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DETAILED RESTORATION PROJECT DESCRIPTION

Project Title: Monitoring, Habitat Use, and Trophic Interactions of Harbor Seals in Prince William Sound, Alaska

Project ID #: 95064

Lead Agency: Alaska Department of Fish and Game (ADF&G)

Cooperating Agencies: National Marine Fisheries Service (NMFS) National Marine Mammal Laboratory, NMFS Southwest Fisheries Science Center (SWFSC), University of Alaska Fairbanks (UAF), Dalhousie University

Start Date: 1 January 1995 **Completion Date:** 30 September 1997

Expected Duration: 3-5 fiscal years

Project Cost:

SFY 95 (October 1994-September 1995)	$347,600
SFY 96 (October 1995-September 1996)	$325,000
SFY 97 (October 1996-September 1997)	$325,000

Geographic Area of Project: Prince William Sound

Project Leader Signature: Kathryn J. Frost 12/10/94
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Project Manager:

Name: Joseph R. Sullivan

Signature: Joseph R. Sullivan

10 December 1994

EVOS Harbor Seal Restoration Study, 1995-1997

A. INTRODUCTION

Harbor seals (*Phoca vitulina richardsi*) occur year-round in Prince William Sound (PWS), where they are commonly seen hauled out on rocks, reefs, beaches, and glacial ice. They pup, breed, molt, and feed in the Sound. During extensive surveys of PWS in 1991-1993, 2,500-2,900 harbor seals were counted on haulouts (Burns 1994, Frost and Lowry 1994a,b, Frost et al. 1994a, Loughlin 1992, Loughlin 1993). Another 1,700 were counted in the Copper River Delta and Orca Inlet. These counts are minimum estimates of the population in this region, since some seals were in the water and not available for counting during surveys, and some small haulouts may not have been surveyed.

From 1984-1988, harbor seal counts at 25 trend sites in PWS declined by 43% due to unknown causes (Pitcher 1989). The decline continued in 1989, exacerbated in oiled areas by the *Exxon Valdez* oil spill (EVOS); 1989 counts of harbor seals at oiled trend count sites declined by 45%, compared to 11% at unoiled sites (Frost and Lowry 1994a, Frost et al. 1994a). Since 1989, molting-period counts have remained about the same. However, as of 1993, there were 51% fewer seals at oiled trend count sites than there were in 1988, and 11% fewer at unoiled sites. For all PWS trend count sites combined, there were 27% fewer seals in 1993 than in 1988, and 57% fewer than in 1984. Counts during pupping were about 20% lower in 1993 and 1994 than they were in 1989 and 1990. The reasons for the ongoing decline, and the lack of recovery from the EVOS, are unknown.

More than 300 harbor seals (36% of the seals in oiled areas) were estimated to have died in PWS because of the EVOS (Frost and Lowry 1994a, Frost et al. 1994a). Seals encountered oil in the water and on haulouts. Behavior of many oiled seals was abnormal following the EVOS, with seals reported to be sick and lethargic (Lowry et al. 1994). Inhalation of light aromatic compounds, which caused brain damage that led to drowning, was the most likely cause of death (Frost et al. 1994b, Spraker et al. 1994). Severe debilitating lesions were found in the brain of a heavily oiled seal collected in Herring Bay 36 days after the EVOS. Similar but milder lesions were found in other seals found dead and in seals collected three or more months after the spill. Pup production or survival was abnormally low in oiled areas in the year of oil spill, but apparently returned to normal in 1990-1992.

Harbor seals are important to residents of PWS for subsistence. They are harvested by Alaska Natives in communities including Tatitlek, Chenega, Cordova, and Valdez. In 1985-1989, they made up 13%-27% of the subsistence foods harvested in Tatitlek and Chenega Bay (Stratton and Chisum 1986, Stratton 1990). During 1992, these two villages harvested approximately 200 harbor seals (Wolfe and Mishler 1993), less than half the number of seals that were harvested annually before the spill. Harbor seals are also watched and photographed by tourists and recreational users of PWS and they interact with and are incidentally killed by commercial fisheries.

EVOS Harbor Seal Restoration Study, 1995-1997

Like all marine mammals, harbor seals have special federal protection under the Marine Mammal Protection Act (MMPA). Because of an ongoing population decline in the Gulf of Alaska, they are currently being considered for listing as depleted under the MMPA. It is essential that current population data be available so that inappropriate restrictions on human activities are not implemented. It is also particularly important to understand what factors are limiting the harbor seal population. We cannot assume, given the recent decline and the lack of recovery in the oiled area, that the number of seals in oiled areas will return naturally to pre-spill levels. It is necessary both to continue monitoring population trends and to identify and appropriately manage areas of particular biological significance in order to augment recovery in any way possible.

Much of the information currently available on harbor seals in PWS consists of counts of animals on haulouts during pupping and molting. While population monitoring is essential for tracking changes in overall abundance, it is not adequate for determining what is causing the seal population to decline, or for designing conservation and management measures to facilitate recovery and ensure the future health of the population. Information is also needed about habitat use, health and disease, stock identity, trophic interactions, and sources of mortality.

Satellite-linked telemetry can be used to gather information about habitat use, including site fidelity, movements between haulout sites, seasonal changes in hauling out patterns, habitats used for feeding, and feeding behavior. Satellite-linked time-depth recorders (SLTDRs) have provided researchers with the ability to monitor location and diving behavior of marine mammals (Mate 1986, 1989, Hill et al. 1987, Stewart et al. 1989, Lowry et al. 1994, Frost and Lowry 1994b). The SLTDRs transmit to a satellite-based Doppler positioning system that calculates locations and tracks movements of animals with considerable accuracy. When combined with appropriate environmental sensors and microprocessor hardware and software, other information about an animal's environment and behavior can be transmitted to the satellite.

This study has demonstrated that SLTDRs are an effective means of monitoring the movements and haulout locations of harbor seals in PWS. During 1991-1994, significant data were received from SLTDRs attached to 26 harbor seals in PWS, including 17 males and 9 females (Table 1). Nineteen were adults and 7 were subadults. SLTDRs were attached to 17 seals from areas in central PWS that were oiled by the EVOS (Seal Island, Herring Bay, Bay of Isles, Applegate Rocks); one from eastern PWS (Gravina Island); and eight from unoiled sites in southcentral PWS (Port Chalmers and Channel Island). SLTDRs were operational for up to 10 months, and provided locations for more than 75% of these days.

SLTDRs deployed during 1991-1993 indicated that the movements of harbor seals were mostly confined to within PWS. Most seals hauled

out only at the tagging location, although some also used one or two nearby locations (Frost and Lowry 1994b). Movements between terrestrial haulouts in central PWS and glaciers in northern PWS were not uncommon. Several seals made substantial movements to the Gulf of Alaska or the Copper River delta, but later returned to PWS.

Most areas where seals were diving and probably feeding were within a few kilometers of haulouts. However, one seal spent several days 30 km from the nearest land in the Gulf of Alaska. The deepest dive by a tagged seal was 404 m, but most dives were to less than 200 m. SLTDR sensors indicated that 58% of 64,000 dives monitored during 1992-1993 were less than 50 m, 39% were 50-150 m, and only 3% were deeper than 150 m. The usual maximum depth for seals smaller than 50 kg was 100-130 m, compared to 130-150 m for seals larger than 50 km (Frost and Lowry 1994b). In combination with data being collected on abundance and distribution of forage fishes and about the prey being utilized by harbor seals in PWS, these SLTDR data will help us to better understand feeding behavior of adult and subadult seals. In addition, they should help us to develop correction factors to be used in interpreting aerial survey data (e.g. Harvey 1987).

Recently, a new method has been proposed for understanding marine food webs through the use of fatty acid signatures (Iverson 1993). Fatty acids are essentially the building blocks of lipid. Organisms are able to biosynthesize and modify fatty acids, but there are biochemical limitations and differences in these processes depending on the organism. Specific fatty acids cannot be synthesized by animals and therefore can only originate from diet. Because of this, some fatty acids in the food chain can be attributed to specific origins (Cook 1985). Lipids from marine organisms are characterized by a very complex array of fatty acids. There are substantial differences in fatty acid composition among species and prey types, as well as within species by geographic region (e.g. Ackman et al. 1975, Iverson 1993). In marine mammals, dietary fatty acids are often deposited in body tissue without modification (Iverson and Oftedal 1992, Iverson et al. submitted). Consequently, it is possible to trace fatty acids obtained from the diet and to compare arrays in the tissues of the predator to those in the prey consumed.

This concept of fatty acids as trophodynamic tracers can be applied to harbor seals. In general, lipid transfer from diet to deposition in tissue is extremely efficient (Iverson 1988, Iverson et al. submitted). Because certain fatty acids cannot be biosynthesized by seals, they are known to be of dietary origin. For example, a pair of monosaturates that occur in one species of copepod act as a tracer in Atlantic cod and herring (Ackman 1980). Since most seals undergo seasonal periods of fasting and depletion of fat stores (e.g. during the breeding season or the molt) followed by intensive blubber deposition (prior to the subsequent breeding season), blubber fatty acids usually reflect the integration of diet over a period of several

months. In contrast, circulating chylomicrons in blood carry the lipid specifically from the last meal. Thus fatty acids in blubber and blood provide information on both immediate diet as well as dietary history of the animal. Since many seals tend to feed on only a single or few selected prey species at a given time or season (e.g. Bowen 1990), this facilitates the use of fatty acid signatures.

During a pilot study in 1994, 41 blubber samples were obtained. Preliminary analysis of eight samples from April indicated substantial individual variation, suggesting differences in feeding modes. Two adult, pregnant females from Stockdale Harbor and Port Chalmers had different fatty acid signatures than did two subadult males from the same general area (Iverson, unpubl. data). This is unlike harbor seals from Sable Island, Nova Scotia, which show little individual variation (Iverson, pers. commun.). Ratios of particular fatty acids in PWS seals were quite different than ratios found in seals in the Atlantic or sea lions in California. It is likely, once prey species have been analyzed, that these unusual isomers can be attributed to particular prey. The stable isotope composition of the whiskers of these same eight seals was also quite different, both at the time of sampling and along the length of the whisker (A. Hirons, pers. commun.). Whiskers of the two adult females showed large changes in del 13C (-12.5 to -17.5) and del 15N (18 to 13), suggesting changes in diet along the length of the whisker. In contrast, the two young males appeared to have been eating prey at the same trophic level throughout the period represented by the whisker. Their isotope ratios showed little change: del 13C ranged from -15.5 to -16.5 and del 15N from about 17 to 16 (Hirons, unpubl. data). If whiskers are replaced annually, these stable isotope data may suggest that adult females utilize very different prey in winter than at other times of year, or feed in different areas.

Recent epidemics and mass mortality caused by phocine distemper virus in the eastern North Atlantic have highlighted the possible role of disease in population declines (Heide-Jorgensen et al. 1992, Thompson and Hall 1993). Since 1989, as part of this and other harbor seal studies, we have been collecting samples for disease investigations. To date, 84 seals from the study area have been screened for phocine distemper virus (72 negative, 12 positive) and 97 for herpes virus (30 negative, 67 positive)(R. Zarnke, pers. commun.). Serum from 98 other seals sampled since 1991 has been sent in for analysis. Seventeen seals sampled in the Kodiak area during 1993 were tested for caliciviruses (including San Miguel sea lion virus), and all were negative (J. Lewis, pers. commun.). Swabs and/or serum from 5 Kodiak-area seals and 13 PWS seals have been screened for Chlamydia; most samples were negative (J. Lewis, pers. commun.). The only potentially pathogenic bacteria found in bacterial swabs from 27 PWS seals and 5 Kodiak seals sampled in 1993 were *Moraxella* sp., *Paturella* sp., and *Bordatella bronchiseptica*. These organisms can occasionally cause

disease in domestic animals. All can occasionally cause pneumonia, and *Moraxella* sp. can cause conjunctivitis. However, in otherwise healthy seals it is unlikely that they would cause a problem.

Although at this time it appears unlikely that disease is responsible for the ongoing decline of seals in PWS and the Gulf of Alaska, it is important to continue to collect samples, conduct some analyses, and archive serum for disease screening.

Measures of genetic diversity are useful for evaluating gene flow among seals in different geographic locations, and in assessing whether particular groups of seals constitute separate biological stocks. This information is important for several reasons. First, it is not possible to put mortality caused by an event such as the EVOS into perspective without some understanding of population structure. In other words, did the 300 seals that died following the EVOS represent 30% of a central PWS stock, 5-10% of a stock that includes all of PWS, or a much smaller percent of either a Gulf of Alaska stock or an Alaska-wide stock? Information about stock identity and stock size is also necessary for evaluating the impact of mortality caused by subsistence hunting, incidental take by fisheries, or predation. It is not possible to recommend a safe harvest level for harbor seals in PWS without knowing how large the stock is from which this harvest is taken.

Use of molecular genetic techniques can help clarify whether seals in adjacent areas are genetically discrete from one another, and provide managers with a better concept of the overall harbor seal population structure, including estimates of gene flow between colonies and site fidelity. Lehman et al. (1993) detected geographic partitioning in harbor seals from PWS, Washington, and California based on genetic variation in minisatellite loci. However, only three seals from a single location in Alaska were included in that study. Lamont and Thomas (1994) found considerable diversity in harbor seal mitochondrial DNA sequences from Washington, Oregon, and California. Although in that study many haplotypes were unique to certain localities, small sample sizes precluded conclusions regarding the amount of gene flow.

B. PROJECT DESCRIPTION

The proposed study is a continuation and redirection of harbor seal NRDA and Restoration studies that have been funded by the Trustee Council and conducted by ADF&G during 1989-1994. Methodology is consistent with that used in previous studies. Through 1994, the study consisted primarily of recovery monitoring and satellite tagging of seals to determine their movements, use of haulouts, and diving and haulout behavior in PWS. The proposed study will build upon previous research findings and incorporate new components to address high-

priority issues regarding harbor seal recovery.

The ongoing declines of harbor seals began over two decades ago in the northern Gulf of Alaska, and showed up at least a decade ago in PWS. Although periodic surveys documented these downward trends, they have done nothing to elucidate the cause of the declines. Unless research is specifically designed and conducted to investigate the factors limiting harbor seals, it is likely that little progress will be made in understanding and mitigating the decline. Similar declines have occurred in Steller sea lions (*Eumetopias jubatus*), also for unknown reasons. For both of these species, it has been suggested that changing prey availability may be an important factor. This is a difficult but important topic to investigate. It will require a multidisciplinary approach that incorporates an understanding of harbor seal behavior, habitat use, and energetics with data about the distribution, abundance, and biology of prey species and predators.

The ADF&G study will have six key components:

1) **Restoration Monitoring** - Harbor seal numbers will be monitored during pupping and molting periods at 25 trend count sites in PWS to determine whether or not recovery is occurring;

2) **Habitat Use** - Seals will be instrumented with satellite-linked time-depth recorders (SLTDRs) to investigate habitat use, movements, and diving and haulout behavior;

3) **Trophic Interactions** - Fatty acids in blood and blubber of harbor seals and in prey species will be compared and relative frequencies matched to provide an indication of diet and to elucidate food webs in PWS;

4) **Demographic Modelling** - The effects of killer whale predation, subsistence harvest, and other known mortality factors on the harbor seal population in PWS will be modelled in order to evaluate the relative influence of these factors on recovery;

5) **Disease Studies** - Blood serum samples will be analyzed for phocine distemper, herpes virus, and other diseases that could cause health problems in the seal population.

6) **Genetics Studies** - Skin samples will be collected and used for genetics analyses to determine the relationships of PWS harbor seals to those in other parts of Alaska, as well as to examine regional genetic variation within PWS.

1. Resources

This study will investigate harbor seals in PWS. Information derived from this study may benefit subsistence hunters, salmon fishermen, tourist operators, and the general public who are interested in and concerned about harbor seals by providing information on trends in abundance, biology of the seals, and insight into possible causes for the ongoing decline.

The information obtained by this study will benefit residents of Tatitlek, Chenega Bay, and other PWS communities that use harbor seals for subsistence. Native residents of PWS utilize harbor seals extensively as a source of food, and have noted the scarcity of seals and the impact this has had on subsistence hunting. Since the EVOS, the annual subsistence harvest of harbor seals in PWS has declined by over 50%.

Commercial fisheries in PWS may face more greater restrictions designed to reduce incidental take of harbor seals unless something can be done to understand and reverse the population decline. Data from this study will help to ensure that restrictive measures are not implemented unnecessarily due to lack of data.

Information contributed by this study will help to identify areas of particular biological significance to harbor seals. Such information will serve as the basis for management recommendations to protect the integrity of important seal habitats and to ensure that human activities do not have further impact on harbor seals. Tagging data will be valuable in further refining aerial survey methodology, particularly in determining the best time to conduct surveys.

2. Relation to Other Work

The project is part of an integrated MARINE MAMMAL ECOSYSTEM package. Other studies in the package include Condition and Health of Harbor Seals (Project 95001, UAF); Harbor Seals and EVOS: Blubber and Lipids as Indices of Food Limitation (Project 95117-BAA, UAF); and Comprehensive Killer Whale Investigation (Project 95012, NMML). Although the study of Isotope Tracers - Food Web Dependencies in PWS (Project 95320-I, UAF) is part of the PWS System Investigation, it will also be closely coordinated with this project. See also section G (Coordination of integrated research effort) for additional description of the relationship between this and other Restoration research.

This harbor seal study will incorporate results from Herring (ADF&G) and Oceanographic (UAF) studies being submitted under the PWS System Investigation, and from the study of Abundance and Distribution of Forage Fish being developed by NMFS to investigate food availability to pelagic predators (Project 95163A). Harbor seal investigators will assist in prioritization of samples to be collected by Herring and Forage Fish studies for stable isotope and fatty acid analyses. Species to be analyzed will be chosen based on their collective importance to harbor seals, seabirds, and killer whales.

Harbor seal investigators are currently and will continue to participate in interactive discussions with subsistence hunters in PWS and the Gulf of Alaska through Project 95244 (Seal and Sea Otter Cooperative Harvest Assistance). These discussions include the

ongoing harbor seal decline, communication of results of Restoration-funded studies, suggestions for future research, and possibilities for local involvement in harbor seal investigations. The Subsistence Restoration Project - Food Safety Testing (Project 95279) is providing samples to this harbor seal study for numerous analyses, including: genetics, stable isotopes, fatty acids, blood chemistry, and stomach contents.

3. Objectives

The goals of this study are to monitor the abundance and trends of harbor seals at trend count sites in oiled and unoiled areas of PWS using standardized methodology (and while doing so refine survey methodology); to gather data on the behavior and habitat use of harbor seals in PWS that can be used to design effective conservation measures; to investigate trophic interactions in order to better understand whether food is limiting the harbor seal population; to model the effects of different sources of mortality on harbor seals; to determine whether disease is responsible for the decline and/or failure to recover from the EVOS; and to determine the genetic relationships among harbor seals in PWS and the Gulf of Alaska.

The objectives of this study are:

a) Monitoring: 1) continue monitoring harbor seal population trends in PWS by conducting aerial surveys at 25 trend count sites during pupping and molting in 1995 and 1996; 2) conduct a power analysis for PWS harbor seal surveys conducted 1984-1994; 3) recommend a monitoring schedule for 1997 and beyond, based on the power analysis; and 4) compare recent data to data collected following the EVOS to evaluate whether seal numbers are continuing to decline, have stabilized, or are recovering to pre-spill levels.

b) Habitat Use: 1) describe hauling out and diving behavior, and by inference, feeding behavior of satellite-tagged seals in PWS relative to date, time of day, and tide; and 2) describe the use of and movements between haulouts and feeding areas.

c) Trophic Interactions: 1) determine individual, seasonal, and interannual differences in fatty acid composition of lipid stores in harbor seals from PWS through analysis of blubber and serum; 2) assess variation in the fatty acid composition of prey species; 3) determine prey items in harbor seal diets using statistical analyses of fatty acid signatures; and 4) evaluate the relative contribution of each prey type to the overall diet using measured fat content of the prey.

d) Demographic Modelling: 1) model the effects of killer whale predation, the subsistence harvest, incidental take by fisheries,

and mortality caused by the EVOS on the harbor seal population; and 2) evaluate how these factors may impact recovery from the EVOS.

e) Disease: 1) conduct viral screening to determine whether disease may be causing or aggravating the harbor seal decline; and 2) archive serum samples for future disease studies.

f) Genetics: 1) conduct genetic analyses to determine whether PWS harbor seals constitute a genetically distinct population; and 2) conduct genetic analyses to examine regional genetic variation within PWS.

4. Methods

We are proposing two additional years of field study (1995, 1996) with final data analysis and reporting to take place in year three. Findings from this study will be evaluated annually, and modifications in study approach will be recommended in order to incorporate recent findings from this and other PWS studies. In addition to the six components outlined in this project description, questions about harbor seal health and condition, stable isotope analyses, predation by killer whales, and prey availability will be addressed by other Restoration studies.

a. Monitoring: Harbor seal abundance will be monitored by flying aerial surveys during pupping (June) and molting (late August-early September). A fixed-wing aircraft will be used to fly a survey of 25 trend count sites at an altitude of 700 ft. These haulout sites have been used by ADF&G for PWS harbor seal trend counts since 1983, including NRDA and Restoration studies in 1989-1994 (Calkins and Pitcher 1984; Pitcher 1986, 1989; Frost and Lowry 1994a; Frost et al. 1994a). The trend count route includes 7 sites that were impacted by the EVOS (Agnes, Storey, Little Smith, Big Smith, Seal, and Green islands, and Applegate Rocks) and 18 unoiled sites (Table 2). The survey methodology and observers will be the same as those used in PWS harbor seal studies conducted in 1989-1994 (see Frost and Lowry 1994a; Frost et al. 1994a), and as summarized below.

Maximum numbers of harbor seals are known to haul out during pupping and molting (Pitcher and Calkins 1979; Calambokidis et al. 1987). Within these periods, more animals are usually hauled out at lower stages of the tide, since availability of many haulout sites is limited by tidal stage. Consequently, our surveys will be conducted during June (pupping) and late August/September (molting) and will begin within two hours before daylight low tides and finish within two hours after low tide. Replicate counts will be made at each site to allow statistical analysis of trend. The number of replicates will be determined based on the results of a power analysis of 1984-1994 data

(in progress), but is expected to be about 7-10 during a survey period (Pitcher 1986, 1989). The number of replicates is also partly determined by weather, which can limit the number of days suitable for flying within a survey period.

Visual counts will be made of seals at each site, usually with the aid of 7 power binoculars. Pups will be counted separately during June. Photographs will be taken of large groups for later verification using a hand held 35-mm camera with 70-210 mm zoom lens and high speed film (ASA 400). Color slides will be commercially developed and the seals will be counted from images projected onto a white surface.

Aerial surveys do not estimate the total number of seals present since they do not account for seals that are in the water or seals hauled out at locations not on the trend count route. Surveys provide indices of abundance based on the number of hauled out seals that is counted. Interpretation of trend count surveys relies on the assumption that counts of harbor seals on select haulout sites are valid linear indices of local abundance. We assume that within a given biological window, such as the molting period, hauling out behavior remains the same from one year to the next, and counts can thus be compared (e.g. Harvey 1987, Pitcher 1989). Standardization of procedures minimizes the affects of variables such as tide and weather that could influence the number of seals hauled out on a given day. Behavioral data obtained from satellite transmitters attached to seals as part of this study will help to verify these assumptions.

Reliable surveys of the trend count route were conducted during the molt in 1984 and 1988-1994. These data will be used for comparisons with data collected in 1995 and later. Analyses of trend count data and comparisons with other years will be conducted following statistical methodology used for previous surveys (Frost and Lowry 1994a, b; Frost et al. 1994a). For each year, daily surveys will be averaged for each site and then sites will be summed to produce yearly estimates for the oiled, unoiled, and total trend count areas. The 95% confidence interval will be estimated by bootstrapping (Efron and Tibshirani 1993). The bootstrap method resamples with replacement from the actual daily counts at each haul-out site to produce a new data set with the same sample size (number of counts) for each site in each year. This resampling will be done 2000 times for each year's data, and then the 2000 bootstrap estimates will be ordered. Ordinarily, the 50th and 1950th ordered bootstrap estimates provide a 95% confidence interval, but as recommended by Efron and Tibshirani (1993), we will use a bias-corrected version that slightly adjusts the choice of the ordered bootstrap estimates for the confidence interval endpoints.

A linear regression model will be fitted to the 1989-1994 yearly estimates at oiled sites, unoiled sites, and for the trend count area as a whole. This will be done for both pupping and molting counts.

During the pupping period, only the counts of non-pups will be used in the analysis. The regression line for each group will take the form,

$$Y = \beta_0 + \beta_1(X)$$

where Y is the mean count/site summed for all sites, β_0 is the y intercept of the line, β_1 is the slope, and X is the year. The significance of regression coefficients will be tested using analysis of variance (Snedecor and Cochran 1969).

Project investigators will cooperate with personnel from the ADF&G Division of Subsistence (Project 95244) in their efforts to inform residents of Chenega Bay, Tatitlek, Valdez, and Cordova about the findings of this study and to incorporate the suggestions of PWS residents in study design. Such an exchange of information will allow biologists to benefit from residents' observations about abundance and behavior of harbor seals in PWS, and will help residents to make informed decisions about their annual harvest of harbor seals.

The April 1995 annual report will contain a complete analysis of trend count methodology, including a power analysis (Gerrodette 1987) of PWS harbor seal trend counts, and recommendations about future monitoring protocols. This analysis will be based on data collected by ADF&G since 1984, and will take advantage of one of the most extensive data sets of its kind. The analysis will examine such things as the effect of number of replicates on the variance; whether sites should be added or deleted; whether any part of PWS seems to be better or worse for evaluating trend; and a comparison of pupping and molting-period surveys.

b. Habitat use and behavior: During 1995 and 1996, SLTDRs will be attached to 12 seals per year at locations chosen because they appear to represent different habitat types, because of their apparent importance to seals, and/or for their proximity to forage fish and oceanographic stations sampled as part of other PWS ecosystem studies. In 1995, six seals will be caught in early spring, well before pupping, so that mothers with newborn pups are not caught. Six more seals will be tagged in September, after the molt, at a variety of locations. After 1995, it is likely that seals will be instrumented only in September.

Emphasis will be placed on instrumenting adult females. In addition, 0.5-watt SLTDRs have recently become available in a smaller-sized package which has made it possible to tag small subadult seals. During 1995, half of the SLTDRs will be placed on small subadults of either sex. Of the remaining six, at least four will be placed on adult females. This sex/age distribution of tags may be modified somewhat based on results of ongoing data analyses and/or conditions experienced in the field. Actual tagging locations will depend on where seals are present and can be caught, but will include sites that

represent different habitat types. Locations will be chosen for comparison with the existing database from Seal Island, Applegate Rocks, Channel Island, and Port Chalmers. Consideration will be given to tagging in eastern PWS (Port Gravina), and southwestern PWS (Dangerous Passage and Icy Bay). At present we have no netting method that is suitable for catching seals in areas with drifting glacial ice. If we can develop such a method, we will instrument some seals from glacial fiord areas (Icy Bay, Columbia Bay, etc.).

Seals will be caught by entanglement in nets placed near the haulouts. Nets will be approximately 100 m long and either 3.7 or 7.4 m deep with standard floats or float line and light lead lines. Mesh openings will be about 30 cm stretched measure. Nets will be deployed from a 6 m boat assisted by one or two other small boats to assist in maneuvering the net and tending it to ensure that all captured seals are quickly detected and removed (see Frost and Lowry 1994b).

When seals become entangled, they will be brought into the boats or to shore, cut free from the tangle net, and placed into hoop nets (large stockings made of 1 cm mesh soft nylon webbing). Smaller seals will be physically restrained during handling and tagging. Larger animals will be sedated with a mixture of ketamine and diazepam administered intramuscularly at standard doses (Geraci et al. 1981). Each seal will be weighed, measured, and tagged in both hindflippers with individually numbered plastic tags. Field personnel will collect approximately 50 cc of blood from the extradural intervertebral vein. Standard blood chemistry panels and virology screens (phocine distemper virus, herpes, and others as indicated) will be run on these samples. The following samples will also be taken: whisker(s) for stable isotope analysis, a small piece of skin for genetics studies, and a 0.5 cm x 2.5 cm blubber biopsy for fatty acid analysis.

Transmitters (14 cm x 10 cm x 4 cm for adults; 14 cm x 5 cm x 4.5 cm for subadults) will be attached to the mid-dorsal surface of the seal by gluing with epoxy resin (Fedak et al. 1984; Stewart et al. 1989). The SLTDRs that are attached in April/May should remain attached until mid-July to mid-August when they will fall off as the annual molt begins and the hair to which they are glued is shed. SLTDRs attached in autumn following the molt should remain attached until the next molt. Mean duration of operation of SLTDRs attached in fall 1993 was 182 days, with a range of 102-311 days (Frost and Lowry, unpublished). Tagging prior to late April is not considered cost-effective or practical. The weather is often severe, the water extremely cold making it difficult to work, and few seals are hauled out. However, we consider it desirable to attach SLTDRs for this three month period in order to investigate the behavior of adult (pregnant) females. Few tags attached in September transmit beyond April or May so we can not currently rely on them to provide information about the pupping period. Some SLTDRs were duty cycled in September 1994, and based on results from them we may duty cycle some of the units attached in

September 1995. If this effectively extends the data acquisition period through the pupping period, we may duty cycle all 1996 SLTDRs and attach them only in September.

