoring and Research
Proposer:	Alaska Department of Fish and Game, Sport Fish Division
Lead Trustee Agency:	ADF&G
Cooperating Agencies:	none
Alaska Sea Life Center:	No
Duration:	4 years
Cost FY 97:	$402,300
Cost FY 98:	$245,000
Cost FY 99:	$245,000
Cost FY 00:	$245,000
Geographic Area:	Prince William Sound
Injured Resource/Service:	Cutthroat Trout Dolly Varden Sport Fishing

ABSTRACT

The *Exxon Valdez* Oil Spill (EVOS) Trustee Council currently lists cutthroat trout (*Oncorhynchus clarki*) and Dolly Varden (*Salvelinus malma*) as "Injured Resources Whose Recovery is Unknown". Various restoration projects have been proposed and supported by the Trustee Council, however no projects have been submitted to evaluate the recovery of these species. The proposed study would evaluate recovery of stocks of cutthroat trout and Dolly Varden exposed to petrogenic hydrocarbons through estimation of growth and survival at oiled and unoiled sites in Prince William Sound. In a study conducted by Hepler et al. (1993), that documented injury to cutthroat trout and Dolly Varden ostensibly due to chronic starvation and direct exposure to petrogenic hydrocarbons, results showed statistically significant reductions in growth at oiled sites, but did not demonstrate statistically significant differences in survival. As proposed, the current study would examine fewer oiled sites than Hepler et al. (1993, see Figure 1) and would separately address both marine and fresh water components of annual growth and survival that were not addressed in earlier studies. This study is designed to answer

remaining questions of reduced survival and demonstrate the present status and rate of recovery for these important fishery resources in Prince William Sound.

INTRODUCTION

Cutthroat trout and Dolly Varden are important recreational and ecological resources in Prince William Sound. Cutthroat trout in Prince William Sound are at the extreme northern range for the species (Scott and Crossman 1979). Both anadromous and resident forms of each species exist. Anadromous forms spend varying amounts of time in fresh water environments, up to 4 years prior to emigration to the marine environment (Scott and Crossman 1979). In the marine environment, each species feeds in nearshore and estuarine areas (Scott and Crossman 1979, Morrow 1980). Cutthroat trout feed on fish (Narver and Dahlberg 1965), whereas Dolly Varden feed on crustaceans, small invertebrates and fish (Armstrong 1971).

Cutthroat trout and Dolly Varden are listed by the Trustee Council as "Injured Resources Whose Recovery is Unknown". Although various restoration projects have been proposed and supported by the Trustee Council, none have been submitted to specifically evaluate the current state of injury to the resource or the recovery status of known populations. In conjunction with ongoing restoration projects, the proposed study would provide information by which the Alaska Department of Fish and Game could develop long term management strategies for the recovery and restoration of cutthroat trout and Dolly Varden in Prince William Sound.

Other restoration projects to which the proposal is linked include: /145 *Cutthroat Trout and Dolly Varden: The Relation Among and Within Populations of Anadromous and Resident Forms*; and, /043 *Cutthroat Trout Habitat Restoration (Monitoring)*. In addition, a USFS project is being conducted to determine population variability, estimate survival rates and document migration patterns and habitat requirements of cutthroat trout at Mile 18 Creek near Cordova. This project was submitted to the Trustee Council (project no. 96043A) but not approved for funding because it was part of an on-going agency effort. In addition, this proposal is linked to a companion ADF&G new proposal: *Cutthroat Trout and Dolly Varden in Prince William Sound: Restoration Project Support and Coordination, Project No. A.*, as submitted.

NEED FOR THE PROJECT

A. Statement of Problem

Petrogenic hydrocarbons from the *Exxon Valdez* oil spill impacted areas utilized by cutthroat trout and Dolly Varden in Prince William Sound. Teal and Howarth (1984) reported that benthic organisms in nearshore areas were particularly susceptible to these

hydrocarbons. Jewett and Dean (1993) and Jewett et al. (1993) reported the size of epifauna and numbers of amphipods, which are important food sources for Dolly Varden decreased in areas exposed to hydrocarbons. Hepler et al. (1993) found that populations of cutthroat trout and Dolly Varden which were exposed to petrogenic hydrocarbons exhibited slower growth rates when compared to populations in unoiled areas during the period of 1989-1991. A similar pattern was exhibited by cutthroat trout in 1990 and 1991, however, this was not the case for Dolly Varden during the same period (Hepler et al. 1993). Although Hepler et al. (1993) reported that averages of estimated survival rates from 1989 to 1990 were less in study populations associated with spilled oil (32% and 22% less for subadult and adult Dolly Varden and 28% less for adult cutthroat trout), none of these differences were found to be statistically significant, given alpha = .05. Chronic starvation and direct exposure to petrogenic hydrocarbons were hypothesized as the pathways that spilled crude oil could have slowed growth of cutthroat trout and Dolly Varden in oiled areas.

B. Rationale/Link to Restoration

The *Exxon Valdez* Oil Spill Trustee Council currently lists cutthroat trout and Dolly Varden as an "Injured Resource Whose Recovery is Unknown". Documented reduced growth (Hepler et al. 1993) and remaining uncertainties regarding reduced survival could have long term impacts upon the continued viability of populations of cutthroat trout and Dolly Varden in areas exposed to oil. These species may live for up to 8 years (Morrow 1980). This, when combined with the expected persistence of oil in the nearshore environment (Lee et al. 1979) suggests the potential for long term detrimental impacts upon these species. Although the Invitation to Submit Restoration Proposals for FY97 issued by the Oil Spill Trustee Council excludes verbiage included in previous invitations stating that "Restoration workshops have consistently identified the need for studies to confirm the injury to cutthroat trout and Dolly Varden and determine whether the injury is continuing, or if recovery has occurred", it is anticipated that the council continues to recognize the need for such studies. Evaluation of the current status of recovery coupled with sustained (e.g. multi-year) monitoring of future recovery is necessary in order to evaluate management strategies for restoration of cutthroat trout and Dolly Varden in Prince William Sound. This study articulates methods and means by which to accomplish the objective of measuring the current status of injury, whether such injury is continuing and the mechanism to monitor recovery.

C. Location

Data collection and field work will be conducted entirely within Prince William Sound. The treatment sites (oiled) shall consist of Eshamy Lakes (western PWS) and Green Island Lakes (western PWS), the control site (unoiled) shall consist of Makaka Lake on Hawkins Island (eastern PWS), see Figure 1. Administrative support for the project will be provided by ADF&G, Sport Fish Division in Anchorage. All communities in Prince

William Sound will benefit from the restoration efforts produced by this project and related Trustee Council projects. Communities that will directly benefit from successful recovery would include Valdez, Cordova and Whittier through ecological enhancement and enhanced recreational and economic opportunities. The communities of Tatitlek and Chenega would benefit through ecological enhancement and increased subsistence, recreational and economic opportunities.

COMMUNITY INVOLVEMENT

All effected communities will be involved to the extent that local resources and community interest exists. Project information and study results will be presented in a non-technical format by project biologists at pre-arranged informational meetings at community centers or other places of local gathering. Traditional and local knowledge of cutthroat trout and Dolly Varden will be solicited from residents of Chenega and Tatitlek through channels to be developed with village elders. Local hire, acquisition of services and equipment as well as other required resources will be afforded local communities to the extent that such items and services are available competitively.

PROJECT DESIGN

A. Objectives

1. Determine the status of injury to the resource and monitor recovery of stocks of cutthroat trout and Dolly Varden exposed to petrogenic hydrocarbons resulting from the *Exxon Valdez* oil spill in Prince William Sound through estimation and comparison of growth and survival within and between sites exposed and sites not exposed to spilled oil.

2. Determine the condition of cutthroat trout and Dolly Varden exposed to petrogenic hydrocarbons resulting from the *Exxon Valdez* oil spill in Prince William Sound through comparison of weight at length within and between sites exposed and sites not exposed to spilled oil.

3. In conjunction with results from other restoration projects funded by the EVOS Trustee Council, identify and evaluate alternative management strategies for restoration of populations of cutthroat trout and Dolly Varden, lost use of the resource and habitat critical to restoration in Prince William Sound (to be accomplished upon completion of this project).