Data will be acquired from the ARGOS satellite receiving system and initially analyzed using software provided by the manufacturer of the transmitters. Each SLTDR will transmit signals to polar-orbiting satellites whenever the seal is hauled out or when it surfaces sufficiently long for transmission to occur. An uplink occurs when a satellite is positioned to receive the signal. Information transmitted by the SLTDR is used by Service ARGOS to calculate the geographic location of the seal. Units will be equipped with built-in programmable microprocessors to collect and summarize data for periods when animals are diving and store it for later transmission, as has been done for crabeater seals (*Lobodon carcinophagus*), Steller sea lions (*Eumetopias jubatus*), and spotted seals (*Phoca largha*) (Hill et al. 1987; R. Merrick, personal communication; Lowry et al. 1994). These data will be stored in six hour blocks and transmitted to the satellite once the six hour data collection period is complete. Sensor information from a pressure transducer and a conductivity switch will be used to indicate when the animal is hauled out. Data from four periods will be stored in memory, providing at least a 24 hour window for transmission before the data are lost. Dive data will be summarized as histograms in depth bins of 4-20 m, 21-50 m, 51-100 m, 101-150 m, 151-200 m, 201-250 m, 251-300 m, 301-350 m, and over 350 m, and duration bins of 0-120 seconds, 121-240 seconds, 241-360 seconds, 361-480 seconds, 481-600 seconds, 601-720 seconds, 721-840 seconds, 841-960 seconds, 961-1080 seconds, and over 1080 seconds. In addition, SLTDRs will store and transmit the amount of time spent in each depth bin.

Each SLTDR broadcasts a unique identification code so that data can be assigned to a particular seal. Position accuracy for all geographical locational information is rated by Service ARGOS to reflect the predicted accuracy of the calculated locations (Fancy et al. 1988, Stewart et al. 1989). Data acquired for harbor seals in this study will be screened for accuracy, and interpretation of results will take into account signal quality. Sensor data will be used to validate whether the animal was at sea or hauled out on land when data were acquired, since errors in calculated locations may falsely indicate that a seal is on land or at sea (see Stewart et al. 1989).

Data on the haulout patterns of tagged seals will be examined for indications of daily or seasonal variations, for example to determine whether there is a change in the frequency of haulout by season, or whether the amount of time spent hauled out changes. Plots of locations where continuous signals are received will be used to determine the degree and regularity of use of particular haulout sites. We expect to receive fewer locations of seals while at sea,

because the transmitter's antenna will frequently be submerged. At-sea locations will be plotted as an indication of areas used for feeding. Information on depth and pattern of diving will be compiled, and will provide additional information on the general areas used for feeding.

Locations calculated by Service ARGOS will be screened for accuracy and plotted on charts of PWS. Locational data will be compared with sensor data, when possible, to verify that information regarding whether the seal is on land or at sea is correct. Patterns of diving and hauling out will be presented as histograms. Dive data histograms will present the number of dives at different depth increments and by duration of dive. Means and standard deviations for dive depth and duration will be calculated and compared for seals in different locations or habitats and at different times of day and year.

Dive data will be presented as graphs and histograms which indicate the range in individual behavior as well as summary data for all seals combined. Compilation of data on time and location of feeding dives will be used to identify feeding areas near different haulouts, if possible. If sensors indicating whether the seal is on land or at sea become more reliable and the necessary SLTDR software is developed to provide a continuous record of this information, then diving and hauling out cycles will be examined relative to time of day, tide, and season. Hauling out bouts and tidal cycles will be overlaid and plotted. Summaries of the number and quality of uplink data and at-sea position data will be presented in tabular form. Tabular summaries will also be prepared for use of different haulouts by individual seals; the number of haulout bouts relative to tidal state and time of day; and frequency of haulout and amount of time spent feeding by season.

These data will be used to evaluate site fidelity of seals, to quantify the amount of interchange among haulouts within and outside of the area impacted by the EVOS, to determine seasonal importance of particular haulouts, and to identify areas used for feeding.

c. Trophic interactions: Blubber samples will be taken from seals using routine biopsies (sterile 6 mm biopsy punches). Samples will initially be collected in spring and fall to coincide with possible seasonal changes in feeding behavior and blubber depletion/deposition. Samples will be placed in chloroform/methanol with BHT as an antioxidant, and kept frozen until analyzed. Samples will be collected from all seals that are caught during tagging operations. Blood will be collected from the same animals and centrifuged in the field. If chylomicrons are evident (milky white or cloudy serum, indicating recent feeding) the serum will be separated, preserved, and stored frozen for later fatty acid analysis. Prey species will also be analyzed by Restoration Project 95121 and/or this study.

EVOS Harbor Seal Restoration Study, 1995-1997

During 1995, fatty acid analyses of seal blubber and serum and prey samples collected in 1994 will be completed. In addition, approximately 50 additional harbor seals will be biopsied and analyzed for fatty acids (from both spring and fall, and representing different parts of PWS). Approximately 10 species of prey that are potentially important dietary items will be sampled during spring and fall. For each species and season, 8 individuals of the size range likely to be consumed by seals will be collected and will be analyzed separately for total fat and protein content and fatty acid composition. During subsequent years of the study, prey species determined to be most important in the diet will be examined in more detail. Seals will continue to be sampled from different parts of the study area. A broader range of prey species will be selected only if the initial ones chosen were not appropriate. Samples will be obtained from herring and forage fish projects. They will be frozen whole in plastic bags and stored frozen until extraction and lipid analysis.

Laboratory analysis and evaluation of data will be conducted by Dr. Sara Iverson at Dalhousie University, Nova Scotia. Fatty acids will be extracted from seal blubber and prey according to methods described in Iverson (1988). Blood samples containing chylomicrons will be processed by ultra-centrifugation after adjusting serum density with sodium bromide and layering with various density salt solutions. Chylomicrons will be decanted from other blood lipoproteins and extracted. Fatty acid methyl esters will be prepared directly from aliquots of the chloroform extract, then extracted and purified in hexane. Analysis of fatty acid methyl esters will be performed according to Iverson et al. (1992) using temperature programmed capillary gas liquid chromatography and linked to a computerized integration system. Identifications of rare isomers will be performed using techniques such as hydrogenation and silver nitrate chromatography (Iverson et al. 1992). Approximately 70 fatty acids and isomers can be separated and quantified in most marine lipids. The proper isolation of all components in any sample is critical in assessing diets and prey items; these methods are currently set up and routinely used in the Dalhousie University laboratory of Dr. Iverson.

Fatty acids will be used to evaluate food webs in two ways. The array of fatty acids in seal tissues will be statistically compared to fatty acids in prey species in order to quantify the relative contribution of each prey item to the overall diet. In addition, single unusual or unique components will be used to trace a specific prey. In the analysis and interpretation of data, fatty acids will be grouped as: 1) components which could readily be biosynthesized by the seal, 2) components that could be biosynthesized but at the measured levels are likely mostly of dietary origin, and 3) components that could only come from the diet. Categories 2 and 3 represent the "indicator" fatty acids (Iverson 1993).

Data will be analyzed using a multivariate model called a tree

because the transmitter's antenna will frequently be submerged. At-sea locations will be plotted as an indication of areas used for feeding. Information on depth and pattern of diving will be compiled, and will provide additional information on the general areas used for feeding.

Locations calculated by Service ARGOS will be screened for accuracy and plotted on charts of PWS. Locational data will be compared with sensor data, when possible, to verify that information regarding whether the seal is on land or at sea is correct. Patterns of diving and hauling out will be presented as histograms. Dive data histograms will present the number of dives at different depth increments and by duration of dive. Means and standard deviations for dive depth and duration will be calculated and compared for seals in different locations or habitats and at different times of day and year.

Dive data will be presented as graphs and histograms which indicate the range in individual behavior as well as summary data for all seals combined. Compilation of data on time and location of feeding dives will be used to identify feeding areas near different haulouts, if possible. If sensors indicating whether the seal is on land or at sea become more reliable and the necessary SLTDR software is developed to provide a continuous record of this information, then diving and hauling out cycles will be examined relative to time of day, tide, and season. Hauling out bouts and tidal cycles will be overlaid and plotted. Summaries of the number and quality of uplink data and at-sea position data will be presented in tabular form. Tabular summaries will also be prepared for use of different haulouts by individual seals; the number of haulout bouts relative to tidal state and time of day; and frequency of haulout and amount of time spent feeding by season.

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Pieces of skin will be taken from the hind flipper of each seal using a 0.5 cm diameter skin punch, and preserved in DMSO-salt solution until they are analyzed. Analyses will be conducted by the genetics laboratory at the NMFS SWFSC in La Jolla, CA. DNA will be amplified using polymerase chain reaction (PCR) procedures and fragment and sequence analyses conducted. Polymorphic mitochondrial DNA sequences and polymorphic nuclear DNA alleles will be sought as markers for morphological, geographic, and management stocks. Preliminary analyses of samples from harbor seals and spotted seals (*Phoca largha*) in Alaska have also demonstrated that this technique produces useful results (O'Corry-Crowe and Westlake 1994).

f. Alternatives: One alternative is to not fund any further harbor seal studies under the restoration program, despite the ongoing decline and absence of recovery in the oiled area. Without a monitoring program will there will not be up-to-date information on harbor seal counts, and therefore trend, in PWS. Without studies of habitat use, trophic interactions, mortality, and disease we will come no closer to understanding the reasons for the decline. No additional information about stock identity or the status of stocks will be acquired to guide management actions that could reduce the impact of human activities on these seals. The lack of up-to-date and better data may impact commercial fisheries in PWS. It is likely that management actions regarding the incidental take of harbor seals in fisheries will be very conservative. Without current data, subsistence hunters in PWS will not have the information they need to make informed decisions about harvest levels in the face of an ongoing decline in seal numbers.

An alternate methodology to satellite-tagging is the use of VHF telemetry. VHF transmitters are inexpensive to purchase. They are quite reliable for short distances when signals are not obstructed by geographic barriers, and are useful for monitoring attendance at particular haulouts (Harvey 1987). However, monitoring of VHF transmitters can expensive and labor intensive; they must be tracked either from aircraft or by field personnel stationed near the tagging location. Remote monitoring stations are of limited utility because of the topography in PWS. During much of the year, weather in PWS is foggy and stormy, and flying is either precluded or dangerous. If the seals swim more than a few miles from the monitoring station, or around an island with significant geographic relief, the signals can no longer be acquired. It would be difficult to relocate seals if they swim long distances in unpredictable directions as some of the SLTDR tagged seals have done. In PWS, VHF technology could only give an indication of some of the haulouts that are used by a tagged seal, and of its activity patterns while it is on that particular haulout.

Satellite telemetry is a preferable alternative to VHF telemetry in PWS. SLTDRs transmit data regardless of whether investigators are in

regression analysis (Clark and Pregibon 1992). This model has recently been applied and modified for fatty acid signature analysis (Iverson pers. commun.). The model considers all 70 component fatty acids in each sample and uses the fatty acid arrays of species to determine classification rules for types of signatures. The model builds complex trees through which predator (seal) samples are run for appropriate classification (i.e., diet). Through this method we will attempt to differentiate prey species being consumed, as well as geographical, seasonal, or interannual differences in diet. The quantitative contribution of each prey species to a given diet can be estimated from its total fat content based on proximate analysis and its fatty acid signature.

d. Demographic modeling: A demographic model will be developed in cooperation with biometricians from the NMFS National Marine Mammal Laboratory, to examine the effects of predation, harvest, and incidental take on the harbor seal population in PWS. The model will use life table data from PWS harbor seals collected by ADF&G in the 1970s (Pitcher 1977; Pitcher and Calkins 1979). Data on the subsistence harvest will come from ADF&G's Division of Subsistence (Project 95244 and others), obtained in cooperation with subsistence hunters from Chenega Bay, Tatitlek, Cordova, and Valdez (see Wolfe and Mishler 1993). Information on killer whale predation will be obtained from the Comprehensive Killer Whale Investigation (Project 95012), as well as from other pertinent studies (e.g., Saulitis 1993). Data on incidental take in fisheries will be obtained from NMFS, and other sources such as Wynne (1990).

e. Disease: Although at this time it appears unlikely that disease is responsible for the ongoing decline of seals in PWS and the Gulf of Alaska, we will continue to collect samples, conduct some analyses, and archive serum for disease screening. The cost of this component is minimal and it allows us to track the health of seals in the study area. During 1995 and beyond, blood will be collected from all seals that are handled during tagging. Serum will be obtained for viral screening, and assays will be conducted for phocine distemper virus, seal herpes virus, and any other viral agents that might be of concern. Additional serum will be archived at ADF&G Fairbanks for future use.

f. Genetics: Mitochondrial sequence diversity will be used to investigate genetic structure among groups of harbor seals in Alaska and within PWS. Small skin samples for genetics analysis will be taken from all seals that are captured during tagging operations in 1995 and beyond. Similar samples were also obtained from seals captured in PWS during 1993-1994, and from seals collected for food safety testing in 1994 (Project 95279). Comparative samples are available from the NOAA-funded ADF&G harbor seal study in Kodiak and southeast Alaska.

will be conducted cooperatively by personnel at NMML and ADF&G. No hydrocarbon analyses are expected as part of this project. Fatty acid analyses will be done at Dalhousie University, Nova Scotia. Disease assays will be coordinated and interpreted by Dr. Randall Zarnke at ADF&G. Phocine distemper and seal herpes virus analyses will be conducted by Dr. A. D. M. E. Osterhaus in the Netherlands. Genetics analyses will be conducted at the NMFS SWFSC.

7. Contracts

Costs of acquiring SLTDR data from Service ARGOS are paid for through a contract with the National Oceanic and Atmospheric Administration (NOAA). This contract covers all ADF&G Division of Wildlife Conservation satellite tagging projects (harbor and spotted seals, caribou), not just this harbor seal restoration project, and is processed by the Division of Wildlife Conservation. Funds for data acquisition must be encumbered and guaranteed to NOAA in early February. Actual contract processing occurs later in the spring.

Charter aircraft for surveys will not require contracts. Vessel support for tagging work will utilize small vessels contracts that will be completed by the PI. Satellite SLTDRs will be purchased under contract award from Wildlife Computers. The contract award was negotiated in 1992 and will be active throughout the duration of this project. Fatty acid analyses and interpretation will be accomplished by Dr. Sara Iverson at Dalhousie University through a Cooperative Agreement between ADF&G and Dalhousie. A Reimbursable Services Agreement (RSA) will be written with University of Alaska Fairbanks for any blood physiology work that is not covered by Project 95001. This RSA will include the cost of personnel to assist in collecting, analyzing, and interpreting blood samples taken from seals that are caught during tagging operations.

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C. SCHEDULES AND PLANNING

This project will be conducted during 1995 and 1996, with either a recommendation for additional field studies or submission of a final report in 1997. A schedule of field activities, data analysis, and report preparation is presented in Table 3 and a list of key personnel in Table 4.

Aerial surveys will be conducted during 7-14 days in June and August/September. Aerial survey data will be analyzed in winter following completion of molting surveys. A power analysis of PWS aerial survey data collected in 1984-1994 will be conducted during fall 1994. A report of the results of this power analysis, with a recommended monitoring strategy, will be submitted as part of the April 1995 annual report.

Satellite tagging and associated sampling for lipid and stable isotope analyses, genetics, and disease work will take place during late April/May and/or September. SLTDRs must be ordered by January of each year. Satellite data acquisition costs must be encumbered in February. Data are received monthly and preliminary analyses will begin as soon as diskettes are received. Final analysis cannot be completed until the SLTDRs have ceased to function. The April 1995 annual report will present a complete analysis of the movements and diving behavior of seals instrumented with SLTDRs in 1992 and 1993 in the form of charts, histograms, graphs, and tables. Data for seals instrumented in September 1994 will not be reported until the 1996 annual report, since by report preparation time there will be only a few months of data and it will not be possible to meaningfully interpret the behavior of seals.

A report of field activities will be submitted in letter form within 30 days following any field activity. The principal investigator will participate in planning workshops, as scheduled by the Trustee Council, and be prepared to present findings of this study. Annual progress reports will be submitted by 15 April of each year. In addition to the products specified in the preceding paragraphs, reports will include the status of tagging operations (number of seals caught, sampled, and instrumented as well at the status of SLTDRs at the time of reporting); analysis of body condition and a comparison of condition data from the 1970s with data from the 1990s; and results of preliminary analyses of fatty acids. A final report will be submitted by 30 September 1997, unless field work is ongoing. Results will be prepared for publication in peer-reviewed journals.

Satellite data and survey data will be archived at ADF&G in digital format. Hard copy will be generated and filed at ADF&G and a copy

sent to the National Marine Mammal Laboratory. All data will be organized and filed according to standard scientific procedures. Original copies of field data will be retained at ADF&G and copies provided to others upon request. Copies of study plans, data analyses, summaries, and reports will also be filed at ADF&G.

The project will be coordinated and managed by ADF&G. The principal investigator is Kathryn Frost, Division of Wildlife Conservation. Lloyd Lowry, Marine Mammals Coordinator for ADF&G will assist with all aspects of the study. Cooperating/contributing institutions will included Dalhousie University, the University of Alaska Fairbanks, the University of Alaska Sea Grant Marine Advisory Program, the NMFS National Marine Mammal Laboratory, and the NMFS Southwest Fisheries Science Center.

Logistics for this project will be arranged by ADF&G. The aerial survey component will require charter of a single engine, fixed-wing aircraft (Cessna 180 or 185) on floats out of Cordova. The tagging component will require the use of multiple small vessels: a chartered sleep-aboard vessel (20 - 30 m) to transport and house project personnel and serve as a base for tagging and laboratory activities; one 6 m Boston Whaler (ADF&G property) to be used in deploying seal nets; and two other 4-5 m skiffs (ADF&G property) to maneuver nets and check for and remove entangled seals.

D. EXISTING AGENCY PROGRAM

This project is funded entirely by the Trustee Council as a restoration project. ADF&G conducts no other studies of harbor seals in PWS that are not a part of the restoration program. ADF&G has no management responsibility for harbor seals. The Subsistence Division of ADF&G is funded by the Trustee Council to monitor the harvest of harbor seals in PWS (Project 95244) and to conduct food safety testing (Project 95279).

ADF&G is conducting studies of harbor seals in southeast Alaska and near Kodiak with funding from NOAA/NMFS. Those studies contain similar components to the PWS study and are closely coordinated to ensure that data are collected and analyzed in a similar manner. This will facilitate comparisons of data from declining populations (PWS and Kodiak) and a stable population (southeast Alaska) of harbor seals. Equipment is shared by the two projects. Consequently, it has not been necessary for the PWS project to purchase many equipment items and supplies solely for the use of this study. Because of these other ongoing projects, the PWS harbor seal project has had access to a GIS system with which to analyze survey and tagging data.

E. ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

NOAA has determined that this harbor seal study qualifies for

categorical exclusion (CE) and does not require an environmental assessment, per a memo from Byron Morris, NOAA, dated 18 December 1992.

As required by the Marine Mammal Protection Act, ADF&G has been authorized under Permit No. 770 to instrument up to 100 harbor seals with SLTDRs during the period 1992-1995 and to conduct a variety of sampling activities including collection of blood, whiskers, skin, and blubber biopsies. All MMPA permit applications are reviewed by federal agencies and the U.S. Marine Mammal Commission. They are available for review by state agencies and the public through a Notice of Receipt published in the Federal Register.

F. PERFORMANCE MONITORING

The PWS harbor seal project will be coordinated by the principal investigator, Kathryn Frost, who is a Marine Mammals Biologist with the ADF&G Division of Wildlife Conservation in Fairbanks. Other key personnel within ADF&G will be Lloyd Lowry, ADF&G Marine Mammals Coordinator, and Rob Delong, Analyst Programmer with the Division of Wildlife Conservation in Fairbanks. The PWS harbor seal study will be a component of a statewide harbor seal study which is being coordinated by Mr. Lowry. The other component of the statewide study being managed by Jon Lewis, Division of Wildlife Conservation in Juneau. The involvement of these three key personnel as a team in all components the harbor seal studies will ensure that methodology for aerial surveys, satellite telemetry, data analysis, and other aspects of these projects will be consistent and coordinated. It will also ensure that at all times there are at least two other persons familiar with all aspects of the harbor seals projects, and thus able to take over in case of emergency or should an unforeseen change in personnel occur. All the above listed individuals were involved in 1991-1994 PWS harbor seal studies and thus are thoroughly familiar with the proposed field activities. The investigators are highly qualified personnel with many years of experience conducting contractual research on marine mammals. They have a long track record of timely completion of high-quality work.

Key non-ADF&G personnel include Dr. Sara Iverson at Dalhousie University (fatty acids), Dr. Bob Small at NMML (modelling and biometrics), and Dr. Greg O'Corry-Crowe at Southwest Fisheries Center (genetics). Project expectations and reporting requirements have been discussed with each of these individuals. Discussions have been held with each institution to ensure that adequate time and personnel are available to complete the required tasks in the available time.

Field trips to conduct surveys and attach SLTDRs will be scheduled 3-6 months in advance. A coordination meeting will be conducted to ensure the availability of field personnel and logistics. Supervisors or support personnel have been consulted to determine their availability

to this project.

The appropriate GIS and associated analytical software are available and are currently being used to analyze data from 1992-1994.

G. COORDINATION OF INTEGRATED RESEARCH EFFORT

This project is a multidisciplinary, inter-agency undertaking. Surveys and satellite tagging will be conducted by ADF&G; lipid analyses and interpretation by Dalhousie University; blood chemistry analyses at UAF; genetics analyses by SWFSC/NMFS; and demographic modelling by NMML/NMFS. Inclusion of interdisciplinary components within the same project will ensure that data are shared and interpreted in an interdisciplinary manner.

This project (95064) will provide logistics, the MMPA permit to conduct sampling, and access to seals and samples for all three PWS harbor seal projects. Archived harbor seal data and blubber samples will be provided to Castellini/UAF for use in analyses of body condition and blubber. Harbor seal investigators at ADF&G and UAF have been working successfully together for the last three years on harbor seals in PWS and elsewhere, and future collaborations should be equally productive. Regular bi-weekly meetings and seminars are held by marine mammal investigators at UAF and ADF&G Fairbanks to exchange information and ideas.

This study will directly interface with the PWS System Investigation study entitled Isotope Tracers - Food Web Dependencies in PWS (Fish, Marine Mammals, and Birds). Samples of seal whiskers and seal prey have and will continue to be provided to that study. Investigators of the two projects (Frost and Hirons) discuss stable isotope results at regular intervals and are pursuing preparation and publication of a joint manuscript describing preliminary findings of this study.

Prey samples for fatty acid analysis will be obtained through PWS System Investigation studies and the Abundance and Distribution of Forage Fish study. Species to be analyzed will be chosen based on their collective importance to harbor seals, seabirds, and killer whales. This project will work with project 95121 to avoid duplicative analyses and to share data. Information on distribution and movements of harbor seals, and diving behavior, will be shared with PWS Sound Investigation modelling studies to look at energy flow within PWS, and with forage fish investigators who may examine the effects of predation on fish population dynamics.

H. PUBLIC PROCESS

Information from the harbor seal study has been presented at oil spill symposia, conferences, and in the published literature. Project

personnel have and will continue to participate and report study results at planning workshops that scientists and the public attend. Information is provided to personnel from the University of Alaska Sea Grant Program and ADF&G Division of Subsistence for use in meetings and discussions with subsistence hunters in PWS. The Principal Investigator has and will continue to talk with representatives of the public, including those from the tourism industry, fisheries, conservation groups, and subsistence communities. ADF&G marine mammals staff regularly attend meetings with various public groups to inform them about status, important conservation issues, and key research needs for harbor seals.

I. PERSONNEL QUALIFICATIONS

Kathryn Frost has conducted research on marine mammals in Alaska since 1975. She has undertaken extensive research on natural history and ecology of seals, including aerial and photographic surveys; studies of food habits and trophic interactions; and studies of habitat use using satellite tags. She has conducted extensive aerial surveys of harbor seals in PWS and boat-based observations and sampling of harbor seals as part of NRDA studies following the EVOS. She has conducted satellite tagging studies of harbor seals in PWS from 1991 through 1994.

Lloyd Lowry is the Marine Mammals Coordinator for the State of Alaska. He has conducted research on marine mammals in Alaska since 1975, including studies of the natural history, ecology, distribution, abundance, and food habits of seals. He has participated in all NRDA and Restoration studies on harbor seals, including the development of methodology to catch and attach satellite tags to harbor seals. He has been responsible for project coordination and management of state and federally funded research projects, and is familiar with the federal marine mammal permit system.

Rob DeLong is an Analyst Programmer for ADF&G. He has developed custom software for the analysis of location and dive data from satellite-tagged seals. He was responsible for programming a PC-compatible Geographic Information System (PC Arc Info and Arc View) that is used in presenting seal location and movements information. Mr. DeLong is also accomplished in seal catching and tagging techniques.

Dr. Jay Ver Hoef is a Biometrician for ADF&G. He has been responsible for statistical analysis of all harbor seal data during NRDA and Restoration studies. He has participated in field work in PWS and is familiar with seal catching and tagging techniques.

Dr. Sara Iverson is an Assistant Professor at the University of Dalhousie. She is currently conducting research at Sable Island, Nova Scotia, on the lipid metabolism of seals and the use of fatty acids to

determine marine food webs. She received her PhD in nutritional sciences, conducting studies of the energetics of reproduction and fatty acid metabolism in seals. She developed procedures for analysis of lipids in milk, blubber and tissues of pinnipeds. Dr. Iverson has published extensively on these subjects.

Dr. Robert Small is a National Research Council Fellow at the National Marine Mammal Laboratory. He is a quantitatively oriented ecologist with experience in the analysis of demographic data, population modelling, population dynamics, the use of GIS to examine habitat utilization, aerial surveys, and predator-prey relationships.

J. BUDGET

		FY95		FY96	
		94 Rpt	New 95	95 Rpt	New 96
1.	Personnel	76.9	42.8	79.2	42.5
2.	Travel	4.0	7.7	4.1	7.6
3.	Contractual	17.0	111.8*	13.0	106.1
4.	Commodities	2.7	55.4	2.5	55.4
5.	Equipment	1.4	0.0	1.4	0.0
6.	Capital outlay	0	0.0	0.0	0.0
	Subtotal	102.0	217.7	100.2	211.6
7.	General admin	12.7	14.7	12.8	13.8
	TOTAL	114.7	232.4	113.0	225.4

* $26,000 will go directly to NMML/NOAA for demographic modelling.

Table 1. Prince William Sound harbor seal trend count route.

Site #	Description	Status relative to EVOS
1	Sheep Bay	unoiled
2	Gravina Island	unoiled
3	Gravina Rocks	unoiled
4	Olsen Bay	unoiled
5	Porcupine Point	unoiled
6	Fairmount Island	unoiled
7	Payday	unoiled
8	Olsen Island	unoiled
9	Point Pellew	unoiled
10	Little Axel Lind Island	unoiled
11	Storey Island	oiled
12	Agnes Island	oiled
13	Little Smith Island	oiled
14	Big Smith Island	oiled
15	Seal Island	oiled
16	Applegate Rocks	oiled
17	Green Island	oiled
18	Channel Island	unoiled
19	Little Green Island	unoiled
20	Port Chalmers	unoiled
21	Stockdale Harbor	unoiled
22	Montague Point	unoiled
23	Rocky Bay	unoiled
24	Schooner Point	unoiled
25	Canoe Passage	unoiled

Table 2. Harbor seals instrumented with SLTDRs and sampled during 1991-1994. Only SLTDRs from which significant amounts of data were received are included.

		SLTDRs							
Location	Date	AdM	SubM	AdF	SubF	DNA	Blood	Fat	Whiskers
Applegate Rocks	May 92		3	1			5		
	May 93	2				5	5		
	Sep 93					1	1		1
Bay of Isles	Sep 93	1				1	1		1
Channel Island	Sep 93	1				3	3		3
	Sep 94	2			1	13	11	13	12
Gravina Island	Sep 94		1			3	3	3	3
Green Island	Apr 94					1	1		1
Herring Bay	Sep 91			1			1		
Little Green Isl.	Apr 94					1	1	1	1
Port Chalmers	Apr 94					2	2	2	2
	Sep 94			3	1	10	10	10	10
Seal Island	Apr 91						4		
	Sep 91	1					4		
	May 92					1	3		
	May 93	3		1		7	7		
	Sep 93	2	1	1		10	10		10
Stockdale Harbor	Apr 94					6	6	5	6
	TOTAL	12	5	7	2	64	78	34	60

Table 3. Schedule of activities from February 1995 through December 1997 for restoration science study "Monitoring, Habitat Use, and Trophic Interactions of Harbor Seals in Prince William Sound, Alaska." Letters are initials of personnel indicated in Table 4.