B. Methods

The following hypotheses will be tested:

1. There is no difference in seasonal marine survival rates of anadromous cutthroat trout and Dolly Varden who reside during winter in lacustrine systems emptying into oiled marine waters (western PWS) and non-oiled marine waters (eastern PWS). The test will be conducted given a level of significance of alpha = 0.05.

2. There is no difference in seasonal fresh water survival rates of anadromous cutthroat trout and Dolly Varden who reside during winter in lacustrine systems emptying into oiled marine waters (western PWS) and non-oiled marine waters (eastern PWS). The test will be conducted given a level of significance of alpha = 0.05.

3. There is no difference in seasonal marine growth rates of anadromous cutthroat trout and Dolly Varden who reside during winter in lacustrine systems emptying into oiled marine waters (western PWS) and non-oiled marine waters (eastern PWS). The test will be conducted given a level of significance of alpha = 0.05.

4. There is no difference in seasonal fresh water growth rates of anadromous cutthroat trout and Dolly Varden who reside during winter in lacustrine systems emptying into oiled marine waters (western PWS) and non-oiled marine waters (eastern PWS). The test will be conducted given a level of significance of alpha = 0.05.

5. There is no difference in seasonal weight at length of anadromous cutthroat trout and Dolly Varden migrating from the marine environment into lacustrine systems emptying into oiled marine waters (western PWS) and non-oiled marine waters (eastern PWS). The test will be conducted given a level of significance of alpha = 0.05.

6. There is no difference in seasonal weight at length of anadromous cutthroat trout and Dolly Varden emigrating from lacustrine systems into oiled (western PWS) and non-oiled (eastern PWS) marine waters. The test will be conducted given a level of significance of alpha = 0.05.

The intended duration of this project is 4 years. Both long and short term aspects of the study will be discussed. As proposed, this project is a modification of growth and survival studies of cutthroat trout and Dolly Varden conducted during 1989-1992 in Prince William Sound by Hepler et al. (1993). Two oiled sites (treatment) and two unoiled sites (control) will be employed, whereas Hepler employed three treatment and two control. The treatment site at Rocky Bay will be excluded from studies because it was only lightly exposed to oil in 1989 and cannot be strictly viewed as either oiled or unoiled. Beyond this, the proposed study will specifically address freshwater and marine components of annual growth and survival. This will be accomplished by continuous

manning of weirs at all study and control sites from ice out in the spring to freeze up in late fall. This will enable sampling of spring emigration to marine waters and fall migration into overwintering sites producing data sets suitable for estimating freshwater and marine components of growth and survival.

In the spring of 1989, cutthroat trout and Dolly Varden were still in freshwater residence at the time of the oil spill. Hepler et al. (1993) used information gathered during the 1989 spring emigration from oiled and non-oiled sites as a baseline for comparing growth and survival during subsequent years. Because no significant difference was found in length at age for cutthroat trout and Dolly Varden between oiled and non-oiled sites during the 1989 spring out-migration, it was assumed that growth and as a consequence, survival at oiled (western PWS) and non-oiled (eastern PWS) sites were the same prior to the oil spill, Hepler et al. (1993). Because no other empirical information exists to establish pre oil spill baseline growth and survival for these species, these assumptions will again provide the basis for comparing estimates during subsequent years.

The EVOS Trustee Council and it's technical staff have expressed concerns that there may be intrinsic historical differences in marine productivity between the eastern and western portions of Prince William Sound, placing in question assumptions made by Hepler et. al (1993) and some of the conclusions reached as a result of his studies, i.e. "Is the difference in growth of stocks of cutthroat trout and Dolly Varden between oiled and unoiled sites a result of exposure to petrogenic hydrocarbons as concluded by Hepler, or was it a natural result of differences in productivity in the marine environment"? By separately estimating marine and freshwater components of annual growth and survival, results will allow temporal comparison of marine survival and growth within and between study and control sites and allow for comparison of fresh water components between study sites. Results should provide sufficient discrimination to resolve the influences of freshwater and marine environments on annual growth and survival and provide a measure of current injury and the subsequent dynamics of recovery in the marine environment since 1989.

Sampling design will be based upon the model of migratory behavior of anadromous Dolly Varden developed by Armstrong (1970, 1974, 1984) and Armstrong and Morrow (1980). Juvenile Dolly Varden remain in their natal stream for up to four years, then smolt to sea during spring. In late summer or early fall, all surviving Dolly Varden return to freshwater to overwinter. Dolly Varden spawned in watersheds with lakes (lacustrine watersheds) return to their natal watersheds to overwinter in one of its lakes; fish spawned in watersheds without lakes (fluvial watersheds) enter lacustrine watersheds in search of lakes suitable for winter residence. Each spring, adults and immature Dolly Varden again migrate to sea with adults out-migrating earlier than younger fish. Within each age group, larger Dolly Varden migrate earlier. Once a Dolly Varden has spent a winter in a particular lake, it returns to that lake each winter, provided it survives. Mature Dolly Varden return to their natal streams to spawn in the fall. Migratory habits of anadromous cutthroat trout are the same as Dolly Varden, however, cutthroat trout spawn in the spring (Scott and Crossman 1979, Morrow 1980, Trotter 1989). The timing of

spring emigration of cutthroat trout corresponds to that of smolting Dolly Varden. Because Dolly Varden and cutthroat trout annually leave the ocean and return to the same lacustrine watershed to overwinter, all survivors of the spring emigration from such a watershed would be expected to return in late summer and fall.

As with Hepler et al. (1993), each study stream consists of a freshwater lake-river system that is: 1) a tributary to marine waters that were either impacted by large quantities of oil or received virtually no oil and 2) contains stocks of anadromous cutthroat trout and Dolly Varden. Study treatment sites (oiled) shall consist of Green Island Lake and Eshamy Lake. The control sites (non-oiled) shall consist of Boswell Bay Lakes on Hinchinbrook Island and Makaka Lakes on Hawkins Island (Figure 1).

In the spring of 1997, weirs will be installed on each system upstream from the marine terminus of each stream. Weirs will be installed by no later than April 7 or ice out, whichever occurs earlier, to better sample the emigration of older and larger Dolly Varden, Hepler et. al (1993). Weirs shall consist of inclined aluminum panels containing free moving vertical rods spaced at 2cm. intervals. Panels will measure approximately 2.0x1.0 meters and shall rest on incline against wooden tripods spaced approximately 2.0 meters apart. Bases of each panel will be faced with fine mesh screen and sandbagged into place. Upstream and downstream holding pens will be installed. Provisions for a spillway into the downstream holding pen will be incorporated in the event of flooding, which is common in Prince William Sound. Each weir will completely block respective streams and will direct migrating fish into the respective holding pens.

Data from 1997 field studies should provide estimates for emigration timing to marine environments and return migration timing for cutthroat trout and Dolly Varden at all study sites. Timing information should allow identification of time periods that cutthroat trout and Dolly Varden are not actively migrating, thus leading to potential reductions in time of required weir operation at each site. Subsequent to 1997, it is possible that the duration of operations could be reduced and is reflected in anticipated expenditures in the project budget, as submitted.

All cutthroat trout and Dolly Varden emigrating in the spring and returning in the fall will be counted and measured to the nearest mm fork length (FL). Fish ≥200mm will be marked with individually numbered Floy, T-bar tags (Model 68-B) and weighed to the nearest 0.1kg.. Armstrong (1970, 1974) and Trotter (1989) reported that almost all fish between 200mm and 270mm FL emigrating in the spring are immature (subadults); smaller fish are smolts and larger are adults. Scale samples will be taken from the left side of all cutthroat trout ≥200mm approximately two rows above the lateral line on a diagonal downward from the posterior insertion of the dorsal fin. Otoliths will be taken from Dolly Varden. Otolith sampling levels shall be sufficient to meet statistical criteria established in test hypotheses.