Activity	Dates	Personnel
Coordination meeting	Dec 1995	KF, LL, JL, RS
Reserve 1995 ARGOS satellite channels	Feb 1995	KF, DR
Order SLTDRs	Feb 1995	KF
Analyze fatty acid samples	Ongoing 1995-96	SI
Model population dynamics	Feb-Jul 1995	RS, KF
Analyze genetics samples	Ongoing 1995-96	GO, RW
Attach 6 SLTDRs, sampling	Apr-May 1995	KF, LL, RAD, RS
Retrieve ARGOS data	Apr-Aug 1995	KF, LL
Conduct pupping surveys	Jun 1995	KF
Conduct molting surveys	Aug-Sep 1995	KF
Attach 6 SLTDRS, sampling	Sep 1995	KF, LL, RAD, SI, RS
Retrieve ARGOS data	Sep 1995-Jul 1996	KF, LL
Analyze survey data	Nov-Dec 1995	KF, JV, RAD
Analyze SLTDR data	Ongoing, 1995-96	KF, LL, RAD, RS
Prepare annual report	Feb 1996-Mar 1996	KF, LL, RAD, SI, RS
Submit annual report	15 Apr 1996	KF
Reserve 1996 ARGOS channels	Jan 1996	KF, DR
Order SLTDRs	Mar 1996	KF
Conduct pupping surveys	Jun 1996	KF
Conduct molting surveys	Aug-Sep 1996	KF
Attach 12 SLTDRs	Sep 1996	KF, LL, RAD, RS
Retrieve ARGOS data	Sep 1996-Jul 1997	KF
Analyze survey data	Nov-Dec 1996	KF, RAD, JV, RS
Analyze SLTDR data	Ongoing, 1996-97	KF, LL, RS, RAD
Final data analysis	May-Jul 1997	KF, LL, RS, RAD, JV
Prepare final report	Aug-Sep 1997	KF, LL, SI, RS
Submit draft final	30 Sep 1997	KF
Revise final report	Oct-Dec 1997	KF
Submit revised final	31 Dec 1997	KF

Table 4.Personnel involved in restoration science study "Habitat Use, Behavior, and Monitoring of Harbor Seals in Prince William Sound."

Name	Affiliation	Responsibilities
Kathryn Frost	ADF&G	Project leader; tagging; aerial surveys; data analysis; reporting
Lloyd Lowry	ADF&G	Project review and coordination; permits; tagging, data analysis, and reporting
Rob DeLong	ADF&G	Programming; tagging
Jon Lewis	ADF&G	Project leader harbor seal studies in southeast Alaska and near Kodiak
Dan Reed	ADF&G	Satellite data acquisition; coordination with ARGOS
Jay Ver Hoef	ADF&G	Data analysis; tagging
Brian Fadely	UAF	Morphometrics; blood chemistry; tagging
Sara Iverson	Dalhousie	Fatty acid analysis and interpretation
Robert Small	NMML	Modelling; SLTDR data analysis; survey analysis
Greg O'Corry-Crowe	SWFSC	Genetics analysis
Robin Westlake	SWFSC	Genetics analysis

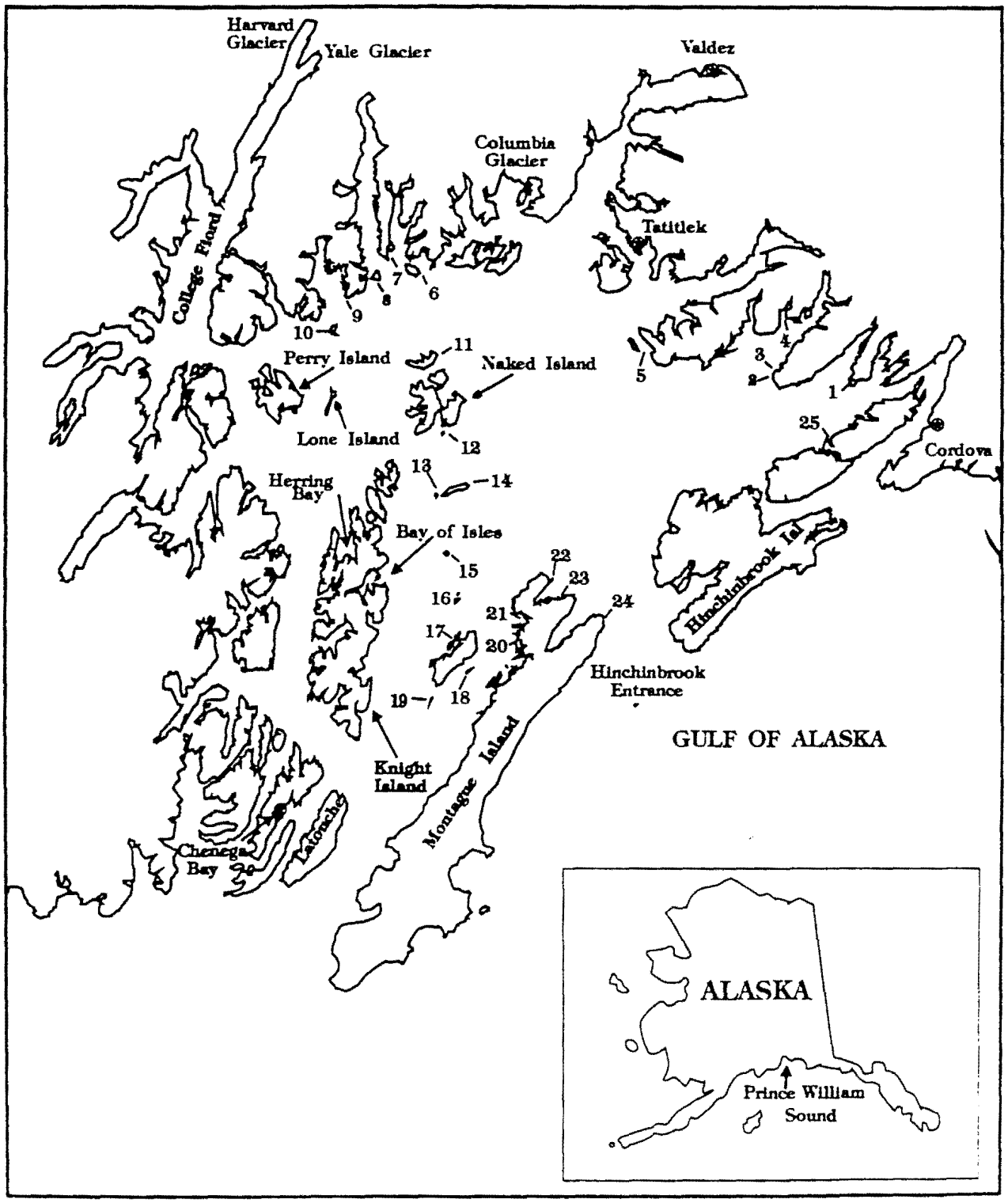

Figure 1. Map of Prince William Sound showing oiled and unoiled trend count sites and other locations referred to in text.

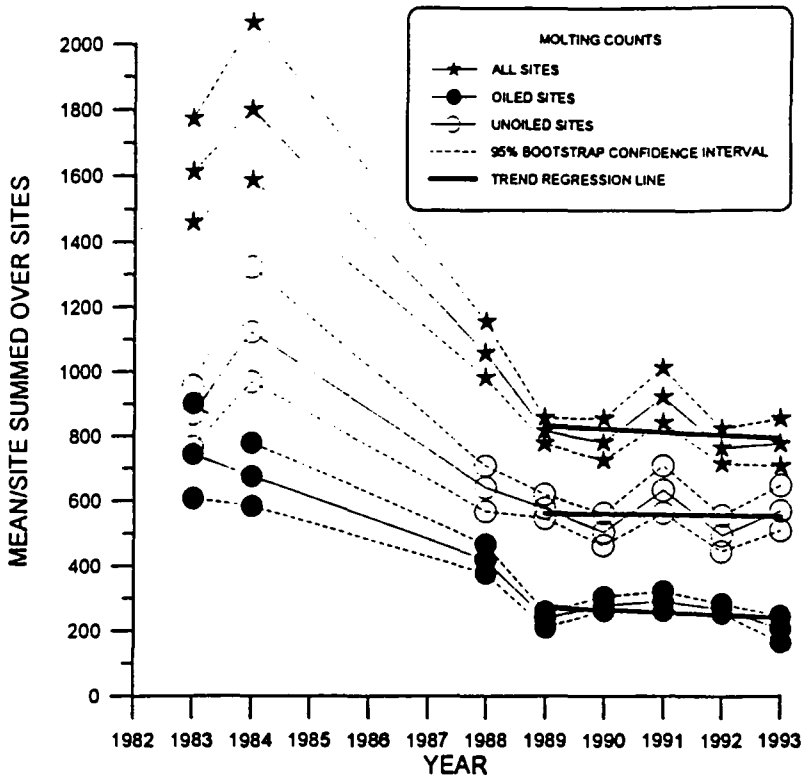

Figure 2. Trend in numbers of harbor seals in Prince William Sound based on counts made during August- September 1983-1993.

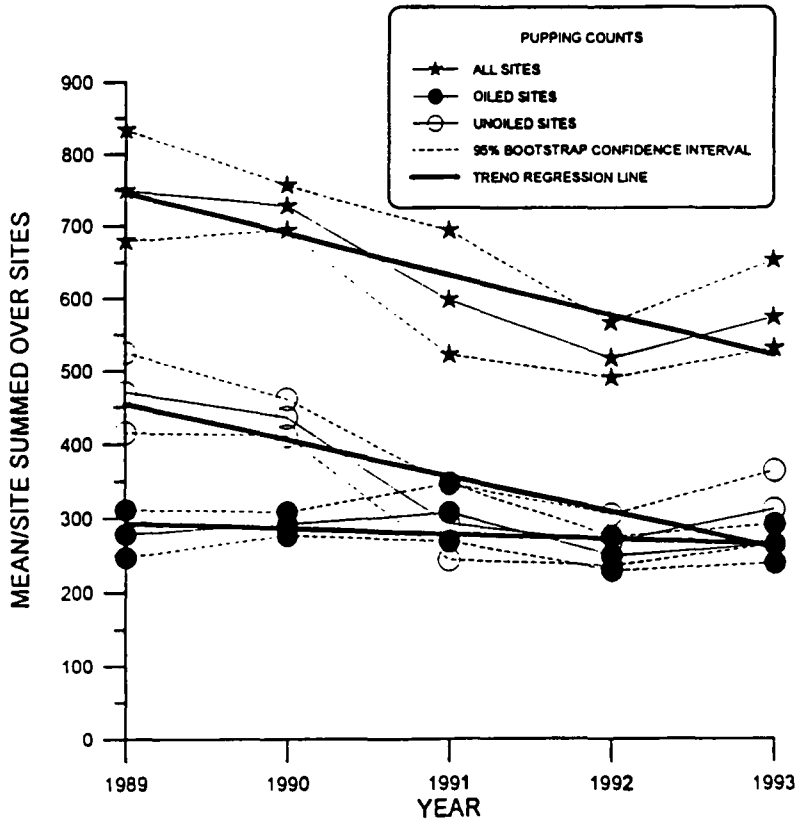

Figure 3. Trend in numbers of harbor seals in Prince William Sound based on counts made during June 1989-1993.

EXXON VALDEZ TRUSTEE COUNCIL
1995 Federal Fiscal Year Project Budget
October 1, 1994 - September 30, 1995

Project Description: This project will monitor the abundance of harbor seals at 23 trend count sites in PWS; characterize habitat use, hauling out, and diving behavior so that important habitat can be properly manage; investigate diet and trophic interactions to better understand whether limited food resources are inhibiting recover; model the effects of killer whale predation, the subsistence harvest, and incidental take by fisheries on the population; and investigate the disease and genetic stock structure. Aerial surveys will be conducted during pupping and molting periods and data will be used to determine whether harbor seals in PWS are recovering from the EVOS. Satellite-linked transmitters will be attached to 12 harbor seals per year to obtain information on movements, use of haulouts, and diving behavior. Seals caught during tagging will be sampled for blood chemistry, disease assays, lipid analysis, genetics, and stable isotope analyses.

Budget Category:	1994 Project No. . . . . Authorized FFY 94	'94 Report/ '95 Interim* FFY 95	Remaining Cost** FFY 95	Total FFY 95	FFY 96	Comment
Personnel	$98.6	$76.9	$42.8	$119.7	$121.7	
Travel	$11.6	$4.0	$7.7	$11.7	$11.7	
Contractual	$82.7	$17.0	$111.8	$128.8	$119.1	
Commodities	$56.7	$2.7	$55.4	$58.1	$57.9	
Equipment	$0.0	$1.4	$0.0	$1.4	$1.4	
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0	
Subtotal	$249.6	$102.0	$217.7	$319.7	$311.8	
General Administration	$20.6	$12.7	$14.7	$27.4	$26.6	
Project Total	$270.2	$114.7	$232.4	$347.1	$338.4	
Full-time Equivalents (FTE)	1.5	1.1	0.6	1.7		
	Dollar amounts are shown in thousands of dollars.					

Budget Year Proposed Personnel: Position Description	Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
Rept See 3A and 3B's for this project				
Personnel Total	0.0	$0.0	0.0	$0.0

NEPA Cost: $0.0

*Oct 1, 1994 - Dec 31, 1994

**Jan 1, 1995 - Sep 30, 1995

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1995

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Project Number: 95064
Project Title: Monitoring, Habitat Use and Trophic In Harbor Seals in Prince William Sound, Alaska
Agency: AK Dept of Fish & Game

FORM 2A
PROJECT
DETAIL

EXXON VALDEZ TRUSTEE COUNCIL
1995 Federal Fiscal Year Project Budget
October 1, 1994 - September 30, 1995

Project Description: This project will monitor the abundance of harbor seals at 23 trend count sites in PWS; characterize habitat use, hauling out, and diving behavior so that important habitat can be properly manage; investigate diet and trophic interactions to better understand whether limited food resources are inhibiting recover; model the effects of killer whale predation, the subsistence harvest, and incidental take by fisheries on the population; and investigate the disease and genetic stock structure. Aerial surveys will be conducted during pupping and molting periods and data will be used to determine whether harbor seals in PWS are recovering from the EVOS. Satellite-linked transmitters will be attached to 12 harbor seals per year to obtain information on movements, use of haulouts, and diving behavior. Seals caught during tagging will be sampled for blood chemistry, disease assays, lipid analysis, genetics, and stable isotope analyses.

Budget Category:	1994 Project No. . . . . Authorized FFY 94	'94 Report/ '95 Interim* FFY 95	Remaining Cost** FFY 95	Total FFY 95	FFY 96	Comment		
						94 Report	96 Field	95 Report
Personnel	$98.6	$76.9	$42.8	$119.7	$121.7	$76.9	$42.5	$79.2
Travel	$11.6	$4.0	$7.7	$11.7	$11.7	$4.0	$7.6	$4.1
Contractual	$82.7	$17.0	$85.8	$102.8	$119.1	$17.0	$106.1	$13.0
Commodities	$56.7	$2.7	$55.4	$58.1	$57.9	$2.7	$55.4	$2.5
Equipment	$0.0	$1.4	$0.0	$1.4	$1.4	$1.4	$0.0	$1.4
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Subtotal	$249.6	$102.0	$191.7	$293.7	$311.8	$102.0	$211.6	$100.2
General Administration	$20.6	$12.7	$14.7	$27.4	$26.6	$12.7	$13.8	$12.8
Project Total	$270.2	$114.7	$206.4	$321.1	$338.4	$114.7	$225.4	$113.0
Full-time Equivalents (FTE)	1.5	1.1	0.6	1.7				

Dollar amounts are shown in thousands of dollars.

Budget Year Proposed Personnel: Position Description		Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
Rept	Wildlife Biologist III	6.0	$37.8	4.0	$25.2
	Wildlife Biologist III	1.5	$9.8	1.0	$6.5
	Analyst Programmer III	1.5	$7.7	1.0	$5.1
	Biometrician II	1.0	$5.7	0.0	$0.0
	Fish and Wildlife Technician IV	3.0	$11.7	0.0	$0.0
	Program Manager	0.8	$4.2	1.0	$6.0
	Personnel Total	13.8	$76.9	7.0	$42.8

NEPA Cost: $0.0

*Oct 1, 1994 - Dec 31, 1994
**Jan 1, 1995 - Sep 30, 1995

Project Number: 95064
Project Title: Monitoring, Habitat Use and Trophic In Harbor Seals in Prince William Sound, Alaska
Agency: AK Dept. of Fish & Game

FORM 3A SUB-PROJECT DETAIL

EXXON VALDEZ TRUSTEE COUNCIL
1995 Federal Fiscal Year Project Budget
October 1, 1994 - September 30, 1995

		Reprt/Intrm	Remaining
Travel:			
Rept	3 RT Fairbanks/Anchorage @ $0.4 + 3 days per diem	$1.6	
	1 RT Fairbanks/Cordova @ $0.6 + 2 days per diem	$0.9	
	1 RT Fairbanks/Seattle @ $0.9 + 4 days per diem	$1.5	
Rem	4 RT personal vehicle Fairbanks/Portage @ $0.33		$1.3
	4 RT vehicle + boats on Portage-Whittier train @ $0.4		$1.6
	2 RT Fairbanks/Cordova @ $0.6		$1.2
	Per diem for 2 people for 2 weeks for field work		$3.6
	Travel Total	$4.0	$7.7
Contractual:			
Rept	ARGOS - FFY94 obligation	$14.0	$0.0
	Print/graphics	$0.9	$0.0
	Long distance phone charges/postage	$0.9	$0.0
	Software maintenance	$1.2	$0.0
Rem	Aircraft charter 60 hours @ $0.22	$0.0	$13.0
	Data acquisition time for ARGOS @ $4.0/ppt year for 3.23 ppt years	$0.0	$13.0
	Vessel charter for tagging and sampling @ $1.5/day for 16 days	$0.0	$24.0
	Lipid analysis contract	$0.0	$30.0
	Genetic analysis contract	$0.0	$5.0
	Freight and shipping of samples	$0.0	$0.4
	Long distance phone charges	$0.0	$0.4
	Contractual Total	$17.0	$85.8

Project Number: 95064
Project Title: Monitoring, Habitat Use and Trophic Interactions of Harbor Seals in Prince William Sound, Alaska
Agency: AK Dept Fish & Game

FORM 3B
SUB-PROJECT DETAIL

EXXON VALDEZ TRUSTEE COUNCIL
1995 Federal Fiscal Year Project Budget
October 1, 1994 - September 30, 1995

Commodities:		Reprt/Intrm	Remaining
Rept	Office supplies	$0.5	$0.0
	Computer supplies	$0.6	$0.0
	Computer software for graphics, GIS, and other analyses	$1.6	$0.0
Rem	12 PPT's @ $4.0/PPT	$0.0	$48.0
	Film	$0.0	$0.4
	Fuel for skiffs and research vessel	$0.0	$3.0
	Repair supplies for skiffs, nets, etc.	$0.0	$2.0
	Field supplies for tagging and other sampling	$0.0	$2.0
	Commodities Total	$2.7	$55.4
Equipment:			
Rept	Computer memory for GIS computer	$1.2	$0.0
	Modem for access to Service ARGOS and E-Mail	$0.2	$0.0
	Equipment Total	$1.4	$0.0

Project Number: 95064
Project Title: Monitoring, Habitat Use and Trophic Interactions of Harbor Seals in Prince William Sound, Alaska
Agency: AK Dept. Fish & Game

FORM 3B
SUB-
PROJECT
DETAIL

EXXON VALDEZ TRUSTEE COUNCIL
1995 Federal Fiscal Year Project Budget
October 1, 1994 - September 30, 1995

Project Description: This project will monitor the abundance of harbor seals at 23 trend count sites in PWS; characterize habitat use, hauling out, and diving behavior so that important habitat can be properly manage; investigate diet and trophic interactions to better understand whether limited food resources are inhibiting recover; model the effects of killer whale predation, the subsistence harvest, and incidental take by fisheries on the population; and investigate the disease and genetic stock structure. Aerial surveys will be conducted during pupping and molting periods and data will be used to determine whether harbor seals in PWS are recovering from the EVOS. Satellite-linked transmitters will be attached to 12 harbor seals per year to obtain information on movements, use of haulouts, and diving behavior. Seals caught during tagging will be sampled for blood chemistry, disease assays, lipid analysis, genetics, and stable isotope analyses.

Budget Category:	1994 Project No. . . . . Authorized FFY 94	'94 Report/ '95 Interim* FFY 95	Remaining Cost** FFY 95	Total FFY 95	FFY 96	Comment
Personnel	$0.0	$0.0	$0.0	$0.0	$0.0	
Travel	$0.0	$0.0	$0.0	$0.0	$0.0	
Contractual	$0.0	$0.0	$26.0	$26.0	$0.0	
Commodities	$0.0	$0.0	$0.0	$0.0	$0.0	
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0	
Subtotal	$0.0	$0.0	$26.0	$26.0	$0.0	
General Administration	$0.0	$0.0	$0.0	$0.0	$0.0	
Project Total	$0.0	$0.0	$26.0	$26.0	$0.0	
Full-time Equivalents (FTE)	0.0	0.0	0.0	0.0		
Dollar amounts are shown in thousands of dollars.						

Budget Year Proposed Personnel: Position Description	Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
Rept				
Personnel Total	0.0	$0.0	0.0	$0.0

NEPA Cost: $0.0

*Oct 1, 1994 - Dec 31, 1994
**Jan 1, 1995 - Sep 30, 1995

Project Number: 95064
Project Title: Monitoring, Habitat Use and Trophic In Harbor Seals in Prince William Sound, Alaska
Agency: National Oceanic & Atmospheric Administration

FORM 3A SUB-PROJECT DETAIL

EXXON VALDEZ TRUSTEE COUNCIL
1995 Federal Fiscal Year Project Budget
October 1, 1994 - September 30, 1995

		Reprt/Intrm	Remaining
Travel:			
Rept			
Rem			
	Travel Total	$0.0	$0.0
Contractual:			
Rept			
Rem	To fund National Research Council Fellowship for biometrician support (modelling, ppt data analysis, survey data)		$26.0
	Contractual Total	$0.0	$26.0

Project Number: 95064
Project Title: Monitoring, Habitat Use and Trophic Interactions of Harbor Seals in Prince William Sound, Alaska
Agency: National [illegible]anic & Atmospheric Administration

FORM 3B
SUB-
PROJECT
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EXXON VALDEZ TRUSTEE COUNCIL
1995 Federal Fiscal Year Project Budget
October 1, 1994 - September 30, 1995

Commodities:	Reprt/Intrm	Remaining
Rept		
Rem		
Commodities Total	$0.0	$0.0
Equipment:		
Rept		
Equipment Total	$0.0	$0.0

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1995

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Project Number: 95064
Project Title: Monitoring, Habitat Use and Trophic Interactions of Harbor Seals in Prince William Sound, Alaska
Agency: National Oceanic & Atmospheric Administration

FORM 3B
SUB-
PROJECT
DETAIL

DETAILED PROJECT DESCRIPTION
for
FY 95 RESTORATION PROJECT 95074

Project Title:	HERRING REPRODUCTIVE IMPAIRMENT[1]
Project Number:	95074
Project Type:	Research
Lead Trustee Agency:	National Marine Fisheries Service
Cooperating Agency:	State of Alaska, Department of Fish and Game, Division of Commercial Fisheries
Project Start-up Date:	February 1, 1995
Project Completion Date:	March 1, 1996[2]
Expected Project Duration	4 years (1994 through 1997)
Cost of Project:	$407 K (1995), $407 K (1996), $119 K (1997)
Geographic Area:	Prince William Sound, Sitka Sound, and Auke Bay, Alaska. Includes laboratory research at Auke Bay, Juneau, Alaska
Project Leaders:	Jeep Rice[3], National Marine Fisheries Service (NMFS). 907-789-6020 Mark G. Carls[3], NMFS, 907-789-6019 Scott Johnson[3], NMFS, 907-789-6063
Agency project manager:	Bruce Wright[3], NMFS, 907-789-6605, FAX 907-789-6608

P.I.

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[1]NOAA component

[2]Phase two of a four year project.

[3]NOAA/NMFS, Auke Bay Laboratory, 11305 Glacier Hwy., Juneau, AK 99801. FAX: 907-789-6094

A. INTRODUCTION

The 1993 crash in Prince William Sound herring resources stimulated a multi-disciplinary suite of studies to look at toxicological and ecological factors affecting long term recovery of the stocks. This proposal is the toxicological part of the herring package.

Oil toxicology is a question concerning herring impacts and recovery. Oil damage was measured in several studies in the short term aftermath of the 1989 spill. Herring stock in Prince William Sound (PWS) may have been reproductively impaired by the 1989 Exxon Valdez oil spill, and it is feared that continuing long-lasting effects could hamper restoration of the stocks that have crashed since the spill. Most or all of the life stages of herring may have been exposed to oil after the 1989 *Exxon Valdez* oil spill in PWS. Significant histopathological damage was observed in adults collected in oiled areas in 1989 and 1990 (ADF&G), and over 40% of the spawning areas were oiled (Brown et al. 1994). Exposure of herring eggs to petroleum hydrocarbon concentrations frequently results in abnormal larvae with poor survival potential (Kuhnold 1969; Linden 1976; Rosenthal and Alderdice 1976; Pearson et al. 1985; Kocan 1993). In the pectoral fins of herring embryos exposed to oil, anaphase aberrations were elevated (Hose et al. in prep.), giving some credence to the hypothesis that long term genetic damage was possible to the germ line. Some field research (Baker and Biggs, 1993; Kocan et al. 1994) suggests reproduction may have been impaired by previous exposure of adult or juvenile herring to oil in the water column, but with many uncontrolled (and unknown) factors, it is difficult to interpret these field data. Because year-class strength is heavily influenced by survival of herring larvae (Stevenson 1949; Taylor 1964; Outram and Humphreys 1974), contamination of pre-spawn adults, eggs, or larvae by petroleum hydrocarbons may have an adverse impact on herring populations.

Although immediate impacts were measured in the 1989-91 damage assessment studies, long term impacts remain a question. Recruitment failures appear to continue, and standing biomass has decreased; the toxicological influence of oil on either is unknown. The purpose of this proposal is to examine the possibility of long term impacts using intense laboratory and field measurements. In the laboratory part, we will expose different life stages to oil, and measure somatic chromosomal aberration rates, along with other direct impact measurements. In the field part, we will sample spawn from different sites and age classes in PWS to measure reproductive impacts that may still persist.

Lab tests: The laboratory exposures will attempt to produce abnormalities and impacts measured in the field projects of 1989-91, but will have quantified oil exposures to known life stages. This will aid in the interpretations possible with the earlier damage assessment studies where impacts were measured, but oil exposures were difficult to document, exposure levels unknown, and life stage at exposure was unknown. We wish we could measure genetic damage in reproductive tissues or by quantitative crosses, but that is not practical given the life cycle of herring.

Field tests: Sampling of the spawn by site and by year class will permit a measurement on the status of reproductive success. Spawn from PWS will be returned to the laboratory and reared in a controlled environment: hatching viability and abnormality rates will be determined. The field component will be integrated with the two other herring components- the age/weight/length analyses by ADF&G, and sampling for disease measurements by an independent contractor

This four year project started in FY 94 with laboratory exposures to adult herring and impact measurements on larvae. In FY 95 and 96, we will have controlled laboratory exposures to eggs and larvae, and will also measure reproductive impairment in field spawnings from Prince William Sound. Table 1 gives the time line of this four year project.

Table 1

LABORATORY:

Year	Exposure	Measurement
FY94	pre-spawn adults	impacts on larvae
FY95	eggs	impacts on larvae
FY96	larvae	impacts on larvae
FY97	-	final report

FIELD:

Year	Exposure	Measurement
FY95	-	spawn viability by area and year class
FY96	-	spawn viability by area and year class
FY97	-	final report

B. PROJECT DESCRIPTION

1. **Resources and/or Associate Services:** Pacific herring, *Clupea pallasi*, are a major resource in Prince William Sound from both commercial and ecological perspectives. Several thousand pounds of herring and herring spawn on kelp are harvested annually for subsistence purposes and form and important part of the local native culture. Herring provide important forage for many species, including humpbacked whales, sea lions, gulls, sea ducks, shorebirds, halibut, salmon, and other fish. Recovery of this cornerstone species, therefore, has a direct impact on recovery of many other species in the PWS ecosystem and the services they provide.

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Although immediate impacts were measured in the 1989-91 damage assessment studies, long term impacts remain a question. Recruitment failures appear to continue, and standing biomass has decreased; the toxicological influence of oil on either is unknown. The purpose of this proposal is to examine the possibility of long term impacts using intense laboratory and field measurements. In the laboratory part, we will expose different life stages to oil, and measure somatic chromosomal aberration rates, along with other direct impact measurements. In the field part, we will sample spawn from different sites and age classes in PWS to measure reproductive impacts that may still persist.