Hepler et al. (1993) reported that at all recaptured Dolly Varden from study populations except Boswell, had lost less than 2% of their tags; all recaptured cutthroat trout had retained their tags. Consequently, tag loss shall be assumed to be minimal. Tag numbers will be recorded for each tagged fish and recapture event. For estimation of marine survival and growth the study population will consist of all marked fish released during the previous out-migration. For estimation of freshwater growth and survival the study population will consist of all marked fish released during the fall migration into freshwater and recaptured during the subsequent spring out-migration.

Length at age for cutthroat trout and Dolly Varden will be compared with data from Hepler et al. (1993) to identify trends in annual growth as a measure of recovery. Weight at length data will be compared within and between study populations and their association with exposure to oil as a measure of recovery as indicated by condition.

Estimates for marine and freshwater survival will be computed for each study site through analysis of tag returns. If all emigrating fish in the spring and all migrating fish in the fall can be examined for marks, the estimates for survival (S) can be simply computed as:

$S=m_2/R_1$

where: m_2 = number of fish recovered in migration event y+1
R_1 = number of fish tagged in migration event y.

If weirs remain fishtight throughout the season, the hypothesis of equal survival between oiled and control sites will be tested using contrast within a multinomial analysis of variance (Woodward et al. 1990). Cutthroat trout and Dolly Varden of different sizes suffer different rates of mortality (Armstrong, 1984, Sumner, 1953). Consequently, size structures of different populations will be examined and controlled in the ANOVA.

If weirs are compromised, survival will be estimated with log-linear models following Cormack (1989) as applied by Hepler et al. (1993). Because immature and mature Dolly Varden and cutthroat trout typically suffer different survival rates, study populations will be divided into adults (≥ 270mm) and subadults (<270mm), with the analysis repeated for each group. Precision of average survival rates across study populations will be estimated through a two stage Monte Carlo simulation based on empirical distributions for estimated survival rates derived through bootstrapping capture histories (Efron 1982, Sauermann 1989, Buckland and Garthwaite 1991) as applied by Hepler et al. (1993). The significance of differences in estimated survival across associations with spilled oil will be judged relative to the precision of the distribution of simulated survival rates. Each of the four combinations of species and maturity will correspond to two distributions of simulated survival rates: one for study populations associated with spilled oil and one for study populations not associated with spilled oil. If the distributions of simulated survival rates are not normally distributed, an angular transformation will be used. The Z statistic

will be used as the basis for testing the hypothesis of no difference in survival between populations exposed and populations not exposed to oiled marine environments.

Freshwater and marine growth components will be calculated from tagging and biological sampling data as the difference between length at time of release and length at time of recovery. Weight at length will be calculated from biological sampling data. Analysis of variance (ANOVA) will be used to test for significant differences in growth and condition between fish from oiled and control sites and between years for fish from oiled sites to quantify recovery. Variation due to differences in years and initial length can be controlled through the use of a block and covariate in the linear model if necessary. Sampling levels shall be sufficient to meet statistical criteria established in test hypotheses.

The assumptions of the analysis are:

1. random sample
2. normal distribution, and
3. homogeneity of variance.

The assumption of normality will be tested using Kolomogorov's D statistic. If the data is not normally distributed, then a logarithmic or rank transformation will be employed. The homogeneity of variance assumption will be tested with a Bartlett's test. Again, if the assumption is not valid, a transformation will be used.

C. Cooperating Agencies, Contracts, and Other Agency Assistance

Not applicable.

SCHEDULE

A. Measurable Project Tasks for FY97 (October 1, 1996 - September 30, 1997)

Sept.1- Oct 31:	Solicit traditional input, Chenega, Tatitlek
November 1 - January 20:	Prepare detailed operational plans
January 22-25:	Attend annual restoration workshop
February 1 - April 1:	Coordinate logistics & purchasing, 97 field season
April 1 - November 15:	**Field data collection/weir operations, FY97-FY98**

B. Project Milestones and Endpoints

Project objective 1 & 2 will be met on an annual basis, with results available as follows:

Marine survival & growth estimates for 1997:	April 15, 1998
Freshwater survival & growth estimates for 1997-98	April 15, 1999
Marine survival & growth estimates for 1998:	April 15, 1999
Freshwater survival & growth estimates for 1998-99	April 15, 2000
Marine survival & growth estimates for 1999:	April 15, 2000
Freshwater survival & growth estimates for 1999-00	April 15, 2001
Marine survival & growth estimates for 2000:	April 15, 2001

Project objective 3 will be met upon completion of the project and will be presented to the EVOS Trustee Council within the annual project report, due April 15, 2001.