Lab tests: The laboratory exposures will attempt to produce abnormalities and impacts measured in the field projects of 1989-91, but will have quantified oil exposures to known life stages. This will aid in the interpretations possible with the earlier damage assessment studies where impacts were measured, but oil exposures were difficult to document, exposure levels unknown, and life stage at exposure was unknown. We wish we could measure genetic damage in reproductive tissues or by quantitative crosses, but that is not practical given the life cycle of herring.

will measure herring reproduction success from several age classes collected from several sites in PWS. Some of the age classes were exposed to oil, but post-1990 year classes were not. Spawn will be returned to the lab and reared until hatch to determine larval viability and abnormality rates.

Primary test hypothesis: Fertility, percent hatch, larval viability and morphological abnormalities were caused by the *Exxon Valdez* oil spill.

Assumptions: 1) The year classes prior to 1989 were potentially exposed to oil in 1989, 2) the 1989 year class was potentially exposed to oil in pre-spawning adults, eggs, and larvae, and 3) year classes after 1989 were not exposed to oil, except that the 1990 year class may have been exposed to residual oil in intertidal areas.

Controls will be post-spill year classes and two or three sites in Southeastern Alaska, including Sitka.

4. **Methods.** Detailed methods are presented in appendicies 1 and 2; short summaries are presented below. Both laboratory and field tests require extensive incubation of eggs, isolated by female, with monitoring for 30 to 40 days. We have the capacity to incubate eggs from approximately 950 individual females and will involve six technicians in addition to staff biologists at peak hatch. Some hatch staggering is possible by controlling laboratory spawnings, but the field spawnings will be driven by the fish.

4a. **Laboratory Methods:** Pre-spawning adult herring will be collected by purse seine, maintained in the laboratory for several weeks, then spawned onto glass slides (identified by female parent) in clean seawater. Eggs will be incubated for 16 d in one of four oil treatments or clean seawater, then transferred to clean water. Treatment levels will be approximately the same as those to which adults were exposed in 1994. In addition to the primary treatment, eggs will be exposed for varying lengths of time (2, 4, and 8 d) to a dose known to cause substantive sublethal effects. Egg fertility will be determined during the early phase of incubation. Approximately one week before hatch, eggs will be isolated by female. Hatch timing, hatch success, larval vigor, larval survival, and larval abnormalities will be observed daily until hatch is complete. Hatched larvae will be preserved for genetic analysis and length measurement. Dead eggs and embryos will be quantified at the end of hatch. Chromosomal aberration rates will be the primary genetic measurement. The number of mitoses per fin and chromosomal (anaphase-teleophase) aberrations will be assessed from subsets of newly hatched larvae. Data will also be collected to determine graded severity indices (morphological defects), condition of interphase cells, and number of degenerating cells.

The laboratory study will require 4 people full time during hatch.

2. **Relation to other damage assesment/restoration work:** This project is a continuation of project 94166 and is part of an inter-agency cooperative study with ADF&G; it is the toxicological part of the 'Herring Package'. The other ADF&G/SEA plan projects are focused on the current status of the population and other factors that may limit recovery. Researchers from ABL will work closely with ADF&G to collect fish; age, length, weight, and VHN samples will be simultaneously collected from the same sites and year classes that reproductive impairment samples are collected, thus integrating state and federal research objectives.

3. Objectives:

Goal 1. The goal of the laboratory portion of the study is to determine if genetic damage to early life stages of herring can be caused by exposure of pre-spawning adult, egg, and larval stages to oil and relate this damage to larval survival potential. Impacts will primarily be measured in larvae. Both short term and long term impacts may be caused by exposure. Short term impacts include effects on hatching success, morphological abnormalities, and larval size. Long term effects may include disruption of cell division, determined by observation of anaphase-telophase aberration rates of somatic cells. From estimates of anaphase-telophase aberration, we will infer the possibility that exposure of herring to oil can cause genetic damage that is transmissible to subsequent generations. It is not practical to measure germ line damage directly in the laboratory because it is not practical to rear herring from eggs to maturity. In 1994, pre-spawning adults were exposed and artificially spawned; the pectoral fins of newly hatched larvae were inspected for genetic aberrations. In 1995, herring eggs will be exposed to oil during incubation, and genetic aberrations will be measured. Aberration rates will be compared across exposure doses and life stage exposed.

Primary test hypothesis: Anaphase-teleophase aberration in mitotic cells of the pectoral fins of herring larvae are caused by exposure of herring adults (1994) or eggs (1995) to oil in water. (Proposed for 1996 is direct exposure of herring larvae to oil.) Other measurements include egg fertility, percent hatch, larval viability, morphological abnormality, and amount of exposure time required to cause damage.

Assumption: Disruption of normal somatic mitotic processes may signal future meiotic disruption, or reduce the potential of larvae to survive to reproductive age.

Goal 2. Survey herring in PWS for reproductive impairment by measuring larval viability by location and age class. Herring reproduction may have been impaired as a result of past oil exposures at one or more life stages. In 1995, we

oil-spill related herring research.

C. SCHEDULE

1994 brood year: finish analyses and reports.	Mar 1995

1995 Brood year:

1.	reproductive impairment survey in PWS:	Feb - Jun 1995
2.	Laboratory exposures:	Jan - Jun 1995
3.	Chemical and contract analyses:	Jul - Nov 1995
4.	Data analysis and final report:	Dec 95 - Apr 96

An event calendar is attached.

D. EXISTING AGENCY PROGRAM:

NOAA will contribute 35 man-months of salary beyond the 55 man months funded by this study plus wetlab space.

E. ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

EA or EIS are not required by this project.

F. PERFORMANCE MONITORING

A report detailing results of the experiment will be generated for each year of the project. Reports will be written in standard scientific format (introduction, methods, results, and discussion).

G. COORDINATION OF INTEGRATED RESEARCH EFFORT

This project is an integral component of the suite of herring studies in the SEA plan. Reproductive impairment sample collection will be integrated with herring disease and spawn deposition research.

H. PUBLIC PROCESS

When available, data will be presented in a public forum.

I. PERSONNEL QUALIFICATIONS

GS-13 Physiologist - Stanley D. Rice

Received BA (1966) and MA (1968) in Biology from Chico State University, and PhD (1971) in Comparative Physiology from Kent State University. Employed at Auke Bay

4b. **Field Methods:** Adult herring will be captured by gill net at two to four spawning sites in PWS, separated by length into age classes, iced, transported to a laboratory facility, and spawned. The eggs will be transported by air to Auke Bay in chilled seawater. Additional herring will be similarly crossed from a control location, Sitka Sound. Egg fertility will be determined during the early phase of incubation. Approximately one week before hatch, eggs will be isolated by female. Hatch timing, hatch success, larval vigor, larval survival, and larval abnormalities will be observed daily until hatch is complete. A subset of hatched larvae (n = 50 from each female) will be preserved for possible genetic analysis. Dead eggs and embryos will be quantified at the end of hatch.

Specific collection sites will be determined by ADF&G and by availability of fish during commercial harvest events. There are several candidate sites in Southeastern Alaska to serve as controls including Kashakes, Sitka, Auke Bay, and Seymour Canal. Age, weight and length of sampled fish will be analyzed by ADF&G, and disease samples will be collected for analysis. ADF&G will read scales from fish we spawn.

The field study will require 5 people full time during hatch and 3 people in the field for collection.

5. **Location:** Prince William Sound (PWS), Sitka Sound, and Auke Bay Laboratory (ABL). Herring impairment samples will be collected in PWS and at Sitka (control site). All lab exposures and rearing will be at ABL. The project will yield improved understanding of the impacts of the *Exxon Valdez* oil spill on the herring population in PWS.

5. **Technical Support:** All egg and larval culturing and chemical analyses will be conducted at ABL. Chemists at ABL will participate in oil dosing and analysis. Computer services, data archiving, and GIS mapping are all services available in-house at ABL. Herring researchers at ABL will work closely with ADF&G to obtain herring and spawn in PWS, so that age, length, weight, and disease sampling are all from the same spawning sites. We will ask ADF&G to age all of the adult herring spawned. Analysis of genetic aberrations will be contracted out.

6. **Contracts:** 1) Purse seine. The purpose is to collect adult, pre-spawn herring live for the experiment. Contract will be awarded based on availability, suitability of gear, willingness and capacity to handle live herring (including tanks, water supply, and transportation), and cost.
2) Genetic aberration analysis. The purpose is to search for cellular damage and chromosomal aberration in a manner consistent with previous *Exxon Valdez*

SCHEDULE

	EARLY	MID	LATE
JAN	----------order supplies, begin set up ----------		
FEB	----------wet lab setup ---------- weather oil ---		
MARCH	oil rock		seine herring
APRIL	collect samples in Sitka collect samples in PWS Note: spawning in PWS can range from 3/31 to 5/31		Expect ripe fish (laboratory)
MAY	spawn herring clean eggs:count	begin hatch observations (field) ----------	begin hatch observations (lab) --------
JUNE	continue hatch observations----------	hatch should be complete --------	measure larvae (lab)
JULY	begin genetic analysis (lab) begin histopathological analysis (?) (lab) begin hydrocarbon analysis (GC) (lab) Analyze data, begin writing report (field component)		
AUGUST	begin/continue data analysis (lab component)		
SEPT	begin/continue report		
OCT	Complete genetic analysis complete HC analysis		
NOV			
DEC			complete reports

Fisheries Laboratory since 1971 as a research physiologist, task leader and Habitat Program Manager since 1986. Rice has researched oil effects problems since 1971, and has published over 70 papers, including over 50 on oil effects. Studies have ranged from field to lab tests, behavioral to physiological to biochemical studies, from salmonids to invertebrates to larvae to meiofauna. Rice has conducted and managed soft funded projects since 1974, including the Auke Bay Laboratory *Exxon Valdez* damage assessment studies since 1989. Activities since the oil spill have included leadership and management of up to 10 damage assessment projects, field work in PWS, direct research effort in some studies, establishment of state of the art chemistry labs and analyses in response to the spill, quality assurance procedures in biological-chemical-statistical analyses, establishment of hydrocarbon database management, servicing principal investigators and program managers in NOAA and other agencies with reviews and interpretations, provided direct input into agency decisions, interacted with other agencies in various ways (logistics coordination, critique experimental designs, interpret observations, etc.).

GS-11 Fishery Biologist - Scott W. Johnson

Received a BS (1974) in Zoology from San Diego State University, San Diego, CA, and a MS (1982) in Fisheries from Humboldt State University, Arcata, CA. Scott has been employed by NMFS for 15 years--3 years at the Southwest Fisheries Center in La Jolla, CA, and the last 12 years at the Auke Bay Laboratory. His principal studies have included research on 1) the habitat and ecology of juvenile salmonids, 2) riparian habitat issues, 3) effects of mining on marine resources, and 4) monitoring trends in marine debris abundance on the outer coast of Alaska. Scott has been a senior or contributing author on about 20 papers related to the above topics. Scott is presently Task Leader of two projects--Marine Debris and Mining Studies.

GS-12 Fishery Biologist - Mark G. Carls

Received BA (1975) in Biology from Gustavus Adolphus College, St. Peter, MN, and MS (1978) in Biological Oceanography from Dalhousie University, Halifax, Nova Scotia. Mark has been employed at the Auke Bay Fisheries Laboratory since 1979. His principal involvement has been in research of petroleum hydrocarbon toxicology to marine fish and invertebrates, including egg, larval, and adult life stages. Mark has published 12 papers, and has 5 *Exxon Valdez* damage assessment papers pending publication. Since 1989, he has been involved as a principal investigator and co-investigator on several studies resulting from the *Exxon Valdez* oil spill.

J. BUDGET ($K)

attached

with plastic clamps (Tygon) and suspended with monofilament line from a mobile overhead rack. Jars will be placed in a flowing seawater bath; eggs in these jars will be monitored for hatch. The earliest hatch is expected 25 d after fertilization, and peak hatch after circa 30 d. Hatch timing, hatching success, larval viability, and larval abnormalities will be observed daily for each fish. Hatched larvae will be assessed for swimming ability and gross morphological deformities, anesthetized with tricaine methanesulfonate, and preserved in buffered formalin. (Preservation will be daily by female, except first and last 10% will be grouped). Live larvae will be preserved independently of dead larvae. After hatch is complete, the remaining eggs and embryos will inspected and enumerated Preserved larvae will be measured; subsamples will be prepared for genetic analysis.

Tanks: Each living stream will be subdivided with 4 black larval incubation tanks, thus 4 living streams are necessary. (Each black tank can accomodate spawn from approximately 10 females.) Additionally, 2 streams are needed for transfer when eggs are isolated. [After the black tanks are vacated the streams could be cleaned up and used for isolation space.]

Requirements:

2 people full time during hatch
5 living streams

Appendix 1: Laboratory Experiments

Study 1. Oil in water

Purpose: Expose developing herring eggs to oil in water during incubation.

Design: Four oil treatments plus controls: control, trace, low, mid, and high oil concentrations. Concentrations will be approximately the same as those in the 1994 adult exposures.

Numbers: (4 oil treatment levels + control) * 3 replicates/ treatment = 15 replicates. Spawn 7 females per replicate (15 * 7 = 105 females). Only 2 slides are needed as egg substrate per female (1 to observe hatching, 1 for backup), except spawn 8 extra slides per female for mid treatment (for time trials) and 15 extra slides for high treatment (hydrocarbon uptake and depuration). This design will require 17 man hours per day during egg clean-up and hatch.

Method: Eggs will be spawned on glass slides (by female). Ovarian membranes will be cut longitudinally and the eggs removed with a hydrocarbon-free stainless steel spatula. From each female, eggs will be deposited on two 25 x 75 mm glass slides placed at the bottom of a shallow glass dish in ambient seawater (10 slides per female for mid treatment and 15 to 45 extra slides for the high treatment). Approximately 100 eggs per slide will be deposited with gentle swirling. Eggs from each female will be placed in a staining rack and suspended in separate beakers of seawater. Milt from 3 males will be prepared by cutting sections of testes into small segments. A few milliliters of milt will be added to beakers containing eggs. The eggs and milt will remain in contact 5 min with gentle stirring.

Grouped by replicate treatment, eggs will be incubated and dosed in 40 to 50 l tanks for 16 d. Water will be supplied through rock coated with weathered oil (or clean rock for controls). Eggs in racks will be suspended from monofilament line attached to arms driven by an offset cam to cause slow movement (1 rpm) through the water. Lighting will be natural, supplemented by overhead fluorescent light during daylight hours.

The eggs will be examined for fertilization success and development. Excess eggs will be removed from all slides by scraping, i.e., those along slide margins susceptible to mechanical damage, and clumps of eggs where not all eggs were exposed to water. This processing will be accomplished in water with a minimum of emersion. Eggs on both slides will be counted to quantify fertilization success and development.

Before hatch (after 21 d incubation), all eggs will be isolated by female; to avoid stimulation of hatch, slides will be transferred in water. One randomly chosen slide per female will be isolated in a 1000 m l glass jar; these slides will be held

Study 3. Hydrocarbon Uptake and depuration.

Purpose: to measure bioaccumulation and depuration of hydrocarbons in herring eggs.

Design: Use one dose; the high dose will give the highest measurement sensitivity. Sample at 0, 1, 2, 4, 8, and 16 d exposure. Sample additional control eggs on days 8, 16, and 24. Sample depuration 0.25, 0.5, 1, 2, 4, and 8 d after transfer to clean water.

Numbers: 2 treatment * 2 replicates/treatment = 6 replicates. 6 replicates * 7 females/replicate = 42 females (Use extra spawn from control and high treatment females in experiment 1.) Spawn a minimum of 15 slides of eggs per replicate. Eggs will not be cleaned or enumerated.

Method: Spawn high treatment eggs on glass slides; eggs density will be much higher than in primary experiment, but generaly one layer thick. Eggs will be supplied from high treatment used in study 1 and fertilized with milt from several males. Separated by replicate, multiple females will contribute eggs to each slide. For the high treatment, a minimum of 15 slides per replicate will receive eggs; if more surface area is needed, use 30 or 45 slides/replicate. Eggs will be incubated in high treatment oil for 1 to 16 d (plus a time zero control) or clean water (controls). Five to 10 g samples will be collected for hydrocarbon analysis after 1, 2, 4, 8, and 16 d exposure. After 16 d exposure, remaining eggs will be transferred to clean water and sampled periodically (0.25, 0.5, 1, 2, 4, 8 d) until hatch. Additional unexposed control samples will be collected on days 8, 16, and 24.

Tanks: 1 clean water and 3 oiled water compartments are needed, so 1 living is required.

Requirements:

0	no additional people needed
1	living streams

Study 2. Time to affect.

Purpose: to vary exposure time of developing eggs to oil (how much exposure is required to cause an effect?).

Design: Use one dose, known to cause substantive sublethal effects. (The mid dose met these criteria in 1994). Controls are the same as in experiment 1.

Numbers: 1 treatment * 3 replicates/treatment = 3 replicates. 3 replicates * 7 females/replicate = 21 females (Use extra spawn from mid treatment females in experiment 1.) Spawn 8 slides of eggs per female: 4 observation times * [1 to observe hatching plus 1 for backup]. This experiment will generate 84 isolated jars (4 observations/female * 7 females/replicate * 3 replicates) and will require 14 man hours per day during egg clean-up and hatch.

Method: Primary methods would be the same as experiment 1. Proposed exposure times are 1, 2, 4, and 8 d (plus 0 and 16 d from experiment 1).

Tanks: 4 clean water and 4 oiled water compartments are needed, so 2 living streams rigged with black tanks would be required. Two additional streams are needed for isolation and hatch observation. [After the black tanks are vacated the streams could be cleaned up and used for isolation space.]

Requirements:

2 people full time during hatch
4 living streams

seawater. Approximately 100 eggs per slide will be deposited with gentle swirling. Eggs from each female will be placed in a staining rack and suspended in separate beakers of seawater. Milt from 3 males will be prepared by cutting sections of testes into small segments. A few milliliters of milt will be added to beakers containing eggs. The eggs and milt will remain in contact 5 min with gentle stirring. Fertilized eggs will be transported to the Auke Bay Laboratory for incubation (water containing eggs will be oxygenated before transportation). Eggs will be suspended from monofilament line attached to arms driven by an offset cam to cause slow movement (1 rpm) through the water. Lighting will be natural, supplemented by overhead fluorescent light during daylight hours.

The eggs will be examined for fertilization success and development. Excess eggs will be removed from all slides by scraping, i.e., those along slide margins susceptible to mechanical damage, and clumps of eggs where not all eggs were exposed to water. This processing will be accomplished in water with a minimum of emersion. Eggs on both slides will be counted to quantify fertilization success and development.

Before hatch (after 21 d incubation), all eggs will be isolated by female; to avoid stimulation of hatch, slides will be transferred in water. One randomly chosen slide per female will be isolated in a 1000 m l glass jar; these slides will be held with plastic clamps (Tygon) and suspended with monofilament line from a mobile overhead rack. Jars will be placed in a flowing seawater bath; eggs in these jars will be monitored for hatch. The earliest hatch is expected 25 d after fertilization, and peak hatch after circa 30 d. Hatch timing, hatching success, larval viability, and larval abnormalities will be observed daily for each fish. Hatched larvae will be assessed for swimming ability and gross morphological deformities. Fifty larvae (number 21-70) from each femal will be anesthetized with tricaine methanesulfonate, and preserved in buffered formalin for possible future analysis. After hatch is complete, the remaining eggs and embryos will inspected and enumerated.

Tanks: 10 living streams are required to incubate eggs.

Requirements:

5 people full time for egg clean up and hatch
3 people in field
10 living streams, possibly 12

Appendix 2: Field Research

Purpose: Check viability of spawn of several age classes from several geographic locations. Look for evidence of reproductive impairment in age classes exposed to oil. Compare to unexposed classes and unexposed geographic sites (e.g. Stika).

Design: Compare age classes from each location that could have been exposed to oil and age classes that were not: e.g., 1985-1989 vs 1990 (maybe trace oil or residual oil on beaches?) vs 1991-1992. Compare locations that were oiled with those that were not.

Numbers: Estimate 4 age classes will be spawned per site (there may be 8 age classes per site: 3-10, representing 1985 to 1992). Estimate that 5 locations will be studied (4 in Prince William Sound plus Sitka). [Note: Evelyn suggests that 2 or 3 areas may be more realistic in PWS- spawning has been limited the last few years. One possibility to consider is sampling the early and late spawners at Montague] Another alternative location is Ketchikan. Allow 25 fish per age class. 4 * 5 * 25 = 500 fish = 500 bottles = 10 living streams. If all larvae hatched at the same time, 10 observers would be required full time during peak hatch. However, assume that restricted larval preservation will reduce work load, and not all samples will hatch simultaneously, so 5 observes should be enough.

If the number of fish available is limited, the number of fish per age class can be reduced to 15. In this case , there would be 4 * 5 * 15 = 300 fish, requiring 6 living streams and roughly 3 observers.

Method: Collect spawning fish at sites selected in consultation with ADF&G. Vessel charter details will be shared with ADF&G. After obtaining ripe fish, NOAA personnel will fly back to Cordova and ship gametes or eggs to Juneau by air. ADF&G will age fish in the field (by length). Scales will be collected for later verification. Adult sizes (length and weight) will be recorded.

Length goals are:

class	age	mm
1992	3	165 - 185
1990	5	190 - 205
1988	7	210 - 225
1986	9+	>225

Iced adults will be transported to Cordova. Eggs will be spawned on glass slides (by female). Ovarian membranes will be cut longitudinally and the eggs removed with a hydrocarbon-free stainless steel spatula. From each female, eggs will be deposited on two 25 x 75 mm glass slides placed at the bottom of a shallow glass dish in ambient

1995 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1994 - September 30, 1995

Project Description: Herring Reproductive Impairment - The primary goal of this project is to determine if herring reproduction can be impaired by exposue to oil; a combination of controlled laboratory exposures and viability measurements from herring in the field will be used. In one year (FY 94), the goal was to determine if exposure of pre-spawning adults to oil would result in genetically impaired larvae with reduced survival potential. In FY 95, the laboratory oil exposures will be extended to eggs and larvae, with similar measurements of genetically impaired larvae. This will allow direct comparison of impacts between adult, egg, and larval stages. Data will be used to infer what the relative effects the Exxon Valdez oil spill were on adult and early life stages of herring in Prince William Sound.

Budget Category:	1994 Project No. 94166 Authorized FFY 94	'94 Report/ '95 Interim* FFY 95	Remaining Cost** FFY 95	Total FFY 95	FFY 96	Comment
Personnel	$92.6	$120.3	$122.9	$243.2	$96.7	
Travel	$3.1	$2.0	$18.5	$20.5	$4.0	
Contractual	$50.0	$0.0	$64.0	$64.0	$0.0	
Commodities	$23.8	$8.5	$25.0	$33.5	$4.0	
Equipment	$0.0	$0.0	$5.0	$5.0	$0.0	
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0	
Subtotal	$169.5	$130.8	$235.4	$366.2	$104.7	
General Administration	$17.4	$18.0	$22.9	$40.9	$14.5	
Project Total	$186.9	$148.8	$258.3	$407.1	$119.2	
Full-time Equivalents (FTE)	1.8	2.2	2.4	4.6	2.5	
Dollar amounts are shown in thousands of dollars.						

Budget Year Proposed Personnel: Position Description	Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
Project Leader GS - 12	6.0	$35.1	5.0	$29.1
Chemist GS - 11	7.0	$34.7	5.0	$24.8
Chemist GS - 9	7.0	$28.7	5.0	$20.6
Zoologist GS - 7	6.0	$17.4	5.0	$15.8
Physiologist GS - 12	0.0	$0.0	3.5	$20.7
Biol. Technician GS - 5	0.0	$0.0	4.5	$11.4
Program Manager	0.9	$4.4	0.6	$0.5
Personnel Total	26.9	$120.3	28.6	$122.9

NEPA Cost: $0.0

*Oct 1, 1994 Dec 31, 1994

**Jan 1, 1995 - Sep 30, 1995

Project Number: 95074
Project Title: Herring Reproductive Impairment
Agency: National Oceanic & Atmospheric Admin

FORM 2A PROJECT DETAIL

Appendix 3: Logistics summary

The laboratory experiment will require 4 people and 10 living streams. The field experiment will require 8 people and 10 to 12 living streams.

1995 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1994 - September 30, 1995

Commodities:	Reprt/Intrm	Remaining
Wet lab supplies and exposure apparatus	$2.5	$6.0
Office suplies - consumables	$0.5	$0.5
Chemistry lab supplies	$2.0	$6.5
Consumables, glassware, detergent, first aid supplies, protective eye wear, etc.		
Culturing supplies	$1.5	$3.0
Media, glassware, tubing, etc.		
Field supplies, gear	$1.5	$4.0
Nets, float coats, buckets, sample jars, etc.		
Dissecting equipment	$0.0	$3.0
All < $500: scissors, scalpels, slides, trays, etc.		
Film, photography supplies	$0.5	$2.0
Commodities Total	$8.5	$25.0
Equipment:		
Micro Balance		$5.0
Equipment Total	$0.0	$5.0

07/14/93

1995

Printed: 9/12/94 11:51 AM

Project Number: 95074
Project Title: Herring Reproductive Impairment
Agency: National Oceanic & Atmospheric Admin

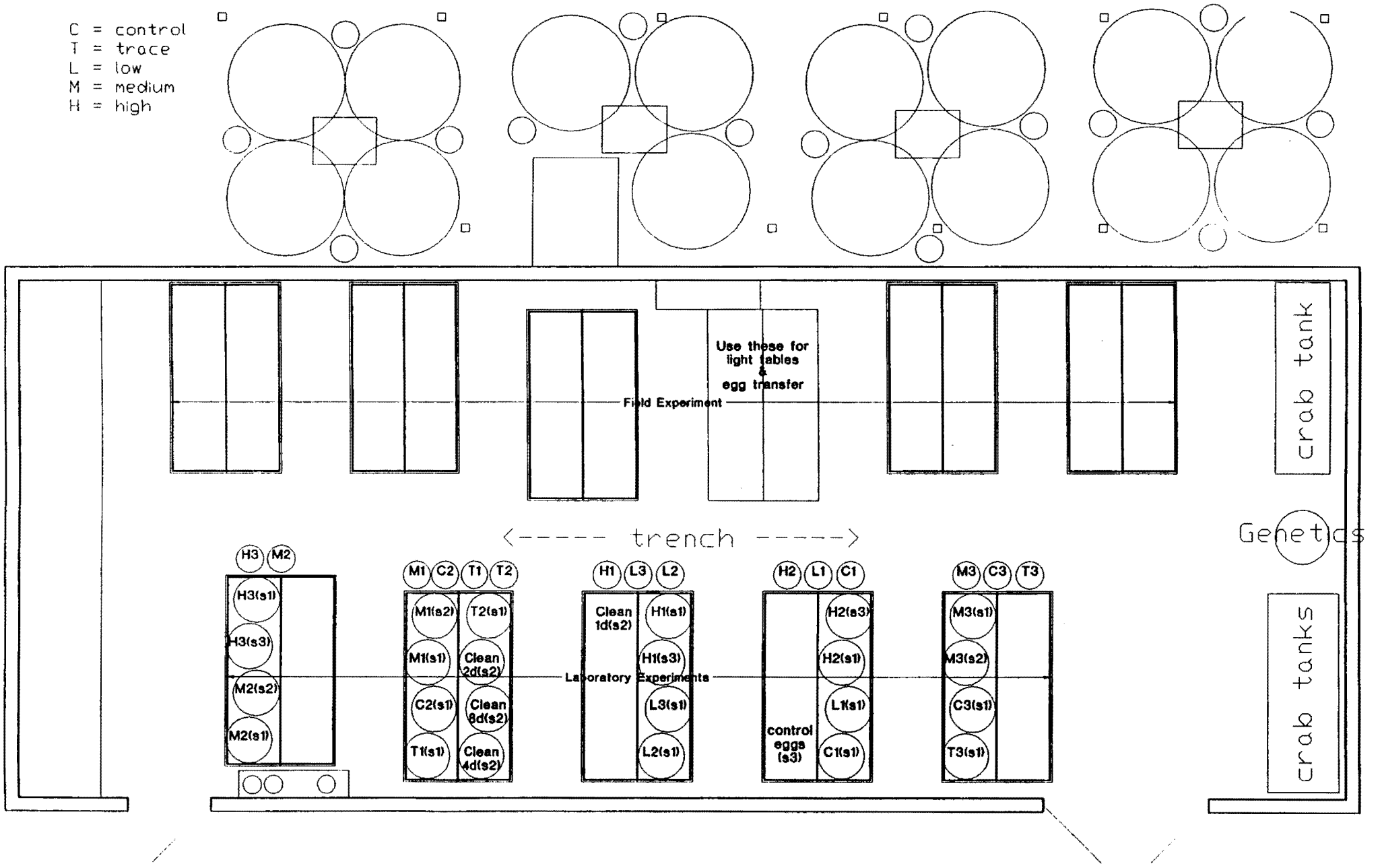
FORM 2B
PROJECT
DETAIL

1995 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 1994 - September 30, 1995

		Reprt/Intrm	Remaining
Travel:			
Rept	4 roundtrip Juneau to Anchorage, workshop, meetings for P.I., staff	$2.0	$2.5
Rem	Airfare $450; perdiem 12d @ $225		
	11 roundtrips to Prince William Sound for field sampling		$10.9
	Airfare $352; perdiem 40d @ $175		
	6 roundtrip to Sitka for control field sampling		$5.1
	Airfare $162; per diem 24 d @ $175		
	Travel Total	$2.0	$18.5
Contractual:			
Rept	Purse seine contract to collect adult herring for oil exposure to eggs and larvae		$10.0
Rem	Genetic analyses contract for possible genetic injury to larval herring		
	1,500 larvae @ $20/larvae		$30.0
	Histopathological evaluation of oil-exposed larvae		$6.0
	86 larvae @ $70/larvae		
	Maintenance contract for gas chromatograph/mass spectrometer		$12.0
	Data entry contract		$4.0
	Repair contract for compound microscopes, osmometer, etc.		$2.0
	Contractual Total	$0.0	$64.0

Project Number: 95074
Project Title: Herring Reproductive Impairment
Agency: National Oceanic & Atmospheric Admin

FORM 2B
PROJECT
DETAIL


C = control
T = trace
L = low
M = medium
H = high
Use these for light tables & egg transfer
Field Experiment
crab tank
<----- trench ----->
Genetics
H3 M2
H3(s1)
H3(s3)
M2(s2)
M2(s1)
M1 C2 T1 T2
M1(s2)
T2(s1)
M1(s1)
Clean 2d(s2)
C2(s1)
Clean 8d(s2)
T1(s1)
Clean 4d(s2)
H1 L3 L2
Clean 1d(s2)
H1(s1)
H1(s3)
L3(s1)
L2(s1)
Laboratory Experiments
H2 L1 C1
H2(s3)
H2(s1)
L1(s1)
control eggs (s3)
C1(s1)
M3 C3 T3
M3(s1)
M3(s2)
C3(s1)
T3(s1)
crab tanks

95076

January 26, 1995

EXXON VALDEZ OIL SPILL, DETAILED PROJECT DESCRIPTION

Title: Effects of oiled incubation substrate on survival and straying of wild pink salmon

Project Number: 95076

Lead Trustee Agency: National Marine Fisheries Service (NMFS)

Project Start-up: 1/95 **Completion:** 9/99 **Duration:** 5 years

Cost of Project:
FY95: $180.0 K
FY96: $327.5 K
FY97: $424.3 K
FY98: $314.7 K
FY99: $245.2 K

Geographic Area: Little Port Walter, Baranof Island, Southeast Alaska

Project Leader: Alex C. Wertheimer (NMFS)
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(907) 789-6094 (fax)

P.I.

Co-investigators: Stanley D. Rice (NMFS)
Ronald A. Heintz (NMFS)
Adrian G. Celewycz (NMFS)

Project Manager: Bruce Wright (NMFS)
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(907) 789-6608 (fax)

A. INTRODUCTION

Reliable estimates of the straying rate and damage to the fitness of wild pink salmon are essential for the effective restoration of the damaged pink salmon population in Prince William Sound (PWS). Previous Natural Resource Damage Assessment (NRDA) research has documented reduced survival of pink salmon embryos exposed to oil during incubation, and has suggested that the damage may be heritable (Bue et al. 1995). Gametes from both the 1993 and 1994 broods of pink salmon from oiled streams in PWS suffered higher mortality than gametes from unoiled streams, even when these gametes were incubated in a similar, controlled environment at a hatchery (pers. comm., Brian Bue, ADF&G). Stock separation information to help management protection of damaged stocks has been identified as a high priority general restoration technique for PWS, but without reliable estimates of straying rate, stock separation information is of limited value.

The degree of straying of wild pink salmon is also a key issue in the current controversy involving the effects of large-scale enhancement on wild pink salmon populations in PWS as part of the restoration process. Little is known about the straying rate of wild pink salmon even without the effect of oil in the environment. High straying rates for wild pink salmon were observed in PWS after the oil spill for fish from both oiled and non-oiled streams(NRDA F/S Study No.3). However, the results were confounded because fish from non-oiled streams may have been exposed to oil during their saltwater migrations as they migrated along oiled beaches, and the tagging process may have contributed to the observed straying rates (pers. comm., Jim Seeb, ADF&G). If high straying rates occur without any influence from oil, then the genetic structure of the populations in PWS should be relatively homogeneous, and large-scale mixing of wild stocks and the hatchery stocks derived from them should be of minor concern. Restoration of damaged pink salmon runs can therefore be expected to occur naturally through recolonization from healthy stream systems. However, if the presence of oil increases straying, then the genetic diversity among and within wild stocks may be in jeopardy from increased straying, and fisheries managers must be aware that genetic damage hypothesized to occur as a result of incubation in oiled substrate may be passed on to pink salmon in streams originally not oiled by the *Exxon Valdez*.

The lethal and sublethal effects that have been documented for pink salmon embryoes incubated in oiled substrate suggest that such exposure causes developmental abnormalities that could persist and affect the fitness of the fish during subsequent life-history stages. Fish eggs and larvae are particularly sensitive to exposure to oil. Mironov (1969) observed reduced survival of fish eggs and larvae exposed to very low aqueous doses (1 ul oil/l seawater) of oil. Moles et al. (1987) confirmed that pink salmon eggs take up PAHs and demonstrated that the uptake was much greater in an intertidal environment than in strictly freshwater conditions. Long-term intra-gravel oil exposure (7-8 months) to freshly fertilized eggs provides embryos sufficient time to accumulate polynuclear aromatic hydrocarbons (PAHs) from very low aqueous concentrations of crude oil, and results in retarded development of pink salmon embryos, decreased survival to eyeing and emergence, an increased occurrence of gross lesions at emergence, altered emergence timing, and reduced growth of fish in the marine environment (Restoration Study No. 94191).

The effect on straying from exposure of pink salmon embryoes to oil is unknown. Previous research on the effects of oil on straying has focused on exposing returning adult salmon to oil for a short period of time (1-2 hours). Short-term exposure to oil had no deleterious effect on homing of either chinook salmon (Brannon et al. 1986) or coho salmon (Nakatani et al. 1985). Short-term oil exposure did cause temporary disorientation in migrating adult pink salmon, but did not prevent the eventual return to the home stream (Dames and Moore 1989). Anecdotal information in PWS indicated that the 1991 adult pink salmon returns from the heavily exposed 1989 brood year had unusual migration timing and spatial distribution. The developmental abnormalities noted for juvenile pink salmon incubated in oiled substrate leave open the possibility that oil exposure could also affect the development of the physiological or behavioral capacity for imprinting and homing.

The deleterious effects of incubation in oiled substrate may also decrease the subsequent marine survival of pink salmon. For fish that survive the lethal effects of incubation in an oiled substrate, the sublethal effects of retarded development, delayed timing, and reduced growth probably confer a selective disadvantage in competition for resources in marine waters with fish incubated in an oil-free environment. Marine survival of pink salmon has been directly related to their early marine growth and migration timing (Mortensen et al. 1991). The degree of damage to the fitness of the exposed populations may thus extend beyond the impairment of reproductive viability, and may include reduced survivability in the marine environment.

B. PROJECT DESCRIPTION

This project has been designed to examine the effects of oil exposure during embryonic development of pink salmon on: 1) straying rate, 2) marine survival, and 3) gamete viability of returning adults. Pink salmon eggs will be incubated in a controlled simulation of oiled intertidal habitat which occurred in Prince William Sound after the *Exxon Valdez* oil spill. Fry will be tagged to identify treatments and released to migrate to the Gulf of Alaska. Returning adults will be recovered at the release site and at other streams within 50 km of coastline of the release site. Recoveries of tagged adults will be used to determine treatment-specific straying rates and marine survival. Tagged adults returning to the release site will be held and spawned, and the fertilized eggs will be incubated in a clean environment to determine gamete viability of fish from the original treatment groups.

Estimation of the effects of oil incubation on straying may be confounded by other factors that could influence this behavior. To control for the effects of such factors on the observed responses to oil exposure, this project will also examine the influence of: 1)incubation environment (freshwater vs. intertidal); 2)stock (upstream stock vs. intertidal stock); 3) coded-wire tagging (pelvic-fin-clipped wild fry vs. CWT wild fry); and 4) origin (artificially spawned and incubated fry vs. wild fry) on straying behavior.

These two aspects of the study (the determination of relative response to the degree of oil exposure and the evaluation of the effects of other factors on straying) are described in the methods as Component A and Component B, respectively. While Component A is the primary rationale for this research, Component B greatly strengthens the evaluation of dosage response on straying by providing insight into the influence of other factors on straying behavior. For both

components, two brood years of pink salmon will be studied.

1. Resources and/or Associated Services: This research will benefit the restoration of pink salmon resources damaged by the *Exxon Valdez* oil spill. The study will be conducted on two brood years of pink salmon (*Oncorhynchus gorbuscha*) enhanced from Lover's Cove Creek and Sashin Creek on southern Baranof Island, southeast Alaska (Figure 1); the results will be applicable to wild pink salmon populations exposed to *Exxon Valdez* oil in PWS. Benefits include defining the damage to pink salmon exposed to oil during incubation; determining the extent genetic damage could be spread by increased straying behavior; and providing information on natural straying behavior of pink salmon. This information is important to develop management and enhancement actions for restoring and maintaining wild pink salmon populations in PWS.

2. Relation to Other Damage Assessment/Restoration Work: This study will provide information that either validates the high straying rates documented for PWS pink salmon in NRDA F/S Study No. 3, or that identifies factors unrelated to oiling that may have caused the observed straying. This study will also complement Restoration Study No. 94191 by providing estimates of marine survival for wild pink salmon exposed to different levels of oil in the incubation substrate and released to migrate to the Gulf of Alaska, and by examining gamete viability of surviving adults from the different oil treatment groups.

3. Objectives: The objectives of Component A are to expose pink salmon to oil during egg incubation in a simulated intertidal environment, release the fry into salt water, and determine the effect on: 1) straying rate, 2) marine survival, and 3) gamete viability of returning adults. The objectives of Component B are to determine the influence on straying behavior of: 1) incubation environment (freshwater vs. intertidal); 2) stock (upstream stock vs. intertidal stock); 3) coded-wire tagging (pelvic-fin-clipped wild fry vs. CWT wild fry); and 4) origin (artificially spawned and incubated fry vs. wild fry).

4. Methods:

A. Gamete collection, egg incubation, and fry tagging

Component A: Pink salmon gametes will be collected in the fall of 1995 and 1996 from Lover's Cove Creek, Baranof Island, southeast Alaska. Ripe adult pink salmon will be seined from Lover's Cove Creek, and gametes from 125 females and 125 males will be collected and transported to the nearby NMFS research station at Little Port Walter (LPW) to be spawned. A randomized embryo pool will be created by: 1) spawning the females into a common container, 2) randomizing the eggs within the container, 3) dividing the eggs into 125 aliquots, 4) fertilizing each aliquot with an individual male, and 5) recombining all fertilized eggs into a composite embryo pool. This composite embryo pool will then be divided into 40 aliquots of approximately 4000 eggs each. Each aliquot will then be randomly assigned to one of the 4 oiled gravel treatments (10 aliquots per treatment). The individual aliquots will be incubated in individual pipe incubators filled with gravel.

Instream incubation will be simulated in the pipe incubators. These incubators will be constructed from 30-cm long sections of 20-cm diameter polyvinyl chloride pipe. The pipe will

be stood on end, sealed, and fitted with a water intake at the bottom. The pipe will then be filled with appropriately-treated gravel. This design will allow water to upwell through the gravel and then out through an outlet fitting at the top of the incubator pipe. Fertilized eggs will be laid on top of the gravel to incubate. Upon hatching, the alevins will be permitted to burrow into the substrate.

Embryos will be exposed to salt water for 4-hour intervals every 12 hours to simulate an intertidal environment. Water supply to the incubators will flow from a large head tank. During saltwater exposure periods, salt water with 26-30 parts per thousand salinity will be pumped from the bay into the head tank. At the end of each saltwater exposure cycle, saltwater flow into the head tank will be shut off, and freshwater flow into the head tank will be resumed. Salinity will thus rise and fall gradually at the beginning and end of each saltwater treatment period.

The fertilized eggs will be incubated at LPW under one of four treatments of oiled gravel: control, low oil, medium oil, and high oil. Dosing levels will be established by analyzing hydrocarbon concentrations with gas chromatograph and mass spectroscopy (GC/MS) in incubator effluent and substrate at the beginning of the experiment and in incubator effluent, substrate, and fish tissue at each major developmental stage: eyeing, hatching, and emergence.

Various parameters will be recorded during incubation. Survival to eyeing and emergence, size at emergence and release, and emergence timing will be measured for each treatment group. Upon emergence, fry will be moved to separate freshwater raceways for each treatment group to be held before being tagged. While being held, fry will be fed and treated with erythromycin as indicated to control bacterial kidney disease.

In the spring of 1996 and 1997, a total of 120,000 pink salmon fry (30,000 per treatment) will be coded-wire tagged (CWT) each year before being released into marine waters at LPW (Table 1). An analysis of power indicates 80% certainty that differences in straying of 3-5% between treatments will be detected 95% of the time with this number of fish tagged. Assuming 2% marine survival and a straying rate between 7% (pers. comm., Ladd Macauley, Douglas Island Pink and Chum, Inc., 2697 Channel Drive, Juneau, Alaska, 99801.) and 26.3% (Sharp et al. 1993), the total number of strays/treatment should range from 41 to 157.

Each treatment will be composed of 30,000 fry tagged in 3 code lots of 10,000 fry each. This will allow calculation of the variance of straying based on replicates within treatment. Approximately 10,000 fish can be tagged per day. To control for the effect of emergence timing on subsequent survival and straying, fry from each treatment group will be allocated into three strata depending on emergence timing (early, mid, and late). For each strata, tagging will alternate randomly between treatment groups (in batches of 10,000 fry or one code lot). Each code lot will be released 2-3 days after tagging except for a subsample which will be held for 14 days to measure tag retention.

Component B: To examine the effects of stock and incubation environment on straying rates, pink salmon gametes will be collected from Sashin Creek concurrently with the egg-takes from Lover's Cove Creek. The Sashin Creek pink salmon stock is composed predominately of upstream spawners, whereas the Lover's Cove Creek stock is composed predominately of

intertidal spawners. Gametes from both stocks will be incubated in pipe incubators (described above) in both the simulated intertidal environment used for Component A, and in freshwater only (to simulate an upstream environment). An additional 22 ripe adult females and males will be seined from Lover's Cove Creek, and 63 ripe adult females and males will be collected from the weir on Sashin Creek. Not as many additional gametes need be collected from Lover's Cove Creek because the control group in Component A doubles as a treatment group for Component B. For each stock, gametes will once again be randomly mixed into a composite embryo pool and then divided into 20 aliquots (Sashin Creek) and 10 aliquots (Lover's Cove Creek) of approximately 4000 eggs each. For gametes from Sashin Creek, each aliquot will then be randomly assigned to one of the 2 treatments (freshwater only vs. simulated intertidal, 10 aliquots per treatment). For Lover's Cove Creek, because the control group in Component A doubles as the simulated intertidal treatment group in Component B, each additional aliquot will be assigned to the freshwater-only treatment. The individual aliquots will be incubated in individual pipe incubators filled with gravel.

For each treatment group, 30,000 fry will be marked with CWTs (3 code lots per treatment) in the spring of 1996 and 1997 before being released into salt water at LPW (Table 2). Once again, to control for the effect of emergence timing on subsequent survival and straying, fry from each treatment group will be allocated into three strata depending on emergence timing (early, mid, and late). For each strata, tagging will alternate randomly between treatment groups (in batches of 10,000 fry or one code lot). Each code lot will be released 2-3 days after tagging except for a subsample which will be held for 14 days to measure tag retention. This requires an additional 90,000 fry to be tagged beyond Component A.

To measure straying rates of naturally emigrating wild fry and to test whether coded-wire tagging may induce straying, wild pink salmon fry emigrating from Sashin Creek and Lover's Cove Creek in 1996 and 1997 will also be captured, marked, and released. In Sashin Creek, fry will be captured with either an inclined-plane trap adapted to the existing weir or screw traps, and in Lover's Cove Creek, fry will be captured with screw traps or fyke nets. Capture methods for this component of the study will be tested in Spring 1995 to determine the most effective technique. From each stream, a total of 30,000 fry will be tagged with CWTs (3 code lots) and 30,000 fry will receive a pelvic-fin clip (left-pelvic-fin clip for Lover's Cove Creek and right-pelvic-fin clip for Sashin Creek, Table 2). A 3-person crew will alternate capturing and tagging fry between streams; on a given day, up to 3000 fry will be tagged with CWTs and 3000 fry will be pelvic-fin clipped.

B. Adult recoveries

In order to assess the rate of homing vs. straying behavior, returning adult CWT pink salmon will be recovered from streams on the eastern shore of Baranof Island from Cape Ommaney to Red Bluff Bay (Figure 1) in the fall of 1997 and 1998. Because the majority of fish should be returning to the vicinity of LPW, most of the recovery effort will be directed to Sashin Creek and Lover's Cove Creek. An average of approximately 30,000 adult pink salmon return each year to Sashin Creek to spawn, and an average of approximately 60,000 return to Lover's Cove Creek. There are an additional 37 pink salmon spawning streams identified between Cape Ommaney and Red Bluff Bay. Most of these are small (<3000 average annual escapement), but at least two have average annual escapements of 3000-7000 pink salmon, two have average annual

escapements of 20,000-30,000 pink salmon, and one has an average annual escapement over 100,000 pink salmon. From 600,000 to 1,000,000 pink salmon also return to a hatchery at Port Armstrong, approximately 10 km south of LPW.

Pink salmon returning to Sashin Creek at LPW will be captured at the existing weir to enumerate total escapement and to recover fish from the experimental treatment groups. All pink salmon will be checked for fin clips when they enter the creek. The weir will be operated so that fish can enter the stream only through the trap, but can exit the creek volitionally through one-way passage gates. Pelvic-fin-clipped fish entering Sashin Creek will be tagged with two external, individually-labeled anchor tags and released upstream of the weir. This will permit evaluation of probing behavior, the extent to which a fish from another stream (in this case, Lover's Cove Creek) enters Sashin Creek but leaves again prior to spawning. Tags will be cryptically colored to avoid selection by predators. Double tagging will be used to determine tag-loss rate. Adipose-fin-clipped fish entering Sashin Creek will be retained for ripening for spawning, at which time the tags will be removed and decoded. Unmarked fish will be counted and released into Sashin creek.

Total escapement to Sashin Creek will be estimated by the total count minus the number of fish recounted. Estimates of number of fish recounted will be derived by recapture of externally-marked fish. Tagging experiments will be done on the 1995 returning adults to determine if the expected number of external tags on pelvic-fin-clipped fish will be sufficient for estimating recounts.

Pink salmon returning to Lover's Cove Creek will also be sampled to collect fish from the experimental treatment groups. Carcasses will be examined on daily stream walks and at a carcass weir. All carcasses will be counted, and tails will be removed from all carcasses to prevent recounting in subsequent surveys. Heads from fish without adipose fins and from carcasses too decomposed to recognize the presence or absence of the adipose fin will be checked for CWTs back at LPW.

Total escapement in Lover's Cove Creek will be estimated with a mark-recapture approach. Fish will be seined weekly in the lower intertidal reach of the stream during the spawning run and tagged with two external, individually-labeled anchor tags. Tags will be cryptically colored to avoid selection by predators. Double tagging will be used to determine tag-loss rate. Each tagging event will have a different numeric code. Carcass counts of tagged and untagged fish will be used to generate escapement and variance estimates.

Pink salmon spawning in other streams on the eastern coast of Baranof Island will also be sampled for the presence of tagged fish. Streams within 30 km of LPW will be sampled twice weekly during the spawning season. These streams will be accessed by a 5.1-m Boston Whaler skiff. Spawning streams 30-50 km from LPW will be sampled twice during the peak of the run; these streams will be accessed by either contract vessel, helicopter charter, or NOAA vessel, depending on availability and cost. Foot counts will be used to index run magnitude. Heads will be removed from adipose-fin-clipped carcasses and checked for the presence of CWTs back at LPW. All carcasses checked for fin clips will be counted, and the tail will be removed to prevent recounting in subsequent samples.

The location of CWTs within the heads of returning adult pink salmon will be examined to determine whether straying was influenced by where the tag was placed within the snout of the fish. Heads from adipose fin-clipped adults will be X-rayed so that tag location in fish that stray can be compared with tag location in fish that home. Samples of up to 100 heads will be X-rayed from each of three recovery categories: Sashin Creek, Lovers Cove, and other area streams. The samples from Lovers Cove and the other area streams will be from spawning or spawned-out fish. At Sashin Creek, however, all adipose fin-clipped fish returning to the weir will be held alive after capture and the tag removed and decoded at spawning in order to identify the treatment group; the sample X-rayed for tag location will be taken from fish that die prior to spawning.

For both Components A and B, marine survival and straying rates for the different treatment groups will be determined from the tagged adult pink salmon returning to spawn at LPW and the surrounding area. For Component A, the effect of oiled incubation gravel on marine survival and straying rates will be tested (Table 1). For Component B, the effect of: 1) incubation environment (freshwater vs. intertidal); 2) stock (upstream stock vs. intertidal stock); 3) coded-wire tagging (pelvic-fin-clipped wild fry vs. CWT wild fry); and 4) origin (artificially spawned and incubated fry vs. wild fry) on marine survival and straying rates will be tested (Table 2). Further details on the models and analyses for both components are provided in Appendix A.

C. Reproductive viability

Gamete viability and offspring survival to emergence will be determined for each treatment group from Component A in each brood year. Gametes from surviving adult pink salmon from each treatment group in Component A will be collected, crossed, and incubated in an oil-free environment. Intra-group pairings will be made for each of the first generation treatment groups. Confining the experiment to within-group pairings simulates the natural homing characteristics of pink salmon and the relatively low levels of genetic interchange thought to occur between streams in the wild. Second generation pairings will again use a randomly mixed common gamete pool utilizing equal numbers of males and females. These eggs will be incubated through emergence. The numbers of defective or dead progeny will be compared between treatment groups. Because these gametes will not be incubated in an oiled environment, any observed increases in mortality or defective individuals can be attributed to oiling effects upon the first generation.

5. Location: The project will be implemented at the NMFS research station at Little Port Walter (LPW). This location is appropriate because of the logistic and infrastructure support the station provides for this complex array of experiments. It is also important to examine the response of pink salmon straying to oil exposure at a geographic locale remote from PWS, away from the confounding effect of prior oil exposure. Gametes will be collected from Lover's Cove Creek and Sashin Creek, Baranof Island, southeast Alaska (Figure 1). Eggs will be incubated, and pink salmon fry will be tagged at LPW, near the mouth of Sashin Creek, 10 km from Lover's Cove Creek. Returning adult pink salmon will be recovered from streams on the eastern coast of Baranof Island within 50 km of LPW.

6. Technical Support: The NMFS will provide use of the research station at LPW as a base for the fieldwork. This station will provide housing for project personnel, a wet lab for egg

incubation, a weir across Sashin Creek for recovery of adult pink salmon, microscopes for the decoding of CWTs, and facilities for the spawning of adult pink salmon. The Auke Bay Laboratory will provide four tagging machines, vessel support, and computer services. Materials and personnel will be transported to and from LPW via the NOAA vessel R/V John N. Cobb and air taxi charters.

A chemist will establish a dosing protocol, determine hydrocarbon concentrations, and evaluate results of hydrocarbon analysis. A biometrician will ensure that the study design provides a reasonable chance of reaching statistically valid conclusions.

7. Contracts: All GC/MS samples will be analyzed under contract with the NMFS Auke Bay Laboratory. Personnel for the tagging and stream crews will be hired by contract. The Port Armstrong Hatchery will be contracted to screen their returning adult pink salmon for any tagged pink salmon from this study that have strayed to their facility. Contracts for helicopter or vessel charters may be needed to transport crews to recover returning adult pink salmon from streams more than 30 km from LPW.

C. SCHEDULE

Date	Activity
1/95	Initiate procurements, hiring, contracts needed for project
4/95	Test fry capture techniques
6/95	Reconfigure LPW wetlab for experimental design
7/95	Set up incubators for 1995 brood
8/95	Oil gravel
9/95	Spawn pink salmon (1995 brood)
9/95-3/96	Incubation, 44 GC/MS samples collected
3/96	Install weirs for collecting 1995 brood wild fry
4/96	Tagging and release of 1995 brood hatchery and wild fry
4/96	Annual Report
6/96	Clean incubators from previous year
7/96	Set up incubators for 1996 brood
8/96	Oil gravel
9/96	Spawn pink salmon (1996 brood)
9/96-3/97	Incubation, 44 GC/MS samples collected (1996 Brood)
12/96	Contract deliverable, 44 GC/MS samples from 1995 brood
4/97	Tagging and release of 1996 brood hatchery and wild fry
4/97	Annual Report
7/97	Install weirs for collecting returning 1995BY adults
8-9/97	Recovery and spawning of returning adults (95 brood)
	Contract deliverable, Port Armstrong Hatchery
9/97-3/98	Incubation of gametes from returning adults
12/97	Contract deliverable, 44 GC/MS samples from 1995 brood
4/98	Annual report
7/98	Install weirs for collecting returning 1995BY adults
8-9/98	Recovery and spawning of returning adults (95 brood)

9/98-3/99	Incubation of gametes from returning adults
4/99	Annual report
9/99	Final report

D. EXISTING AGENCY PROGRAM

The major activities for FY-95 for this project include reconfiguration of the LPW wet lab to accommodate the experimental design, incubator construction, oiling of the treatment gravel, spawning of adult pink salmon from Sashin Creek and Lovers Cove Creek and incubation of fertilized eggs. These activities will be integrated and supported by the normal operations of the LPW research facility. The NMFS will provide use of the research station at LPW. The station will provide housing for project personnel, facilities for the spawning of adult pink salmon, and a wet lab for egg incubation. Some materials and personnel will be transported to and from LPW via the NOAA vessel R/V John N. Cobb.

E. ENVIRONMENTAL COMPLIANCE, PERMITTING, AND COORDINATION STATUS

Compliance for NEPA will be met by a categorical exclusion. Broodstock for the 1995 and 1996 broods will require an ADF&G Fish Transport Permit (FTP). Feeding of erythromycin to pink salmon fry to control bacterial kidney disease will require an Investigational New Animal Drugs (INAD) permit no. 4333

F. PERFORMANCE MONITORING

Performance will be monitored by ongoing evaluation of time-specific milestones identified in the project schedule. Annual reports will document the accomplishment of project milestones. A GM-14 physiologist (Rice) will oversee and provide quality control for the whole project. A GM-13 biologist (Wertheimer) will be the project leader. A GS-13 chemist (Short) will establish a dosing protocol, determine hydrocarbon concentrations, and evaluate results of hydrocarbon analysis. A GS-11 biologist (Heintz) will help with the design of the project, and with data management and analysis. A GS-11 biologist (Celewycz) will be task leader of Component A. A GS-11 biologist (not yet identified) will be task leader of Component B. A GS-9 biologist (Maselko) will assist in setting up the experiments, collecting data, analyzing data, and reporting results. This project is undertaken as part of the research activities of the Auke Bay Laboratory (ABL) and will be supported by the laboratory infrastructure. The ABL will provide backups if any personnel changes occur. A GS-12 biologist (Wright) will be the agency project manager for coordination of this and other NOAA projects with the Trustee Council.

Quality control procedures will be maintained for data collection and recording, tagging, mark detection, tag decoding, and spawner enumerations. All raw and summarized data and reports will be stored as hard copy and electronically on disks in two separate locations at the NMFS Auke Bay Laboratory. Analysis of GC/MS samples will be done according to quality standards established for EVOS hydrocarbon assessment. Samples will be clearly labeled on both the inside and outside of the container with indelible ink and will be stored in freezers at the ABL.

G. COORDINATION OF INTEGRATED RESEARCH EFFORT

Research by NMFS on effects of oil exposure to pink salmon has been closely coordinated with concurrent research efforts by ADF&G and UAF. This project directly complements Restoration Study No. 94191 and will be fully coordinated with its continuation.

H. PUBLIC PROCESS

The necessity of examining the toxicological impacts of oil on the pink salmon resource of PWS, especially in relation to heritable genetic damage, has been identified in scientific workshops and public forums. It has been flagged as a high priority research issue in the Invitation for Projects. This project will continue to receive public review through the PAG and public review process established by the Trustee Council.

I. PERSONNEL QUALIFICATIONS

GM-13 Fishery Biologist - Alex C. Wertheimer. BS Fisheries Science, Oregon State University (1979); MS Fisheries Science, University of Alaska (1984). Currently employed by National Marine Fisheries Service, Auke Bay Laboratory as a Supervisory Fishery Biologist, Task Leader of Early Ocean Salmon Research. Author of over 20 peer-reviewed papers and 30 agency reports on various aspects of the biology and culture of Pacific salmon. Research on Pacific salmon has included determining early marine growth, distribution, and migration; in nearshore habitat utilization; predator/prey relationships; by-catch mortality; the effects of hydrocarbon contamination on juvenile salmon in the marine environment; the association of early marine conditions with year-class success of salmon; salmon aquaculture and genetics; and status of stocks. Principle Investigator *Exxon Valdez* NRDA Fish/Shellfish 4, NMFS Component, 1989 through project completion in 1993.