C. Completion Date

All project works and restoration objectives will be completed and submitted to the EVOS Trustee Council no later than the close of business, September 30, 2001.

PUBLICATIONS AND REPORTS

Annual and final reports will be submitted as scheduled. In addition, manuscripts may be submitted for publication in professional journals as appropriate. Specific journal names or manuscript titles have not be determined at this point in the development of the project.

PROFESSIONAL CONFERENCES

The Principal Investigator will attend all departmental and Trustee Council meetings appropriate to cutthroat trout and Dolly Varden. Presentations will be made, as appropriate, at state and national American Fisheries Society and other professional meetings.

NORMAL AGENCY MANAGEMENT

The objectives of this project are designed to evaluate the recovery of resources injured as a result of the *Exxon Valdez* oil spill, however the studies will also benefit the normal

ADF&G management activities. None of the proposed activities are mandated in any Alaska statute or regulation. Prior to the oil spill no work of this nature had been conducted in Prince William Sound due to relatively low angler effort and the remote nature of the fisheries. As a result of the oil spill, closures and restriction on these fisheries caused loss of sport fishing opportunity. In addition, publicity regarding Prince William Sound as a result of the spill increased sport anglers awareness and interest in recreational opportunities in the sound in general and on the cutthroat trout and Dolly Varden resources. As a result of the documented injury, increased popularity of the sound and relatively small database regarding these fisheries ADF&G has adopted an extremely conservative approach to management of these species. Without the information from this study and the opportunity to focus development of management strategies, the department will continue to manage conservatively. This type of management may result in unnecessary reduction of opportunity or the potential for additional impact to the cutthroat trout resources in Prince William Sound. This project will result in a permanent improvement of the management of cutthroat trout and Dolly Varden resources in Prince William Sound. No departmental funding for this type of work is expected.

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

The Alaska Department of Fish and Game has been in contact with investigators conducting project /145 *Cutthroat Trout and Dolly Varden: The Relation Among and Within Populations of Anadromous and Resident Forms*; and, /043 *Cutthroat Trout Habitat Restoration (Monitoring)*, each funded by the EVOS Trustee council. The department has assisted and will continue to assist in areas of sample collection required by project /145 and as required by efforts of project /043 with regard to habitat monitoring. Coordination will continue with the USFS cutthroat trout study being conducted at Mile 18 Creek near Cordova.

Existing (ADF&G) vehicles, inflatable rafts, outboard motors and camp equipment will be utilized to the fullest extent. If funding for the project is approved utilization of CFM&D site facilities at Eshamy Lake will be coordinated to minimize project costs. Air transportation during the field season will be coordinated with CFM&D, USFS and other agencies active within Prince William Sound to minimize costs.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

Not applicable.

PRINCIPAL INVESTIGATOR

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PERSONNEL

Yet to be determined.

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

Budget Category:	Authorized FFY 1996	Proposed FFY 1997
Personnel		$223.3
Travel		$8.6
Contractual		$72.3
Commodities		$54.7
Equipment		$4.8
Subtotal	$0.0	$363.7
General Administration		$38.6
Project Total	$0.0	$402.3
Full-time Equivalents (FTE)		7.1
Other Resources		

LONG RANGE FUNDING REQUIREMENTS

Estimated FFY 1998	Estimated FFY 1999	Estimated FFY 2000	Estimated FFY 2001	Estimated FFY 2002	
$245.0	$245.0	$245.0			

Dollar amounts are shown in thousands of dollars.

Comments: Data from 1997 field studies should provide estimates for emigration timing to marine environments and return migration timing for cutthroat trout and Dolly Varden at all study sites. Timing information should allow identification of time periods that cutthroat trout and Dolly Varden are not actively migrating, thus leading to potential reductions in time of required weir operation at each site. Subsequent to 1997, it is possible that the duration of operations could be reduced and is reflected in anticipated long range funding requirements.