GM-14 Physiologist - Stanley D. Rice. Received BA (1966) and MA (1968) in Biology from Chico State University, and PhD (1971) in Comparative Physiology from Kent State University. Employed at Auke Bay Fisheries Laboratory since 1971 as a research physiologist, task leader and Habitat Program Manager since 1986. Rice has researched oil effects problems since 1971, and has published over 70 papers, including over 50 on oil effects. Studies have ranged from field to lab tests, behavioral to physiological to biochemical studies, from salmonids to invertebrates to larvae to meiofauna. Rice has conducted and managed externally-funded projects since 1974, including the Auke Bay Laboratory *Exxon Valdez* damage assessment studies since 1989. Activities since the oil spill have included leadership and management of up to 10 damage assessment projects, fieldwork in PWS, direct research effort in some studies, establishment of state of the art chemistry labs and analyses in response to the spill, quality assurance procedures in biological-chemical-statistical analyses, establishment of hydrocarbon database management, servicing principal investigators and program managers in NOAA and other agencies with reviews and interpretations, provided direct input into agency decisions, interacted with other agencies in various ways (logistics coordination, critique experimental designs, interpret observations, etc.).

GS-11 Fisheries Biologist (Research) - Ron A. Heintz. Education: BS Ecology, University of

Illinois (1979); MS Fisheries Science, University of Alaska (1986). He has worked for the National Marine Fisheries Service, Auke Bay Laboratory since 1985 concentrating his efforts on salmon enhancement research and salmon genetics. He is the principle investigator and co-investigator on several salmon genetics projects.

GS-11 Fisheries Biologist (Research) - Adrian G. Celewycz. BS Biology, University of Illinois (1979); MS Fisheries Science, University of Alaska (1985). He has worked for the National Marine Fisheries Service, Auke Bay Laboratory since 1981, studying distribution, growth, habitat utilization, predator/prey relationships of juvenile salmon migrations. In addition to being recognized as "The Outstanding Student of Fisheries and Science" by the University of Alaska at Juneau in 1985, he was awarded Certificates of Recognition for superior performance by NOAA in 1989, 1990, and 1993. He served as co-investigator on *Exxon Valdez* NRDA Fish/Shellfish Study No. 4, and was awarded Certificates of Recognition by NOAA for outstanding contributions serving the public trust in response to the *Exxon Valdez* oil spill in 1989 and 1990.

J. BUDGET (x $1000)

A. FY-95 (detailed)

Personnel	
GM-14 (SR)	*
GS-13 (JS)	*
GM-13 (AW)	14.1
GS-12 (BW)	5.0
GS-11 (LPW)	11.6
GS-11 (AC)	26.0
GS-9 (JM)	20.4
Subtotal	76.1
Travel	
LPW	5.8
Meetings	0
Subtotal	5.8
Contracts	
GC/MS samples	4.8
Tagging/fish capture	1.0
Subtotal	5.8
Commodities	
Incubation	
Holding nets	3.5
Fish totes	1.1
Gravel	1.2
PVC pipe	2.4
PVC sheets	1.2
Perforated aluminum	1.2
Tygon tubing	4.0
Valves, fittings, supplies	1.7
Tagging	
Cutters	3.8
Surgical-quality scissors	1.2
Wire	19.0
Head molds	1.7
Groceries/Fuel	2.4

Wild fry capture	
Weir modifications	3.6
Fyke nets	8.4
Subtotal	56.4

*NMFS will contribute salary for 0.1 FTE

Equipment	
Saltwater intake	14.4
Beach seine	3.6
Electronic fish measuring device	6.0
Subtotal	24.0
Capital outlay	0
Subtotal	0
TOTAL	168.1
Administration	11.9
GRAND TOTAL	180.0

B. All years

	FY-95	FY-96	FY-97	FY-98	FY-99
Personnel	76.1	170.0	225.6	209.0	202.0
Travel	5.8	19.9	24.6	19.7	11.7
Contracts	5.8	65.6	106.7	37.1	0.0
Commodities	56.4	41.9	26.1	14.9	1.2
Equipment	24.0	0.0	0.0	0.0	0.0
Capital outlay	0.0	0.0	0.0	0.0	0.0
SUBTOTAL	168.1	297.4	383.0	280.7	214.9
Administration	11.9	30.1	41.3	34.0	30.3
TOTAL	180.0	327.5	424.3	314.7	245.2

K. Literature Cited

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Moles, A., M. M. Babcock, and S. D. Rice. 1987. Effects of oil exposure on pink salmon (*O. gorbuscha*) alevins in a simulated intertidal environment. Marine Environment Research, 21: 49-58.

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Nevissi, A. E., and R. E. Nakatani. 1990. Effects of crude oil spill on homing migration of Pacific Salmon. Northwest Environmental Journal 6:79-84.

Sharp, D., S. Sharr, and C. Peckham. 1993. Homing and straying patterns of coded wire tagged pink salmon in Prince William Sound. Abstracts from the Exxon Valdez Oil Spill Symposium. Oil Spill Public Information Center, Anchorage, AK.

Table 1. Design matrix, Component A. Each treatment group will be composed of Lover's Cove Creek stock, incubated in an intertidal-simulated incubation environment with different levels of oiled gravel. All tag groups of coded-wire tagged (CWT) fish will be represented by replicate code lots of 10,000 fish each.

Oil level	Tagging method	Fry released
Control	CWT	30 K*
Low	CWT	30 K
Mid	CWT	30 K
High	CWT	30 K

* Doubles as a treatment group in Component B.

Table 2. Design matrix, Component B. All tag groups of coded-wire tagged (CWT) fish will be represented by replicate code lots of 10,000 fish each.

Origin	Incubation environment	Tagging method	Stock Lover's Cove Creek	Sashin Creek
Hatchery	Freshwater	CWT	30 K	30 K
Hatchery	Intertidal	CWT	30 K*	30 K
Wild	In-stream	CWT	30 K	30 K
Wild	In-stream	Pelvic clip	30 K	30 K

* Doubles as the control group in Component A.

APPENDIX A

Objectives of this study include determining if incubation in oiled gravel influences the straying rate and marine survival of pink salmon and to construct a dose response relationship for these parameters. Straying rate will be calculated as the proportion of tagged fish recovered from non-natal streams, and marine survival will be calculated as the proportion of tagged fish that are released that are recovered as adults. While differences in straying or marine survival rates between doses may be detected, the magnitudes of the actual rates may be influenced by the effects of other factors. So, three additional experiments have been designed to determine if these other influences exist, and to estimate their magnitudes. If effects of other factors on straying or marine survival are identified, the estimates provided by the experiments will be used to correct the dose response curves. The approach to the statistical analysis of these two parameters will be similar. A detailed description of the models used to evaluate the factors affecting straying are presented here; similar models will be used to evaluate the factors affecting marine survival.

In all experiments, streams will be classified into two groups: natal and non-natal. The proportion of recoveries from each of these streams will be fit to log likelihood models and tested for interaction effects by computing a G test for independence with expectations intrinsic to the data. Significance testing will use a critical value for G test for independence where alpha = 0.05. The models, null hypotheses and interpretations are described below.

The first experiment (Component A) is designed to reveal differences in straying rate between groups of salmon exposed to different doses of oil. Returning adults, exposed during incubation, will be recovered from natal and non-natal streams. Recovered tags will be classified by dose and recovery location and fit to the following model:.

$$\mathrm{Ln}\, f_{ij} = \mu + \beta_i + \Delta_j + \beta\Delta_{ij}$$

where f_{ij} is the expected frequency of the i^{th} dose in the j^{th} stream, μ is the overall average of the logarithms for frequency, β_i is the marginal frequency associated with the i^{th} dose, Δ_j is the marginal frequency associated with the j^{th} stream, and $\beta\Delta_{ij}$ is the Interaction between the i^{th} dose and the j^{th} stream. The null hypothesis is:

$$\beta\Delta_{ij} = 0 \text{ for all ij.}$$

If the null hypothesis is rejected then an interaction between dose and homing fidelity will be assumed since streams will be classified as natal and non-natal.

Differences in straying rate established using the analysis described above, reflect only proportional differences between doses, and rates may also be influenced by factors such as the laboratory environment. Component B seeks to evaluate the effects of fish culture on the true straying rates, so that the estimates provided by component A can be adjusted to provide a more accurate estimate of the dose-induced wild straying rates in wild fish exposed to oil. Table 2 identifies the three main experiments designed to determine the influence of other factors on straying rates. These experiments test the effects of origin (hatchery or wild), incubation environment (natal or non-natal) and mark (pelvic clip or adipose clip and coded wire tag) on straying rates.

Analysis of recovery data will proceed systematically to maximize the power of the three tests. The effects of mark will be tested first followed by incubation environment since these are subdivisions of the larger experiment on origin. The results of these two analyses will determine which data are included in the analysis of the effects of origin. If no interaction between straying rate and mark is detected then fish representing both treatments can be used to represent wild fish in the analysis of the experiment on the effects of origin. Likewise, if fish incubated in non-natal environments stray just as frequently as fish incubated in natal environments, then these groups can be pooled and used to represent the hatchery fish in the hatchery/wild comparison. Alternatively, comparison of the straying rates of hatchery and wild fish may need to be limited to fish cultured in natal environments and marked with a coded wire tag.

Once the effects of factors other than oil exposure are identified, then the observed numbers of straying fish due to oiling can be adjusted to provide more accurate estimates using the following:

$$N_{adj} = N_i - \Sigma N_i h_j.$$

Where N_{adj} is the adjusted number of strays from the i^{th} dose and N_i is the number of strays observed for the i^{th} dose and h_j is the proportional increase in straying due to the j^{th} fish culture effect. The straying rate for a dose will be calculated by dividing the total number of tag recoveries for the dose into the adjusted number of strays.

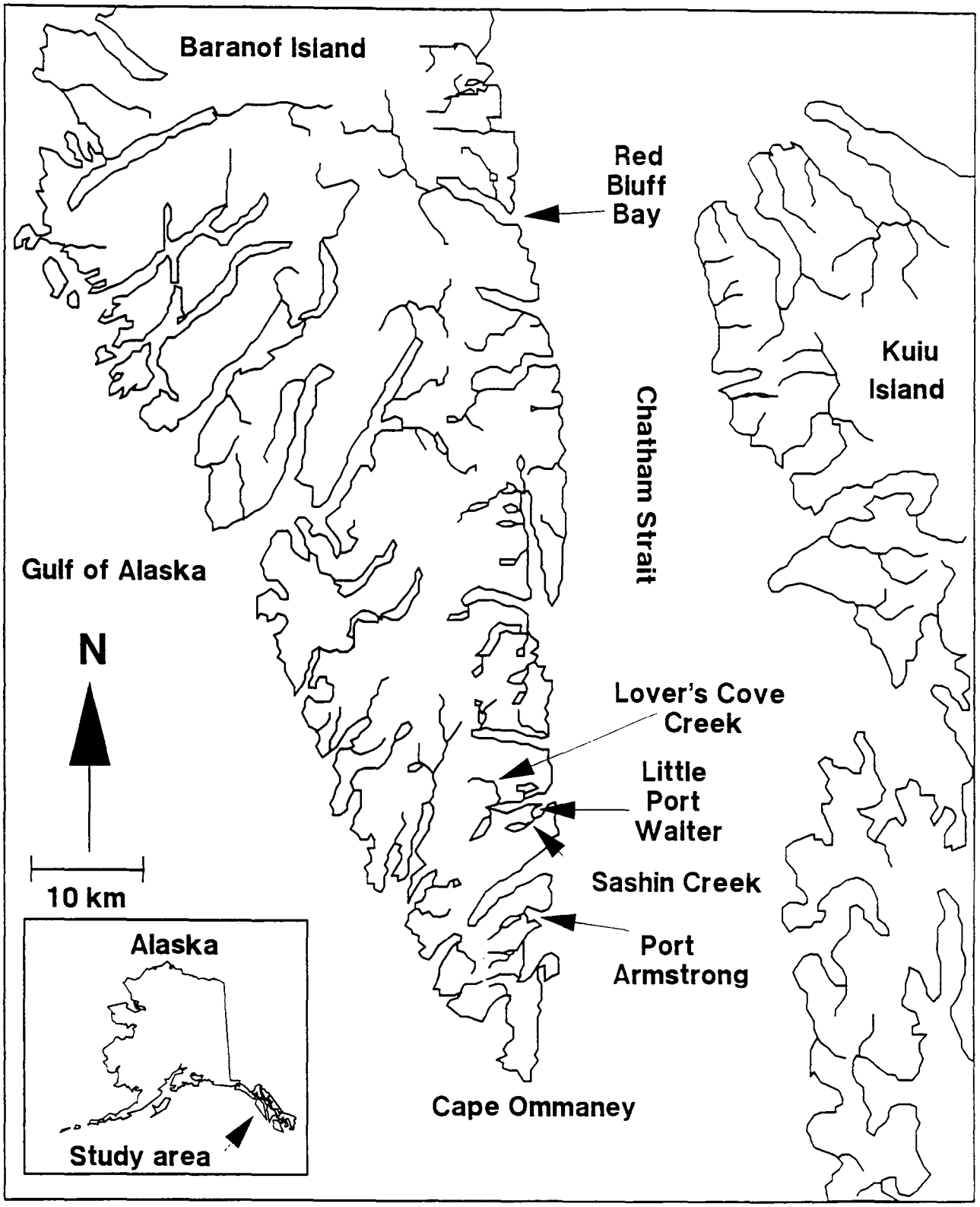


Figure 1. Lower Baranof Island, southeastern Alaska.

EXXON VALDEZ Oil Spill TRUSTEE COUNCIL
Draft Detailed Project Description

Project Title:	Herring Bay Monitoring and Restoration Studies
Project ID Number:	95086C
Project Leader(s):	Drs. Raymond C. Highsmith and Michael S. Stekoll
Project Coordinator:	Dr. Raymond C. Highsmith
Lead Trustee Agency: **Cooperating Agencies:**	Alaska Department of Fish and Game University of Alaska
Start-up/Completion Dates:	Oct 1994/ Sep 1996
Expected Project Duration:	2 Years
Cost of Project/FY 95:	$ 388,561
Cost of Project/FY 96 Report Preparation:	$ 165,534
Geographic Area of Project:	Herring Bay, Knight Island, Prince William Sound
Lead Agency Project Manager:	Dr. Joe Sullivan Alaska Department of Fish and Game Habitat and Restoration 333 Raspberry Road Anchorage, Alaska 99518-1599 (907) 267-2213

A. INTRODUCTION

Following the *Exxon Valdez* oil spill (EVOS) and subsequent clean-up activities, research was conducted under the Coastal Habitat Injury Assessment (CHIA) program within the shallow subtidal and intertidal zones in the oil-affected habitats in Prince William Sound (PWS), and in the intertidal zones in Cook Inlet - Kenai Peninsula (CIK), and Kodiak - Alaska Peninsula (KAP). In addition, the Herring Bay Experimental and Monitoring Studies were conducted within Herring Bay, Knight Island, in Prince William Sound. All of these projects found damage to both the shallow subtidal and intertidal invertebrate and algal communities. Significant differences were detected between oiled and reference sites for grazing invertebrates such as *Tectura persona, Lottia pelta, Littorina sitkana,* and *L. scutulata* and for the primary space competitors *Fucus, Mytilus,* and several species of barnacles. Most of the invertebrates showing damage are prey for either other invertebrates or for foraging birds or marine mammals. Further research will allow better interpretations of key relationships in the damaged nearshore ecosystem.

Several of the ongoing monitoring and experimental studies that were established in Herring Bay during 1990 will continue through the 1995 field season, at which time all studies will be closed out unless future funding becomes available. These studies were initially proposed to identify important community interactions between and among invertebrates and algae for determining factors that limit or control recovery. More specifically, the proposed studies are designed to answer one or more of the following ecosystem process questions:

1. Do dominant competitors and resident predators limit recovery of the damaged intertidal community? Included within this question are whether the presence of certain grazers limits the recovery of algal species.

2. Are predators limited by reduced populations of prey species? Included in this question are the effects of reduced algal cover as a food source to grazers.

3. Is the recovery of the community structure limited by recruitment processes?

4. Do physical processes limit recovery of damaged intertidal species, including the effects of damaged species that act as structure and protection for other species?

The ongoing experiments in Herring Bay are designed to elucidate some of the ecosystem processes that control community structure and recovery.

Need for the Project

Five years after the EVOS, several intertidal species are still showing damage, including *Fucus*, the important structural component of the intertidal ecosystem. Continued monitoring of several key invertebrate and algal species in Herring Bay will allow estimates of the degree and rates of recovery of damaged species. This project will aid in defining the rates and potentials for recovery of damaged intertidal resources by ascertaining the major limitations to settlement, recruitment, and growth of *Fucus* and of invertebrates such as barnacles, mussels, and limpets.

A restoration aspect of the experimental study is focusing on the restoration of the damaged *Fucus* populations in the upper intertidal. This experiment is testing the feasibility of using a biodegradable substrate seeded with *Fucus* embryos to recolonize the high intertidal habitat by reducing heat and desiccation stress.

B. PROJECT DESCRIPTION

1. Resources and/or Associated Services:

The resource targeted during this study will be the intertidal community within the EVOS impacted area using Herring Bay as an experimental study site. To fully understand the dynamics of recovery, it is essential that we continue to monitor the intertidal zone. Monitoring until population sizes stabilize at oiled sites will allow us to more fully assess the original damage observed. If there are differences between recovery end-points at paired sites, a correction for the difference in the initial analyses can be made.

2. Relation to Other Damage Assessment/Restoration Work:

The intertidal is used as foraging grounds by predators such as Black Oystercatchers, Harlequin Ducks and other waterfowl, Sea Otters and River Otters, just to name a few. All of these have been studied by Damage Assessment and/or Restoration teams since 1989. Results stemming from the Herring Bay Study have been incorporated by other investigators especially during this past year, and it appears that more requests for specific information from this project are being sought by several of the Nearshore investigators. During the first three field seasons (through the summer of 1991) following EVOS, research was conducted within the intertidal zone throughout the oil-affected region during the Coastal Habitat Injury Assessment project (CHIA). This extensive data set showed clear damage to intertidal invertebrates and algae through the final sampling period in 1991. The experimental study sites in Herring Bay allow us to follow the recovery of some these key intertidal species that showed damage during the CHIA study.

3. Objectives:

The objectives of this study are to identify the key relationships between damaged intertidal invertebrates and algae, to monitor the rates and degree of recovery of damaged intertidal resources, and to measure the natural rates and the feasibility of *Fucus* restoration in the upper intertidal.

These objectives will be accomplished by focusing each experiment to answer one or more of the following questions:

1) are some species limited by predation and/or competition?

2) what limits food availability for grazers (i.e. limpets, littorines) and predators (i.e. *Nucella*)?

3) is recovery limited by recruitment and, if so, what are the limiting factors?

4) how do physical factors, such as reduced protective cover or water circulation, limit species recovery?

We have keyed each experiment listed below to these question numbers.

4. Methods

Monitoring

a. Population dynamics (1).

Population dynamics of *Fucus*, sessile invertebrates, and grazers will continue to be quantified in established quadrats at five pairs of oiled and reference sheltered rocky and coarse textured sites. Organisms will be counted within six quadrats that have been permanently established within each of the first three meters of vertical drop (MVD) below mean high water. The quadrats will be visited twice during the summer. The number of *Fucus* plants in various size classes will be determined. Reproductive status and condition of the plants will also be recorded. Limpets, *Nucella spp.*, and *Littorina sitkana* will be counted, and subsamples of each will be measured.

b. *Fucus* egg settlement (3)

Fucus egg settlement on oiled and control sites will continue to be monitored because of its importance to *Fucus* recovery. Grooved plates designed to catch *Fucus* eggs will be placed at three tidal levels (0.5, 1.0, and 2.0 MVDs) along four transects at each of four pairs of sites. The number of eggs settled on plates after 24 hours will be recorded. The experiment will be repeated three consecutive days at each site.

Experimental

a. Fucus/limpets/other algae interactions (1,3,4)

The area of disturbance may affect the recolonization processes of *Fucus*, limpets and other algae. To monitor this we will continue to monitor cleared plots with various sized buffer zones that were established in 1993. Each replicate consists of four plots at the 2 MVD level, one for each buffer zone treatment plus an unmanipulated control. Circular buffer zones of 50, 100, and 200 cm radii were cleared around the monitored plots. The sampling area consists of a cleared 25 cm radius circle. Canopy, understory, and primary space percent cover will be estimated for each plot. In addition, the density of large (>1 cm) and small limpets will be monitored.

b. Barnacle species interactions (1,3)

Data collected during the Coastal Habitat Intertidal Assessment project showed significantly higher densities of *Chthamalus dalli* on oiled sites compared to control sites within the first three MVDs. In undisturbed systems, *Chthamalus* species tend to be restricted to the highest zones in the intertidal, as they are excluded by the superior space competitors, *Balanus glandula* and *Semibalanus balanoides*, in the lower intertidal. *Chthamalus dalli* appears to be the barnacle species that initially benefited from the free space created by the oil spill and clean-up activities. We will continue to monitor recruitment and post-settlement survival ratios of *C. dalli* compared to *S. balanoides* and *B. glandula*. The three sites used in this study are all on oiled vertical rock faces.

c. Effects of herbivores on *Fucus* recruitment, growth, and survival (1,3)

To test the effects of herbivores on *Fucus* recruitment, survival, and growth, heterogeneous plates were placed at three tidal levels (1, 2, and 3 MVDs) in 1994. At each level there were three treatments: full cage, roof control, and no

cage. This experiment was replicated at six sites. The number of germlings and size of the five largest germlings on each plate will be recorded this year.

d. Mussel recruitment/filamentous algae interactions (2,3,4)

Mussel larvae tend to settle temporarily on filamentous algae in the mid and low-intertidal zones. On three pairs of oiled and reference sites, filamentous algal percent cover will be determined within each MVD. Filamentous algae samples will also be collected at each MVD to determine the number of young mussels that have settled onto the algae. The data will be related to mussel size-frequency distribution data collected within the mussel zone.

e. Substrate use by *Fucus* (3,4)

Substrates used by large and small *Fucus* will be examined in relation to substrate availability. The proportion of plants from three different size classes (<2 cm, 2-10 cm, and >10 cm) using cracks, barnacles, rock surface, and other substrates will be compared to relative availability of the different substrates.

f. Effects of water movement on mussel and *Fucus* growth rates (4)

a. To test whether mussel growth rates on oiled sites within Herring Bay are different from those on control sites, tagged and measured mussels have been caged in the intertidal and periodic measurements will be made to determine growth rates. Any differences detected may be due to differences in relative water motion on oiled versus control sites. To test this idea, calcium sulphate dissolution rates will be determined on all sites where mussel growth rates are being measured.

b. Study of water flow effects on *Fucus* growth rates will continue. At a variety of sites, six *Fucus* plants were tagged and measured in 1994. At each of the sites average net water flow was estimated using calcium sulphate dissolution rates. The sites range from those that are exposed at the mouth of Herring Bay, to very protected sites at the base of the bay.

Restoration

a. High intertidal *Fucus* restoration (3,4)

Restoration of severely damaged intertidal algal populations has been started on a small scale basis at a heavily oiled rocky intertidal site in Herring Bay, Prince William Sound. A series of high intertidal plots were started in 1992 to test various techniques for increasing *Fucus* recruitment. These techniques included the attachment of erosion control fabrics to the rock substrate to produce a more favorable microclimate for small *Fucus* plants. Surveys made in May 1994 showed that there were dense populations of small *Fucus* plants on the coconut fiber fabric deployed in 1993, especially in the lower portions and where we had transplanted fertile plants. We will continue to monitor these plants to quantify their reproduction and their contribution to new recruitment on the substrate around the fabric strips. We will also test other methods for seeding the fabric with embryos to get higher densities of plants.

5. Location:

The proposed restoration, monitoring, and experimental studies will be conducted in the Herring Bay, Knight Island area. Intertidal studies were initiated in Herring Bay in May 1990

and are continuing through the 1995 field season. Herring Bay was heavily oiled in 1989, and was a central area for clean-up efforts. The bay was chosen for experimental studies because of its oiling history and close proximity to non-oiled sites used as controls.

6. Technical Support

Principal investigators from the University of Alaska School of Fisheries and Ocean Sciences, will cooperate to provide expertise on different aspects of the intertidal study: invertebrate and algal taxonomy and ecology. All mobilization/demobilization efforts associated with the charter vessel will be accomplished through the Seward Marine Center in Seward, Alaska. A project manager will oversee all logistical and personnel aspects of the project.

All sample and data analysis will take place at the School of Fisheries and Ocean Sciences, University of Alaska Fairbanks and the Juneau Center for Fisheries and Ocean Sciences, using available computers and established data management services.

7. Contracts

A contract will be issued for the use of a research vessel able to support the field work in Herring Bay. This vessel must be able to meet all University safety requirements and be of sufficient size and configuration to meet the needs of the science specified above. Bid specifications will be drawn up and request for proposals will be sent out to prospective bidders. A contract will also be issued to Coastal Resources Associates (CRA) of Vista, California. CRA has been involved with the Herring Bay study from its inception in 1990. In order to maintain consistency with the data collection, experiment modifications, analyses and report writing, it will be necessary to continue the existing contract established with CRA.

C. SCHEDULE

During the summer of 1995 there will be three trips to Herring Bay, of ten to twelve days in duration. The trips will occur during low tidal cycles from mid- to late May, in late June/early July, and in late August. A schedule of major landmarks is as follows:

Oct-Jan	Prepare study plans and SOP's for experiments
Oct-Jan	Initiate procurement procedures for charter vessel
Feb-May	Finalize SOP, sign charter contract
Mar-May	Purchase / prepare field equipment
May-Aug	Field sampling period
Sep-Nov	Data analysis / interpretation
Nov-Dec	Report preparation / writing
Jan	Submit draft report to ADF&G and peer reviewers
Mar-Apr	Submit final report 45 days after draft is returned

Major project personnel will dedicate their time to this research as follows:

1. Dr. Ray Highsmith (Coordinator, Principal Investigator)
   Responsible for overall coordination of project personnel, experimental design, interpretation of data, writing of reports and subsequent proposals, administering the budget, and overall logistics for the project.

2. Dr. Michael Stekoll (Co-Principal Investigator)
   Responsible for algal experimental design, interpretation and synthesis of data, and writing of reports.

3. Dr. Peter van Tamelen (Research Associate)
   Responsible for algal experimental design (including *Fucus* restoration study), supervising field studies, interpretation and synthesis of data, and writing of reports.

4. Dr. Lawrence Deysher

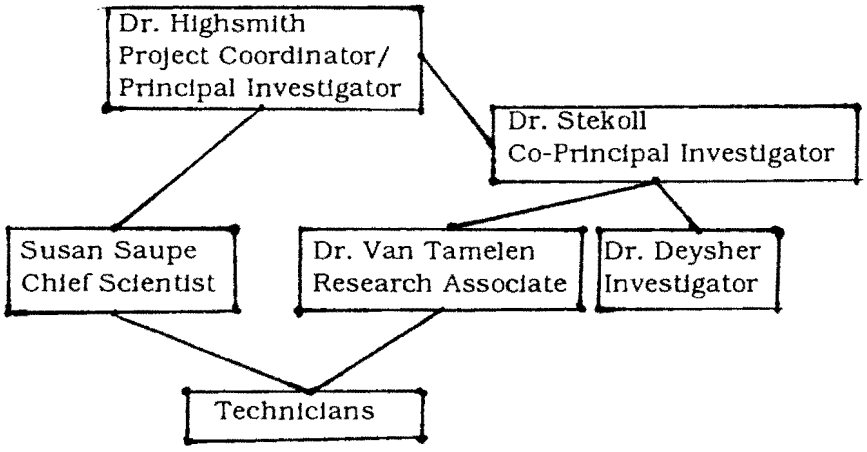
   Responsible for *Fucus* restoration study design and implementation, data analysis, and writing of reports.

5. Susan Saupe

   Responsibilities include acting as Chief Scientist for field research, design and implementation of invertebrate studies, interpretation of data, and writing of reports.

6. Technicians (TBA)
   Technicians will conduct field monitoring studies in addition to sample and data analysis in preparation for reports.

Organizational Chart:



D. EXISTING AGENCY PROGRAM

Not applicable.

E. ENVIRONMENTAL COMPLIANCE, PERMITTING AND COORDINATION STATUS

We anticipate that this project will again be categorically excluded from all NEPA regulations. State scientific collection permits will be obtained prior to the start of the field season from the Alaska Department of Fish and Game.

F. PERFORMANCE MONITORING

The Coordinating Principal Investigator, Dr. Ray Highsmith, will be responsible for the overall completion of the proposed project. He will oversee the design of the experiments, data analysis, and the preparation of the final report. The Project Manager, Dave Doudna, will be responsible for budget management, and administering contracts. and coordinating the research efforts with the other investigators. The Co-Principal Investigator, Dr. Michael Stekoll, along with Dr. Peter van Tamelen and Susan Saupe, will be responsible for coordinating research efforts, drafting standard operating procedures, establishing and monitoring experiments, analyzing data, and writing reports. Dr. Larry Deysher will coordinate efforts with Dr. Stekoll for the continuation of the *Fucus* restoration study.