1997

Prepared: 4/9/96

Project Number: 97172
Project Title: Cutthroat Trout & Dolly Varden Recovery in Prince William Sound
Agency: ADF&G, Sport Fish Division

FORM 3A
TRUSTEE
AGENCY
SUMMARY

4/12/96

1997 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1996 - September 30, 1997

Personnel Costs:		GS/Range/	Months	Monthly		Proposed
Name	Position Description	Step	Budgeted	Costs	Overtime	FFY 1997
Undetermined	Principal Investigator	18-C	2.0	4.9		9.8
	Fishery Biologist III					0.0
Undetermined	Project Biologist	16-B	9.0	4.4		39.6
	Fishery Biologist II					0.0
Undetermined	Crew Leader	14-A	8.0	3.0		24.0
	Fishery Biologist I					0.0
Undetermined	Fishery Technician II (8)	9-A	65.5	2.2		144.1
	2 ea @ 4 study sites, April 15-Nov 15					0.0
Undetermined	Biometric Support	19-A	1.0	5.8		5.8
	Biometrician II					0.0
						0.0
						0.0
	Subtotal		85.5	20.3	0.0	
					Personnel Total	$223.3

Travel Costs:	Ticket	Round	Total	Daily	Proposed
Description	Price	Trips	Days	Per Diem	FFY 1997
25 RT Anchorage to Cordova (equivalent to 19 flights @ $200/flight)	0.2	19			3.8
60 days Per Diem @79/day (equalivent to 48days @$100/day)			48	0.1	4.8
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
					0.0
				Travel Total	$8.6

1997

Prepared: 4/9/96

Project Number: 97172
Project Title: Cutthroat Trout & Dolly Varden Recovery in Prince William Sound
Agency: ADF&G, Sport Fish Division

FORM 3B
Personnel
& Travel
DETAIL

4/12/96

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

Contractual Costs:		Proposed
Description		FFY 1997
Vessel charter	Camp Setup & Breakdown (4camps)	
	10 days @ 1200/day	12.0
	Camp Maintenance (re-supply heavy/bulky items for 4 camps)	
	20 days @ 800/day	16.0
Air Charter	Data Pickup/Camp Supply	
	32 trips, 3hr @ 360/hr	34.6
Gas	Gasoline, 150 gal/camp, 4 camps @ 3.00/gal	1.8
	Fuel oil, 200 gal/camp, 4 camps @ 3.00/gal	2.4
	Propane	1.5
Freight		3.0
Storage		1.0
When a non-trustee organization is used, the form 4A is required.	**Contractual Total**	72.3

Commodities Costs:		Proposed
Description		FFY 1997
Food	Field crews, 8ea. x 210 days @ 18/day ea.	30.2
	Supervisory, 2ea. x 105 days @ 18/day ea.	3.8
Field Gear	Raingear, waders, hipboots etc.	2.2
Camp Equipment	Stoves, tents, hardware etc	4.5
Camp Materials	Lumber	2.0
Sampling Equipment		1.0
DP Supplies		0.5
Office Supplies		0.5
Floy Tags		10.0
	Commodities Total	$54.7

1997

Prepared: 4/9/96

Project Number: 97172
Project Title: Cutthroat Trout and Dolly Varden Recovery in Prince William Sound
Agency: ADF&G, Sport Fish Division

FORM 3B
Contractual & Commodities DETAIL

4/12/96

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

New Equipment Purchases: Description	Number of Units	Unit Price	Proposed FFY 1997
			0.0
HF SSB Radios	2	2.0	4.0
12 volt deep cycle batteries for camp radios	4	0.1	0.4
Battery chargers	4	0.1	0.4
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
			0.0
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	$4.8

Existing Equipment Usage: Description	Number of Units	Inventory Agency
Inflatable rafts	3	ADF&G
Outboards	4	ADF&G
Vehicle	1	ADF&G
Camp Stove	2	ADF&G
Generators	4	ADF&G
VHF Radios	4	ADF&G
Existing weir materials	2	ADF&G

1997

Prepared: 4/9/96

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FORM 3B
Equipment
DETAIL

4/12/96