Quality control for counting organisms will occur through multiple counts on site. Technicians are experienced in identifying algae and invertebrates in the field. Spot checks will occur throughout the season to check on their accuracy. Data base programs have been established to enter data from ongoing experiments since 1990. Statistical methods used to analyze the data have been reviewed by WEST, Inc., a statistical consulting firm sub-contracted during several past oil spill studies, including the Herring Bay project during 1990-1994. Data analysis procedures will retain as much continuity as possible with previous Herring Bay data making it possible to make direct comparisons over time.

After the last field trip in August, the effort will shift toward the completion of all data analysis, interpretation and integration of results into a draft report to be submitted by December. A final report will be submitted 45 days after receiving comments from the peer reviewers. The final report will include complete documentation of the methods used for sampling and those used for data analysis, documentation on the location of sites, and summary findings for each of the specific study components. Relevant background information, discussions on methodologies, techniques, equipment, analyses, and interpretations of the results will also be included.

G. COORDINATION OF INTEGRATED RESEARCH EFFORT

Principal investigators from the University of Alaska Fairbanks and University of Alaska, Southeast will be coordinating efforts to study interactions between key invertebrate and algal species. In addition, Dr. Stekoll will be cooperating with Dr. Deysher from Coastal Resources Associates for field sampling for the Restoration of High Intertidal *Fucus* study.
The studies at Herring Bay are closely integrated with the past Shallow Subtidal Studies (S. Jewett) and the Coastal Habitat Monitoring Studies (M. Stekoll and R. Highsmith). In addition this study will provide valuable information for use by studies of higher trophic level organisms such as those on shore birds, ducks and otters, that utilize the intertidal and shallow subtidal ecosystems.

H. PUBLIC PROCESS

Several presentations of results from previous field seasons in Herring Bay have been given during EVOS Oil Spill Symposiums in Anchorage to which the public was invited. Each proposal and report is available to the public for comment and we anticipate that this process for public participation will continue.

This proposal is based on information generated by the public workshop concerning "Research Priorities for Restoration" held in Anchorage during April 13-15, 1994.

I. PERSONNEL QUALIFICATIONS

1. Dr. Raymond Highsmith, Professor, Director West Coast National Undersea Research Center, UAF/SFOS, Fairbanks. - co principal investigator and coordinator.

   Dr. Highsmith has been the coordinator and a principal investigator of two *Exxon Valdez* Oil Spill projects; the Coastal Habitat Injury Assessment project and the Herring Bay Experimental and Monitoring studies. His specialties include ongoing research of recruitment and population biology in the intertidal zone and he is familiar with the effects of the oil spill on intertidal invertebrates throughout the EVOS impacted area.

2. Dr. Michael Stekoll, Professor, UAF/JCFOS and UAS, Juneau - co-principal investigator.

   Dr. Stekoll has been a principal investigator on three *Exxon Valdez* Oil Spill projects: the Coastal Habitat Injury Assessment project, the Herring Bay Experimental and Monitoring Studies, and the Shallow Subtidal Assessment project. He has co-authored annual and final reports for these projects and has produced refereed publications on various aspects of these projects. His specialties include, marine pollution biology, the biology and ecology of seaweeds in Alaska, especially *Macrocystis* and *Fucus*, and the mariculture of kelps and red seaweeds.

3. Dr. Lawrence Deysher, Sr. Scientist Coastal Resource Associates, Inc.- *Fucus* restoration and ecology

   Dr. Deysher is a marine ecologist who has been with CRA since it's inception. He directed field studies of intertidal algae as part of the EVOS damage assessment studies and participated in the original site selection of the CHIA monitoring sites. He has co-authored the annual reports on the intertidal algal monitoring studies and a paper on the use of the DNR GIS in selecting the intertidal monitoring sites for the CHIA studies. He is currently working on the experimental algal studies in Herring Bay as well as directing studies of kelp resources in California using a Geographic Information System.

4. Dr. Peter van Tamelen, Research Associate, UAF/JCFOS,Juneau - algal studies.

   Dr. van Tamelen has been working in Herring Bay on intertidal algal studies since 1990. He has extensive experience in marine intertidal ecology, including studies on plant-herbivore interactions, succession, algal recruitment, and effects of physical factors on biological communities.

5. Susan Saupe, Chief Scientist, UAF/SFOS, Fairbanks.

   Susan Saupe has worked as a Chief Scientist on research vessels for intertidal invertebrate damage assessment studies in 1990 and 1991 for the CHIA and in 1993 and 1994 for the Herring Bay studies. She has supervised the design of experiments during field studies and the data analysis and integration for the CHIA reports and manuscripts.

J. BUDGET

	1995 Experimental	1995 Report (FY96)
Personnel/Benefits	$ 186,757	$ 109,105
Travel	17,520	4,216
Contractual Services	108,400	17,800
Commodities	6,300	2,000
Equipment	0	0
Student Support	4,824	4,824
Capital Outlay	0	0
Overhead @ 20%	64,760	27,589
Total	**$ 388,561**	**$ 165,534**

Revised

Information Management System - (Revised - 10/17/94)

Project Number:	95089
Restoration Category:	Administration, Public Information and Science Management
Proposed By:	Molly McCammon, Director of Operations Exxon Valdez Oil Spill Trustee Council
Lead Trustee Agency:	All
Cost FY 95:	$522,800
Cost FY 96:	$400,000
Total Cost:	Unknown
Duration:	Ongoing
Geographic Area:	Oil spill area
Injured Resource/Service:	Multiple resources and services

INTRODUCTION

This project proposes to further develop an information management system that began with establishment of the Oil Spill Public Information Center (OSPIC) in September 1990 as a public repository for information and materials generated as a result of cleanup, damage assessment and restoration efforts following the Exxon Valdez oil spill. When fully developed, this system will make information that is relevant to the Exxon Valdez oil spill readily available for use by managers, scientists, and the public. This information will support restoration planning, management and policy making, scientific research and coordination, and public information.

NEED FOR THE PROJECT

An Information Management System supports the Mission of the Trustee Council in its efforts to restore the injured environment. Through the management, synthesis and dissemination of information and materials collected as a result of the Exxon Valdez oil spill, meaningful public participation in the restoration process, as mandated by the settlement agreement between the state and federal governments and Exxon, is facilitated.

The Oil Spill Public Information Center (OSPIC) currently serves as the central access point for information and materials generated through the Trustee Council process. Staff librarians respond to inquiries from local, state, national, and international users, including but not limited to students (from preschool to graduate school), educators, scientists, government agency personnel, state and federal legislators, environmentalists, the business community, the media, the legal profession, and other libraries and information providers.

In addition, the OSPIC staff provides priority information service to the Trustee Council, the Executive Director, the Director of Operations, the Public Information Specialist, and the staff of the Exxon Valdez Restoration Office (EVRO). Through the reference services provided to restoration project personnel, the OSPIC serves all restoration activities.

Although the OSPIC does an excellent job at distributing what information is available, it is still unclear what information has been collected, what additional information exists or would be useful, how to acquire it, who maintains it, and how to access it. This project provides an opportunity to develop a plan and the necessary tools to efficiently synthesize and disseminate this pool of information, thereby providing a lasting legacy of oil spill related work.

PROJECT DESIGN

A. Objectives

The objectives of the Information Management System are:

1. To develop a long-term strategy and guidelines to compile, manage, synthesize, and disseminate currently available information about the Exxon Valdez oil spill and the Trustee Council (including damage assessment and restoration final reports) in a manner which can easily and effectively be utilized and understood. This would include the development of an information management mission statement.

2. To develop the products and tools necessary for initial use and distribution as part of an overall strategy to provide up-to-date information on the status of restoration and recovery as well as historical knowledge of the Exxon Valdez oil spill. The first product would be an EVOS Information Summary, an interactive multimedia computer program that would allow the user to explore Exxon Valdez oil spill information.

3. To provide access to local, state, national, and international users of this information through the Oil Spill Public Information Center.

4. To coordinate the Exxon Valdez Oil Spill Trustee Council's efforts with other large data management efforts.

B. Methods

1. Integration: The Director of Operations will oversee the integration of Trustee Council-funded research in order to ensure cost-effectiveness and to maximize the ability to synthesize information and data collected from these efforts.

2. Planning: A contract will be issued to develop a long-term information management strategy. Development of such a strategy will be achieved in consultation with Trustee agencies, representatives of the public, and other users of Trustee information,

3. Coordination: The Director of Operations will oversee the coordination of Trustee Council information and data management efforts with those of other similar efforts.

4. Product development: A plan and schedule for product objectivies, identification of user needs, and testing of product design will be established, with input from an advisory group. This will include the initial phases of development of an EVOS Information Summary, an interactive computer program that will provide a current status report on restoration and recovery to date.

5. Access: The Oil Spill Public Information Center will continue in the near future as the primary repository of information on the Exxon Valdez oil spill, related events and issues, and the actions of the EVOS Trustee Council in working towards restoration of the spill affected area.

C. Schedule

OSPIC
Quarterly and annual reports documenting library usage, acquisitions, expenditures, and user information needs will be submitted by the designated deadline.

Planning Process

Nov 94	Develop RFP for planning contract
Jan 95	Award contract
Feb 95	Establish an interagency/multidisciplinary advisory group which includes members of the public and the Public Advisory Group
Mar - May 95	Long-term information management strategy and mission statement developed
June-Oct 95	Design and preliminary development of initial information products

D. Technical Support

The analyst programmer located in the Restoration Office provides maintenance of the LAN computer network and assistance in establishing a full-text online service for the public. In addition, computer programming support and peer review will be needed in the initial product development stage and as a final review process to ensure that program development is technically correct and accurate oil spill information is presented.

E. Location

The project will be coordinated by the Director of Operations in the Anchorage EVOS Restoration Office, located at 645 G Street, Anchorage, Alaska, 99501, which is also the site of the Oil Spill Public Information Center. Users in the spill area and state, national and international users are served by mail, telephone, fax, and electronic mail.

PROJECT IMPLEMENTATION

The Oil Spill Public Information Center in Anchorage serves as the primary repository of information on the Exxon Valdez Oil Spill and the Trustee Council. The OSPIC has been an integral part of the restoration process since it was established in 1990. A major restructuring by Executive Director Jim Ayers in early 1994 has maximized library efficiency and reduced operating costs. The OSPIC Director reports directly to the Exxon Valdez Oil Spill Trustee Council's Director of Operations.

The OSPIC staff currently respond to information requests that over the past four years have totalled more than 8,500 on-site and off-site requests, In addition, OSPIC has processed 1,300 interlibrary loans of materials, performed 1,200 on-line database searches, and distributed over 16,000 documents. The OSPIC collection is cataloged in the online database of the Western Library Network (WLN), using a Novell-based local area computer network linked by modem to WLN, DIALOG, and other databases. WLN's LaserCat, a CD-ROM product, functions as the OSPIC public access catalog. In addition, the OSPIC staff uses the Internet.

The OSPIC is a repository for documents produced for and by the Trustee Council, including the Natural Resource Damage Assessment Final Reports and the Restoration Project Final Reports, meeting transcripts, agendas, budgets, work plans, correspondence, and public comments. The Trustee Council Administrative Record is maintained as a certified Administrative Record to track the decision making process of the Trustees and to address issues of accountability. The OSPIC staff distributes Trustee Council publications, such as annual reports, work plans, and information packets.

The Director of Operations will work with the Chief Scientist in developing a Request for Proposals for establishing an information management mission and long-term strategy. This plan will determine the need for additional information tools, as well as the timeline for their development, and will be developed in consultation with the public, residents of the spill area communities, the education community, the scientific research community, and others. The RFP will also include the development of the initial phases of an EVOS Information Summary, an interactive computer program.

COORDINATION OF INTEGRATED RESEARCH EFFORT

A further development of the Trustee Council's current Information Management System will go a long ways toward furthering the coordinated integration of the Trustees' research efforts This project provides a unique opportunity for all Principal Investigators to effectively disseminate the information gathered through their work to the general public, restoration staff, and the scientific community. The products generated as a result of this project have the potential to tie all EVOS-related research and historical information together into a meaningful picture for the lay person, scientist, and manager alike. This project must be closely coordinated with the Trustee Council's other major information management project - 95320J.

FY 95 BUDGET ($K) - 95089A		95089B
Personnel	159.0	
Travel	1.3	1.0
Contractual	97.8	200.0
Commodities	15.5	1.0
Equipment	20.5	2.0
Subtotal	274.1	204.0
Gen. Admin.	30.7	14.0
Total	304.8	218.0

95090

DETAILED RESTORATION PROJECT DESCRIPTION

Project Title: Mussel Bed Restoration and Monitoring in Prince William Sound and Gulf of Alaska

Project ID#: 95090

Lead Agencies: NOAA/National Marine Fisheries Service
National Biological Survey

Cooperating Agency: Alaska Department of Environmental Conservation

Project Start-up/Completion Dates: Full year

Expected Project Duration: Indefinite; as needed, until mussel beds restored

Cost of Project: FY95: $438.8K FY96: $216.4K

Geographic Area of Project: Oil spill impacted areas of Prince William Sound, and Kenai and Alaska Peninsulas

P.I. JEEP RICE

Project Leaders:

Malin M. Babcock, National Marine Fisheries Service
11305 Glacier Highway, Juneau AK 99801
907-789-6018 fax:907-789-6094

Gail V. Irvine, National Biological Survey
1011 E. Tudor Rd, Anchorage AK 99503
907-786-3653 fax:907-786-3656

Project Manager: Bruce Wright

Bruce Wright, National Marine Fisheries Service
11305 Glacier Highway, Juneau AK 99801
907-789-6601 fax:907-789-6608

A. Introduction

The persistence of *Exxon Valdez* crude oil underlying some dense mussel (*Mytilus trossulus*) beds in Prince William Sound (PWS) and the Kenai and Alaska Peninsulas began to cause concern in the spring of 1991 and was confirmed in annual surveys by NOAA's Auke Bay Laboratory (ABL) and the National Park Service (NPS). This project was therefore formally funded in 1992.

In 1992, the Auke Bay Laboratory and National Park Service documented 50 mussel beds in PWS and nine on the Kenai and Alaska Peninsulas with underlying sediment concentrations greater than 1700 μg/g total petroleum hydrocarbons (TPH); 27 of the beds in PWS had concentrations in excess of 10,000 μg/g TPH. The highest oil concentrations found in animals or sediments in 1991 and 1992 by any researchers in the *Exxon Valdez* spill area were in mussel beds and underlying sediments from oiled mussel beds in PWS. Many of the same mussel beds were re-sampled in 1993 in PWS, with only some indication of reduction in petroleum hydrocarbon (HC) levels between 1992 and 1993.

This led the Trustee Council to fund NOAA and ADEC to restore selected mussel beds in 1994. Twelve beds on 5 sites were manually restored by removing up to 12 cm oiled sediments from beneath the mussels. This was replaced with tested clean sediments and the mussels replaced. Preliminary evaluation of sediment samples taken post restoration indicate success in providing a buffer of clean sediment underneath the mussel layer. The NOAA portion of this proposal is for evaluation of this restoration process, and for monitoring of oiled mussel beds that were not restored. Some of these beds are recovering slowly and do function as a type of "control" for the restored beds.

Field surveys along the Kenai and Alaska Peninsulas and Kodiak Archipelago were conducted in 1992 and 1993 to establish the geographic extent and intensity of oiling of contaminated mussel beds by the Department of Interior's National Park Service (NPS). There was no sampling in 1994. The National Biological Survey (successor to this work under NPS) portion of this proposal is for monitoring oiled mussel beds in the Gulf of Alaska.

In addition, ABL proposes to handle the associated logistics of sampling mussels for pristane analyses. Levels of pristane will be used to index copepod production which will be used to help forecast salmon returns in future years. This is an objective of the Prince William Sound Ecosystem Study, but the collection logistics have been integrated into this study.

B. Project Description

1. Resources and/or Services

The resource is the mussel beds themselves, as habitat and a food source -- which may be a pathway of oil contamination to higher consumers.

2. Relation to Other Damage Assessment/Restoration Work

Information produced on petroleum hydrocarbon levels will be shared and used by other studies, e.g. harlequin ducks (1994 #94065), oystercatchers (1994 #94020), and shoreline assessment (#95266).

3. Objectives

a. To evaluate chemical recovery of PWS oiled mussel beds that were restored in 1994 by measuring oil contamination in mussels and underlying sediments. Physical and biological stability of the restored beds will be determined by measuring the size of the beds and calculating density of mussels (NOAA, ADEC).

b. To monitor natural recovery in levels of petroleum hydrocarbons in mussels and underlying sediments in oiled mussel beds in PWS not restored (NOAA, ADEC).

c. To monitor recovery in levels of petroleum hydrocarbons in mussels and underlying sediments in oiled mussel beds along the Kenai and Alaska Peninsulas (NBS).

d. To evaluate future sites for treatment based on existing data and efficacy of treatment techniques (NOAA, NBS, ADEC).

d. To provide logistic and staff support for comprehensive sampling of mussels for indexing pristane levels in PWS. This project is closely coordinated among several resource groups (NOAA).

4. Methods

Sampling of mussels, underlying sediments, and replacement sediments will follow the methods used in previous years and consists primarily of taking triplicate pooled samples of mussels and underlying sediments for petroleum hydrocarbon analyses. Beds cleaned in 1994 as well as control (natural recovery) beds will be sampled in PWS. Similar experimental design is used for documented oiled mussels beds along the Kenai and Alaska Peninsulas.

To assess physical and biological stability of restored beds, other measurements will be taken to compare with prerestored conditions and data taken within 1 month after restoration in 1994, i.e. bed size and density of mussels. Photos will also be taken for comparison purposes.

Sediment samples will be analyzed by ultraviolet fluorescence. Selected sediments and mussels then will be analyzed by gas chromatography/mass spectroscopy (GC/MS) for quantitative measurements of HC analytes. All mussels collected for pristane concentrations will be analyzed by GC/MS.

Freezing, chain-of-custody procedures and record keeping will follow Natural Resource Damage Assessment protocol. Data will be analyzed using standard statistical methods, mapped using ABL's computerized data mapping system, and entered into the *Exxon Valdez* Restoration Hydrocarbon Database.

5. Location

Prince William Sound, Kenai and Alaska Peninsulas.

6. Technical Support

With the exception of transportation contracts, NOAA's Auke Bay Laboratory, the National Biological Survey and AK Department of Environmental Conservation will provide all technical support.

7. Contracts

Contracts will be needed for field support (vessel, helicopter and fixed-wing aircraft). All services will be acquired by the Alaska Department of Environmental Conservation through standard State of Alaska procurement protocols.

C. Schedule

Jan-Apr 1995	Logistics planning; evaluation of 1994 data for sites to actually sample; initiation and implementation of contracting for vessel and aircraft charter; and other preliminary planning for 1995 field season.
Mar 1995	First pristane sampling trip in PWS
Apr or May 1995	PWS field trip during low tide series for sampling at 1994-restored mussel beds, several natural recovery sites, regular survey sites, and established sites for pristane analyses.
Jun 1995	Kenai Peninsula field trip during low tide series for sampling at documented oiled mussel beds.
	Pristane sampling trip in PWS
Aug 1995	PWS field trip during low tide series for sampling at restored mussel beds, several natural recovery sites, and the remainder of regular survey sites.
Jun-Aug 1995	Ongoing chemical and data analyses.

Aug 1995-Oct '96	Ongoing chemical and data analyses.
Apr 1996	Annual Report

D. Existing Agency Program

The Program Manager for Habitat Investigations, NOAA's Auke Bay Laboratory, will spend approximately one month's salary coordinating and managing this project, with cost estimated at $10K, and ABL's Senior Chemist will spend approximately ½ month's salary on this project, with cost estimated at $3.5K. Non-recoverable costs associated with this project for operating the ABL chemical analytical facility are estimated at $10K.

This project falls under the statutory authority of NMFS for stewardship of living marine resources.

E. Environmental Compliance, Permitting and Coordination Status

Field sampling of oiled mussel beds is a non-intrusive research project in which routine data collection, limited in context and intensity, will be done; consequently, this work is categorically exempt from requirement to provide an Environmental Impact Statement or Environmental Assessment.

F. Performance Monitoring

1. Personnel and Responsibilities:

NOAA:	
Stanley Rice	ABL Habitat Investigations Program Manager
├ Malin Babcock	PI/Project Leader
│ ├ Patricia Harris	Logistics planning; data collection and analyses
│ ├ Chris Brodersen	Data analyses and collection; program support
│ └ 1 TBA	PWS field crew
└ Jeffrey Short	Chem lab management/Quality assurance & control
└ Marie Larsen	Chemical analysis
└ chemists	Chemical analyses
ADEC:	
└ Ronald Bruyere	PI/Project Leader
└ TBA	Logistics planning, Field duty
NBS:	
└ Gail Irvine	PI/Project Leader: GOA survey, data analysis
└ Joel Cusick (NPS)	GOA survey, data analysis

(Note: Responsibility for the GOA portion of this study has been transferred from the National Park Service to National Biological Survey this year. with the transfer of the PI between these agencies.)

2. **Anticipated reports, presentations and manuscripts**

a. Briefing of Trustee Council on 1994 mussel bed cleaning Jan 1995

b. Manuscript Draft: Contamination recovery of mussels from oiled mussel beds where contaminated mussels and underlying substrates were removed in strips to increase natural flushing of the beds Feb 1995

c. Interim Report, 1994 work Apr 1995

d. Manuscript: Restoration of PWS Mussel Beds (1994) Mar 1995

e. Report: Biological impacts of oiled substrates on mussels three and four years after the *Exxon Valdez* oil spill Jun 1995

f. Tech Memo: Oil contamination in mussels from oiled mussel beds in PWS and the Kenai Peninsula, a geographic look with relative intensities Jun 1995

i. Final Report: 6 months after chemical analyses are completed.

Quality assurance checks are an integral part of ABL's hydrocarbon processing and analyses. ABL participates in a world-wide interlaboratory calibration exercise on an biannual basis and has routinely performed in the top analytical laboratories.

Biological data generation and collection are routinely conducted without reference to the origin of the mussels; i.e., data gathered blindly.

G. Coordination of Integrated Research Effort

Logistics and staff time will be shared and closely coordinated with field expertise needs and other activities under other projects particularly the proposed work on population structure of blue mussels in PWS, if approved for 1995. Data from this project will continue to be shared with subtidal sediment studies and injured species studies (i.e. harlequin duck, etc.). Logistic costs may be reduced for the Kenai and Alaska Peninsula portion by combining resources with the proposed Shoreline Assessment project.

All chemical data from environmental samples will become part of the *Exxon Valdez* oil spill database managed by ABL for the Trustees; as such, data can be shared with interested parties.

H. Public Process

The Public Process for this project has been integrated with the Trustee Council process for the 1995 Work Plan. Interim status reports will be completed according to a schedule set by the Trustee Council.

I. Personnel Qualifications

MALIN M. BABCOCK

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

Experience: 1969-present. Researcher and Task Leader, Auke Bay Laboratory, National Marine Fisheries Service, Juneau, Alaska. Field, lab, and analytical expertise, and data analyses and interpretation particularly with effects of petroleum hydrocarbons on aquatic fish and shellfish. Studies have included Prince William Sound chemical baseline, short term and long term water-soluble fraction of crude oil and sediment toxicity tests assessing physiological and biochemical impacts - including growth and reproduction. I became Task Leader for the Coastal Habitat task within Habitat Investigations, ABL, in 1988 and directly supervise several staff scientists in varied research projects. I have strong participation in overall Habitat Investigations research planning, budget management and staffing.

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

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

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

Relevant Publications: Over 25 publication/reports - most of which involve effects of exposure to petroleum hydrocarbons on various Alaskan species of fish and shellfish. Over 20 public presentations of scientific studies.

GAIL V. IRVINE

Education: University of California at Santa Barbara, 1969.
B.A.(honors), Zoology
University of Washington, Seattle, 1973. M.S., Zoology
University of California at Santa Barbara, 1983. Ph.D. Biological Sciences
(Aquatic and Population Biology)

Experience: 1994 - Current. Position transferred to the new National Biological Survey, Department of Interior.

1990 - 1994. Coastal Resources Specialist, National Park Service. Research in marine community ecology; developing and directing a coastal monitoring and research program for the National Park Service. Thus far, the research has been concentrated in two national parks oiled by the *Exxon Valdez* spill, Kenai Fjords and Katmai National Parks. Supervised the oiled mussel bed, Gulf of Alaska project for the Trustee Council.

1984 - 1990. Marine Biologist, Minerals Management Service. Environmental analysis, including potential effects of oil and gas development on marine plants, invertebrates, and fishes (pelagic, nearshore and benthic communities). Research on coelenterate ecology in the Chukchi Sea.

My education and experience have been concentrated in the fields of community and population biology, with most research in marine systems. I have spent extensive amounts of time doing research at marine labs in Puget Sound (the Friday Harbor Marine Labs) and Panama (through the Smithsonian Tropical Research Institute). Since coming to Alaska, I have gained additional experience in the Gulf of Alaska (Kenai Fjords and Katmai National Parks), Cook Inlet (Lake Clark National Park), and the Beaufort and Chukchi Seas.

K. Budget

	NMFS	NBS	DEC
Personnel	$197.3K	$ 28.6K	$ 39.1K
Travel	16.3K	4.1K	8.1K
Contracts	39.6K	26.4K	3.5K
Commodities	22.5K	4.0K	0.7K
Equipment	0.0K	4.0K	0.0K
Capital Outlay	0.0K	0.0K	0.0K
Sub-total	275.7K	67.1K	51.4K
General Administration	32.4K	6.1K	6.1K
TOTAL	$308.1K	$ 73.2K	$ 57.5K

95093

PWSAC RESTORATION

OF

PUBLIC SALMON

RESOURCES & SERVICES

PLANNING FUNDS ONLY---

NO DPD REQUIRED

Administration, Public Information and Science Management

Project Number:	95100
Restoration Category:	Administration, Public Information and Science Management
Proposed By:	James R. Ayers, Executive Director *Exxon Valdez* Oil Spill Trustee Council
Cost FY 95:	$3,596,900
Cost FY 96:	$3,500,000
Total Cost:	Unknown
Duration:	Ongoing (this project funds the annual operating costs of the Trustee Council's restoration program)
Geographic Area:	Oil spill area
Injured Resource/Service:	Multiple resources and services

INTRODUCTION

The Administration, Public Information and Science Management project provides for overall management, administration and implementation of the Trustee Council's restoration program. This project makes extensive use of existing Trustee Council agency structures to keep administrative costs to a minimum.

The proposed FY 95 budget of $3,596,900 for Administration, Public Information and Science Management represents a substantial reduction in costs relative to the FY 94 budget of $4,200,000. The FY 95 project represents the final step in reorganization of the administration of the Trustee Council executive staff and operations. Specific components of the Administration, Public Information & Science Management project include:

Office of the Executive Director — The budget for the Executive Director includes salaries, benefits, travel, office space, supplies, printing costs, contractual services, utilities, and other such items as may be necessary for efficient operation of the Juneau office of the Executive Director and the Director of Administration. In addition to budget and audit responsibilities, the Director of Administration is assuming the duties once performed by the six-member Finance Committee: developing fiscal procedures, adherence to the procedures, and ensuring overall fiscal standards and reporting for accountability, and efficiency.

Chief Scientist: Science Review Board and Peer Review — The Trustee Council and the Trustee Council-supported principal investigators need access to the best possible scientific knowledge and understanding concerning injured resources and services. This information has been provided continuously by the Chief Scientist and expert peer reviewers since the injury assessment process started in 1989. It is essential that this expertise be retained on an upon-request basis to provide the unbiased scientific review and continuity essential to perform the best possible scientific work. This component will also include the Science Review Board, when adopted by the Trustee Council.

Operations — The budget for Operations includes salaries, benefits and travel for staff that perform the key planning, coordination, communications and project management functions of the Trustee Council. This budget also includes funds for public meetings, teleconferences, Trustee Council meetings, newsletters, brochures and other publications, as well as the operating costs for offices in the Simpson Building in Anchorage.

Public Advisory Group and Community Involvement — The Public Advisory Group (PAG) consists of 17 members, plus two ad-hoc members from the State Legislature, representing 12 principal interest groups and five members from the public-at-large. The role of the PAG is to provide advice to the Trustee Council on such items as the annual work plans, budgets, and the Restoration Plan. The budget reflects the administrative support expenses for the PAG, including staff support, which is now being provided through the state in order to provide more user-friendly travel reimbursement. In addition, this component provides for a series of public meetings throughout the spill area during the year.

Restoration Work Force — The FY 95 budget for the Restoration Work Force reflects support for the six Trustees with a budget of $150,000 per Trustee Council agency. This funding will be used to support staff who function as agency liaisons. These liaisons serve as overseers of work plan development and generally represent the Trustee Council members in matters related to implementation of the restoration program. (Agencies also receive funding for project management in association with individual projects.) Costs involved are salaries, benefits, travel, per diem, equipment and commodities.

NEED FOR THE PROJECT

The project will provide the essential management and administration necessary to efficiently implement the restoration program developed by the Trustee Council.

PROJECT DESIGN

A. Objectives

The fundamental objective of the Administration, Public Information and Science Management project is implementation and management of the Trustee Council's direction to pursue a comprehensive, balanced approach to restoration built upon three basic elements:

- Research and Monitoring
- General Restoration
- Habitat Protection

Specific objectives for FY 95 include:

1. Implementation of a Final Restoration Plan, pending completion of the NEPA Environmental Impact Statement process;

2. Implementation of the approved FY 95 Work Plan;

3. Continued oversight and management of the Trustee Council science program that includes the peer review and project evaluation process under the direction of the Chief Scientist as well as development of a Science Review Board;

4. Sponsorship of an Annual Forum that brings together scientists, agency staff, Trustee Council staff and members of the general public to review the status of injured resources and services and help devise and refine appropriate restoration strategies through an adaptive management process;

5. Further refinement of draft monitoring strategies for injured resources;

6. Further habitat evaluation, appraisals and negotiation with potentially willing sellers as part of both the Large Parcel and Small Parcel Habitat Protection Programs;

7. Continued work on the proposed physical improvements to the Institute of Marine Science facilities in Seward;

8. Regular meetings and interaction with the Public Advisory Group (PAG) as one means of gathering public input into the Trustee Council process;

9. Production of an Annual Report;

10. Publication of a newsletter six times/year regarding activities of the Trustee Council;

11. Development of the FY 96 Work Plan, including opportunity for substantial public involvement and review of the work plan;

12. Oversight and management of the Trustee Council's FY 92-95 Work Plan projects and expenditures, including the production of quarterly reports that track the status of Trustee Council authorized projects;

13. Completion of a financial audit; and

14. Development of an inventory tracking system.

B. Methods

All Trustee Council operations are governed by the state and federal laws and regulations that apply to the respective agencies that comprise the Trustee Council.

C. Schedule

The Trustee Council operates on the federal fiscal year (Sept 30 - Oct 1).

D. Technical Support

Trustee Council operations require limited technical support with computer support services provided by in-house staff.

E. Location

The Trustee Council maintains the Executive Director's Office in Juneau (709 west 9th Street, Juneau, Alaska, 99801) and a Restoration Office in Anchorage (645 G Street, Anchorage, 99501).

PROJECT IMPLEMENTATION

The Trustee Council, established under the terms of a court approved civil settlement, is comprised of the Commissioner of the Department of Environmental Conservation, the Commissioner of the Department of Fish and Game; the Attorney General of the State of Alaska; the Secretary of the Department of the Interior; the Secretary of the Department of Agriculture; and the Director of the National Oceanic and Atmospheric Administration. In order to manage the Settlement as directed by the Trustee Council, an Executive Director has been hired who oversees a small core staff while making use of existing Trustee Council's agency structures to keep administrative costs to a minimum.

COORDINATION OF INTEGRATED RESEARCH EFFORT

As part of an adaptive management process, the Trustee Council will sponsor an Annual Forum that will bring together scientists, agency staff, Trustee Council staff and members of the general public to review the status of injured resources and services and help devise and refine appropriate restoration strategies. This is one mechanism by which research sponsored by the Trustee Council will be coordinated and integrated. Additionally, during FY 95, a Science Review Board will be established and used as a mechanism to provide overall coordination and integration of the Trustee Council science program.

FY 95 BUDGET ($K)

Personnel	1811.0
Travel	268.5
Contractual	1108.5
Commodities	70.4
Equipment	30.5
Subtotal	3288.9
Gen. Admin.	308.0
Total	3596.9

Closeout: Murrelet Prey and Foraging Habitat in Prince William Sound

Project Number:	95102-CLO
Restoration Category:	Research (closeout)
Proposed By:	DOI
Cost FY 95:	$63,800
Cost FY 96:	$0
Total Cost:	$63,800
Duration:	1 year
Geographic Area:	Not applicable
Injured Resource/Service:	Marbled murrelet

INTRODUCTION

This project is the closeout of 94102 - Murrelet Prey and Foraging Habitat in Prince William Sound. The purpose of the project was to identify prey species, locate foraging areas, determine foraging patterns from known nesting areas, and characterize important feeding habitat for marbled murrelets.

NEED FOR THE PROJECT

To complete data analysis and write report for FY 94 field work.

PROJECT DESIGN

A. Objectives

The purpose is to analyze 1994 project data and prepare a final report. The report will be prepared for the peer-review process and presentation to the Trustee Council.

B. Methods

Not applicable.

C. Schedule

October - December:	Data analysis
December - January:	Report writing
February 15:	Draft report
March 31:	Final report

D. Technical Support

Not applicable.

E. Location

Report preparation will occur at the Fish and Wildlife Service Regional Office in Anchorage, Alaska.

PROJECT IMPLEMENTATION

The USFWS is the most appropriate entity to analyze the data and write the report.

COORDINATION OF INTEGRATED RESEARCH EFFORT

Not applicable.

FY 95 BUDGET ($K)

Personnel	55.5
Travel	0.0
Contractual	0.0
Commodities	0.0
Equipment	0.0
Subtotal	55.5
Gen. Admin.	8.3
Total	63.8

SFOS 95-101 95106

95362

PROPOSAL

TO: *Exxon Valdez* Oil Spill Trustee Council
Restoration Office
645 G Street, Suite 402
Anchorage, AK 99501

FROM: Institute of Marine Science
University of Alaska Fairbanks
P.O. Box 757220
Fairbanks, AK 99775-7220

TITLE: Subtidal Monitoring: Eelgrass Communities

PRINCIPAL INVESTIGATOR: Stephen C. Jewett
Research Associate
SS# 004-48-2438

NEW/CONTINUING: New

DURATION: 1 Year

PROPOSED START DATE: March 1995

AMOUNT REQUESTED: $399,906

Stephen C. Jewett 12/12/94
Stephen C. Jewett /Date
Principal Investigator
(907) 474-7841

Joan Osterkamp 12-12-94
Joan Osterkamp /Date
Executive Officer
School of Fisheries and Ocean Sciences
(907) 474-7824

Vera Alexander 13 Dec 94
Vera Alexander /Date
Dean
School of Fisheries and Ocean Sciences
(907) 474-6822

Donald M. Schell/R 12/13/94
Donald M. Schell /Date
Director
Institute of Marine Science
(907) 474-7531

Ted DeLaca/pb 12/14/94
Ted DeLaca /Date
Director
Office of Arctic Research
(907) 474-7314

December 1994

Exxon Valdez OIL SPILL
DETAILED PROJECT DESCRIPTION
FOR A
FY 95 RESTORATION PROJECT

Project Title: Subtidal Monitoring: Eelgrass Communities

Project Number: 95106

Lead Trustee Agency: Alaska Department of Fish & Game

Cooperating Agency: None

Project Start-up/ Completion Dates: FY 95: March-September 1995

Project Duration: FY 95 and 96

Cost of Project: FY 95: $180,770
FY 96: $219,136

Geographic Area: Field work: Western Prince William Sound
Data analyses: UAF/Vista, CA

Name/Signature of Project Leader:

Stephen C. Jewett
School of Fisheries & Ocean Sciences
University of Alaska Fairbanks
Fairbanks, AK 99775-1080
(907) 474-7841 (office); (907) 474-7204 (FAX)

Name/Signature of lead agency Project Manager:

Joseph Sullivan, Ph.D.
Habitat & Restoration Division
Alaska Department of Fish & Game
333 Raspberry Road
Anchorage, AK 99518-1599
(907) 267-2213 (office); (907) 522-3148 (FAX)

A. INTRODUCTION

The shallow subtidal habitats of Prince William Sound, from the intertidal zone to depths of approximately 20 m, typically has dense macrophyte or seagrass assemblages, and is critical habitat for many commercially and ecologically important animals. Subtidal eelgrass beds contain numerous polychaete worms, small snails and clams, amphipods, isopods, sea urchins, and sea stars, many of which serve as food for coastal-feeding fishes, birds, and otters.

The subtidal eelgrass community was one of the several habitats examined relative to *Exxon Valdez* Oil Spill (EVOS) effects and subsequent recovery. Investigations comparing oiled-control sites in this habitat were conducted in 1990, 1991 and 1993 and are summarized below (no sampling occurred in 1992 and 1994) (Jewett et al., 1994).

Almost all components of the eelgrass habitat were affected by the EVOS by the summer of 1990. The health of the benthic community outside the eelgrass bed, at 6-20 m depths, was generally less robust at oiled sites than at control sites. The oiled sites had significantly less total invertebrate abundance; several dominant invertebrate taxa had less abundance and/or biomass. These included families of clams that are important food for sea otters. Another group less prevalent at oiled sites were the oil-sensitive benthic amphipods. Measured parameters less prevalent at the oiled sites in the eelgrass bed (≤ 3 m) included eelgrass turions and flowers, benthic amphipods, and helmet crabs (*Telmessus cheiragonus*). However, the benthic community in the bed had greater total invertebrate abundance and biomass at the oiled sites, primarily attributable to opportunistic infauna and small epifauna attached to the eelgrass blades.

The 1991 data revealed partial recovery. Outside the eelgrass bed (6-20 m) oiled sites were more similar to control sites than in 1990. The greatest indication of recovery was with benthic amphipods which revealed no differences between oiled and control treatment groups. Within the bed (≤ 3 m), no differences were now evident in density of eelgrass turions or flowers, benthic amphipods, and helmet crabs. However, several of the dominant taxa had lower abundance or biomass at oiled bed sites, indicative that recovery was lagging within the eelgrass bed.

By 1993, four years after EVOS, a reversal was revealed from the 1991 appearance of recovery. While toxic effects were doubtful, some segments of the community were significantly diminished at oiled sites (e.g., amphipods); other segments reflect enhancement at oiled sites (e.g., infaunal polychaetes and epifauna on eelgrass). Sediment oil concentrations dropped from an average of 544 ng PAH g^{-1} in 1990 to 145 ng g^{-1} in 1991 to 50 ng g^{-1} in 1993. Although sediment oil contentrations declined greatly over the three-year period, the oiled sites still had higher concentrations than control sites in 1993. The 1993 data tended to resemble 1990, especially in the bed (≤ 3 m) where densities of eelgrass flowers (Dean et al., submitted MS), bivalves and oil-sensitive benthic amphipods were greater at control sites. Enhancement (stimulation) at oiled sites

was evident in several opportunistic or stress tolerant polychaetes (all depths), as well as small epifauna attached to the eelgrass blades (≤ 3 m). Oil-degrading microbes (Braddock and Richter, 1994) presumably stimulated the faunal increases at oil sites as has been observed elsewhere (e.g., Spies and DesMarais, 1983; Spies, 1987). Preliminary examination of selected nearshore fishes (crescent gunnel and pricklebacks) suggested stress-induced abnormalities (i.e., hemosiderosis: Khan and Nag, 1993) at oiled sites.

We know from other studies (e.g., McConnaughey, 1978; Calkins, 1978; Degrange and Sanger, 1987; Shaw and Hameedi, 1988; Bowyer et al., 1994) and from our work that several of the species impacted are important links to higher trophic levels. For example, benthic amphipods are important prey to a variety of fishes and sea birds. The crab *Telmessus* feeds on eelgrass, *Musculus* mussels, and other epiphytes on eelgrass. In turn, *Telmessus* serves as prey for a variety of vertebrates, including sea otters, river otters, and birds (e.g.,). In addition, *Musculus* is a primary component of the diet of juvenile cod that are abundant in the eelgrass habitat. As noted earlier, some of the infaunal bivalves are important food for sea otters. Also, the fishes examined for hemosiderosis are important food for river otters and selected sea birds (Bowyer et al., 1994; Dan Roby, UAF, Pers. Commun).

B. PROJECT DESCRIPTION

1. Resources and/or Associated Services

In our FY 93 Detailed Project Description we reduced our focus from three habitats to one, subtidal eelgrass. We reasoned that the impacts to populations in habitats other than eelgrass appeared short lived. For example, algal populations were apparently reduced by the spill, but began to recover almost immediately following the spill, and were almost fully recovered by 1990. Also, many of the impacts to fauna observed in the other habitats were similar to, but often less severe, than observed in the eelgrass habitat. Because of the similarity of many of the observed effects, a signal of natural restoration in the eelgrass should also signal natural restoration in other habitats. However, the surprising results from the 1993 sampling revealed that recovery was not occurring as fast as anticipated. Furthermore, this implied possible slowed recovery at other oil-impacted subtidal habitats, even though they are more dynamic than eelgrass.

No man-made restoration has occurred, nor has any been recommended, for the subtidal eelgrass habitat to date. It has been generally viewed that any restoration activities in this subtidal habitat would be unrealistic. Complete restoration or recovery implies not only a return to prior abundance levels, but moreover, a return to ecological pathways within the community which may have taken years to develop. These ecological pathways involve a range and magnitude of biological,

chemical, and physical mechanisms with synergistic effects which are little understood, but are believed to be essential to the stability of the community. Drastic changes induced by EVOS undoubtedly altered these pathways and the resulting community may never return to its pre-spill structure and internal integrity, although abundances may return to pre-spill levels.

Our approach for 1995 is to monitor the various successional stages of the eelgrass community toward stabilization by comparing components from four pairs of oiled and unoiled sites. We will target most of the sites that were sampled in 1990, 1991 and 1993 using the same methodology. We will quantify eelgrass, infauna, amphipods, small epifauna attached to eelgrass, large epifauna (i.e., crabs and sea stars), and juvenile Pacific cod. In addition, we will examine sediment hydrocarbon concentrations and some dominant demersal fishes for hydrocarbons and hemosiderosis. The benefit of continued monitoring of the natural recovery of this habitat is to provide information on the progress and general health of this community, including some key trophic components.

2. Relation to Other Damage Assessment/Restoration Work

Information from our monitoring activities will be useful to investigators working in the nearshore regions of Prince William Sound, e.g., river otter recovery monitoring (95062), harbor seals (95064), Harlequin ducks (95427) and nearshore fish (95320N). This project is also closely linked to the monitoring of oil in subtidal (< 20 m) sediments (conducted by NOAA). Several study sites are in common between the two projects.

3. Objectives

The overall objective is to monitor the natural recovery of the shallow (< 20 m) subtidal eelgrass community in Prince William Sound that was impacted by the EVOS. The primary objectives are to: 1) spacially compare richness, diversity, abundance and biomass of dominant taxa between paired (oiled:control) sites; and 2) temporally compare these population parameters. A secondary objective is to examine some of the dominant nearshore demersal fishes for evidence of hemosiderosis.

4. Methods

a. Stratified Sampling - Rationale

A stratified sampling design, modified from the design used in our 1990 and 1991 surveys, will be employed in order to obtain estimates of basic population parameters (abundance and biomass) for infaunal and small epifaunal invertebrates. These estimates will be used to indicate the effects

of the EVOS on this community by comparing abundance (and other parameters) at paired oiled/control sites. The data will also be used in support of other studies (e.g., sea and river otters and birds) since the animals within the subtidal habitats are major food items for these other species.

b. Sampling within the Eelgrass Habitat

Eelgrass is generally found in shallow (less than 5 m), relatively quiet waters with freshwater input. The depth distribution of eelgrass at each site will be determined by swimming three randomly placed transects perpendicular to shore and noting the depth range and distance over which eelgrass occurs. We will sample two depth strata at each site. Within the eelgrass zone, we will establish three 30 m long transects running parallel to shore. We will also establish three additional transects seaward of the eelgrass, at the 6 to 20 m depth strata. The actual sampling depth within each site will be selected at random for each oiled site. Sampling depths at each control site will be matched with the depths for its paired control.

Infaunal invertebrates will be sampled from two randomly placed 0.1 m^2 quadrats on each transect using a suction dredge (airlift) system. The infaunal samples will be taken to a depth of 10 cm. A total of six replicate samples will be taken within each depth strata. A total of 12 samples will be taken at each site (3 transects x 2 depth strata x 2 replicates). In addition, two surface sediment (top 2 cm) samples will be taken to determine grain size and hydrocarbon concentrations at each sampling station. These samples will be archived for later analyses.

Sampling for eelgrass and fishes (within the eelgrass bed only) will follow the procedures previously used. The detailed Standard Operating Procedure for sampling within the eelgrass habitat is presented in Jewett *et al* (1994).

5. Location

A total of 4 oiled sites and 4 control sites have been selected from those we previously studied in western Prince William Sound. In 1995, sampling will occur at the following oil/control paired sites: Bay of Isles (O)/Drier Bay (C); Herring Bay (O)/Lower Herring Bay (C); Sleepy Bay (O)/Moose Lips Bay (C) and Clammy Bay (O)/Puffin Bay (C).

6. Technical Support

Three skiffs will be loaned to us from the EVOS intertidal investigations (Dr. Ray

Highsmith). This loan, which has occurred in past field studies, will be scheduled around their field activities. Three inflatable boats (14 ft) with 25-40 hp outboards has functioned best in our past field efforts.

Dr. A.S. Naidu, of UAF, will provide support to analyze the sediment samples for grain size analysis, as he has previously done for this project.

7. Contracts

a. Coastal Resources Associates, Inc., Vista, CA

CRA has been an integral technical component on the EVOS shallow subtidal investigations since 1989. To ensure project continuity, we will subcontract with CRA for field assistance. Further involvement will be required when we move into the analyses and report preparation phases of this project.

b. Memorial University, Newfoundland, Canada

Dr. R.A. Khan of Memorial University will be contracted to examine intertidal/shallow subtidal fishes for hemosiderosis as a pathological indicator of exposure of fishes to crude oil. Dr. Khan analyzed a few fishes for us in 1993.

c. NOAA, NMFS, Auke Bay, Alaska

All hydrocarbon analyses on sediment and fishes will be carried out through the Auke Bay Facility; they have previously provided this support for this project.

d. Support Vessel

An appropriate vessel will be subcontracted by competetive bid to carry out the field activities. The vessel will accomodate six diving scientists for approximately two weeks during July 1995.

C. SCHEDULE

The following activities are scheduled within this contract period:

a. March - June: ordering supples, securing subcontracts with CRA, Memorial University and a charter vessel, and freighting all sampling supplies and equipment to the field;

b. July 1995: field sampling (to conform with previous sampling) and freighting material to UAF;

c. August - September: laboratory analyses of approximately one-third of the benthic samples, and progress report.

The following activities are scheduled beyond this contract period:

d. October - December 15: laboratory analyses of the remainder of the benthic samples; analyses of samples for grain size, hydrocarbons and hemosiderosis;

e. December 15 - January 15 '96: data entry and analyses;

f. January 15 - February 15: draft final report;

g. February 15 - April 15: Peer review of draft final report;

h. A final report will be submitted 45 days after the peer-reviewed draft final report is returned.

D. EXISTING AGENCY PROGRAM

This project has been implemented by ADF&G since 1990. Two other intertidal/shallow subtidal components (Proj #'s 95025G and 95087) are being proposed by us as part of the Nearshore Vertebrate Predator package (95025). We anticipate that some savings in vessel charter cost can occur if these new projects are also funded. I envision concurrent or overlapping field sampling operations. The cost saving is unknown at this time.

E. ENVIRONMENTAL COMPLIANCE, PERMITTING AND COORDINATION STATUS

The appropriate scientific sampling permit will be obtained from ADF&G prior to sampling. All operations aboard the research vessel will conform to U.S. Coast Guard safety standards. All SCUBA diving activity will conform to the UAF's scientific diving standards (UAF is a member of the American Academy of Underwater Sciences). This project received a categorical exclusion under NEPA from NOAA.

F. PERFORMANCE MONITORING

A rigorous quality assurance/quality control (QA/QC) program will ensure the reliability and validity of field and laboratory data. A QA/QC program was initiated at the start of the

project (1990) and was continued in 1991 and 1993. It also will continue through the 1995 field operations, laboratory analyses, and subsequent data processing. All sample collection, labelling, preservation and storage in the field will be carried out by a team of six divers. Chain-of-Custody forms that accomodate the standard signatory policy will always accompany the benthic samples and sediment hydrocarbon samples to UAF until processing has been completed. A procedure of double checking all labelling and entry of data in field notebooks and data forms will be performed by a member of the team that did not complete the original field notebook. All field and laboratory QA/QC procedures will follow those detailed in Jewett *et al* (1994).

G. COORDINATION OF INTEGRATED RESEARCH EFFORT

This project is closely linked to the monitoring of oil in subtidal (< 20 m) sediments (conducted by NOAA). Several study sites are in common between the two projects.

H. PUBLIC PROCESS

Since this study got underway in 1990, it has had intense internal and public review through workshops, EVOS Symposium, meetings, Final Report reviews, and peer reviews of manuscripts for publication, including in a special publication through the Transactions of the American Fisheries Society.

I. PERSONNEL QUALIFICATIONS

Stephen C. Jewett, Principal Investigator and Research Associate at the School of Fisheries and Ocean Science (SFOS), University of Alaska Fairbanks will be responsible for the organization and the management of this project, including interpretation and synthesis of data and writing of reports. Mr. Jewett has been a Research Associate at UAF since 1975. During this time he has been involved in numerous benthic investigations throughout Alaska that emphasize assessment and/or monitoring. He has been the coordinator of the federal/state EVOS shallow subtidal investigations in Prince William Sound (1989-94). Mr. Jewett also serves as the Scientific Diving Officer for UAF, coordinating all scientific diving operations.

Joan Osterkamp, Executive Director of SFOS, University of Alaska Fairbanks, will be the Financial Officer overseeing the project.

Thomas A. Dean, Ph.D., is President of the ecological consulting firm Coastal Resources Associates, Inc. (CRA) in Vista, CA. He has had a major role in both the shallow subtidal and intertidal EVOS investigations conducted through UAF since 1989. His has extensive experience in long-term monitoring studies with marine plants and invertebrates. Dr.

Dean will mainly be responsible coordinating the plant investigations on this study, as well as assisting in the carrying out of the project objectives.

Arny Blanchard, Laboratory Supervisor for the shallow benthic component, has direct control and involvement of all laboratory analyses, quality control of the data, and submission of the data to Data Management at SFOS .

Max Hoberg, Research Technician, is a diver/benthic invertebrate taxonomist at SFOS. He will assist A. Blanchard in the laboratory.

J. BUDGET

		FY 95	FY 96	FY95-96
1.	Personnel	$73,309	$117,843	$191,152
2.	Travel	3,033	4,770	7,803
3.	Contractual Services	70,300	57,000	127,300
4.	Commodities	4,000	3,000	7,000
5.	Equipment	0	0	0
6.	Capital Outlay	0	0	0
7.	General Administration	30,128	36,523	66,651
		$180,770	$219,136	$399,906

EXXON VALDEZ STEE COUNCIL
1995 Federal Fiscal Year Project Budget
October 1, 1994 - September 30, 1995

Project Description: The subtidal eelgrass community was one of the several habitats examined relative to EVOS effects and subsequent recovery. Investigations comparing oiled and control sites in this habitat were conducted in 1990, 1991, and 1993. After the 1991 samplint it was apparent that recovery was underway. However, the 1993 data reveals a reversal, suggesting that some segments of the community are once again in a toxic phase (e.g., amphipods) and othr segments reflect enhancement (e.g., epifauna on eelgrass). This project will revisit eelgrass sites from earlier studies to monitor the recovery of the eelgrass communities. Since no sampling occurred in 1994, and since community recovery had not occurred through the 1993 sampling, it is advisable to reexamine these eelgrass sites again in 1995 to monitor their recovery.

Budget Category:	1994 Project No. . . . . Authorized FFY 94	'94 Report/ '95 Interim* FFY 95	Remaining Cost** FFY 95	Total FFY 95	FFY 96	Comment 96 Field	Comment 95 Report
Personnel	$0.0	$0.0	$6.0	$6.0	$10.2	$6.0	$4.2
Travel	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Contractual	$0.0	$0.0	$180.8	$180.8	$399.9	$180.8	$219.1
Commodities	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Equipment	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Capital Outlay	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Subtotal	$0.0	$0.0	$186.8	$186.8	$410.1	$186.8	$223.3
General Administration	$0.0	$0.0	$13.6	$13.6	$22.0	$13.6	$16.0
Project Total	$0.0	$0.0	$200.4	$200.4	$432.1	$200.4	$239.3
Full-time Equivalents (FTE)		0.0	0.1	0.1			

Dollar amounts are shown in thousands of dollars.

Budget Year Proposed Personnel: Position Description	Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
Program Manager	0.0	$0.0	1.0	$6.0
Personnel Total	0.0	$0.0	1.0	$6.0

NEPA Cost: $0.0

*Oct 1, 1994 - Dec 31, 1994
**Jan 1, 1995 - Sep 30, 1995

06/01/94

1995

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Project Number: 95106
Project Title: Subtidal Monitoring: Eelgrass Communities
Agency: AK Dept. of Fish & Game

FORM 2A
PROJECT
DETAIL

EXXON VALDEZ TRUSTEE COUNCIL
1995 Federal Fiscal Year Project Budget
October 1, 1994 - September 30, 1995

			Reprt/Intrm	Remaining
Travel:				
Rept			$0.0	$0.0
Intrm				
		Travel Total	$0.0	$0.0
Contractual:				
RSA with UAF to conduct a monitoring study on the eelgrass communities of PWS.			$0.0	$180.8
The RSA line item breakout is as follows:				
100	$73.3			
200	$3.1			
300	$70.3	Includes subcontracts for vessel charter ($32.0) and CRA ($34.0).		
400	$4.0			
500	$0.0			
Subtotal	$150.7			
UAF General Admin.	$30.1			
RSA Total	$180.8			
		Contractual Total	$0.0	$180.8

EXXON VALDEZ ....STEE COUNCIL
1995 Federal Fiscal Year Project Budget
October 1, 1994 - September 30, 1995

	Reprt/Intrm	Remaining
Commodities:		
Rept	$0.0	$0.0
Intrm		
Commodities Total	$0.0	$0.0
Equipment:	$0.0	$0.0
Rept		
Intrm		
Equipment Total	$0.0	$0.0

07/14/93

1995

Printed: 7/13/94 10:17 AM

Project Number: 95106
Project Title: Subtidal Monitoring: Eelgrass Communities
Agency: AK Dept. of Fish & Game

FORM 2B
PROJECT
DETAIL

1995 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1994 - September 30, 1995

Project Description:

Examination of eelgrass sites from earlier studies (1990-1993) will be re-examined to monitor recovery.

Budget Category	1994 Project No. Authorized FFY 94	'94 Report/ '95 Interim* FFY 95	Remaining Cost** FFY 95	Total FFY 95	FFY 96	Comment
Personnel				73309.00	117843.0	
Travel				3033.0	4770.0	
Contractual				70300.0	57000.0	
Commodities				4000.0	3000.0	
Equipment				0.0	0.0	
Capital Outlay				0.0	0.0	
Subtotal	0.0	0.0	0.0	150642.0	182613.0	
General Administration				30128.0	36523.0	
Project Total	0.0	0.0	0.0	180770.0	219136.0	
Full-Time Equivalents (FTE)				17.0		
	Dollar amounts are shown in thousands of dollars.					

Budget Year Proposed Personnel: Position Description	Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
Principal Investigator (S. Jewett)			4.0	29723.0
Technician			2.0	9774.0
Technician			3.0	14969.0
Lab. Asst.			2.0	5961.0
Divers (2)			2.0	10705.0
Stud. Asst.			4.0	2177.0
Personnel Total	0.0	0.0	17.0	73309.0

* Oct 1, 1994 - Dec 31, 1994

* * Jan 1, 1995 - Set 30, 1995

1995

Project Number:

Project Title: Subtidal Monitoring: Eelgrass Communities

Sub-Project:

Agency: ADF&G

FORM 3A SUB-PROJECT DETAIL

Commodities	Reprt/Intrm	Remaining
Rept		
Intrm		
Field Supplies		3000.0
Laboratory Supplies		1000.0
Commodities Total	0.0	4000.0

Equipment		
Rept		
Intrm		
Equipment Total	0.0	0.0

1995

Project Number:
Project Title: Subtidal Monitoring: Eelgrass Communities
Sub-Project:
Agency: ADF&G

FORM 3A
SUB-
PROJECT
DETAIL

1995 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 1994 - September 30, 1995

	Reprt/Intrm	Remaining
Travel:		
Rept		
Intrm		
R/T Faibanks - Seward @$300/trip		900.0
Per diem - Seward (@$147/day)		1323.0
R/T Fairbanks - Anchorage @$300/trip		300.0
Per diem - Anchorage (@$170/day)		510.0
Travel Total	0.0	3033.0
Contractual:		
Rept		
Intrm		
Subcontract to Coastal Resources Associates		30000.0
Vessel Charter - 15 days @$2500/day		37500.0
Freight/shipping		1700.0
Compressor maintenance		500.0
Microscope/balance maintenance		300.0
Communications		300.0
Contractual Total	0.0	70300.0

1995

Project Number:

Project Title: Subtidal Monitoring: Eelgrass Communities

Sub-Project:

Agency: ADF&G

FORM 3A
SUB-
PROJECT
DETAIL

Budget
October 1, 1994 - September 30, 1995

SALARIES AND BENEFITS				
	Wages	*Mos.*		
	Jewett, S.	4.00	$18,980	
	Technician	2.00	$5,722	
*	Technician	3.00	$9,156	
	Lab. Asst. II	2.00	$3,490	
*	Divers (2)	2.00	$7,015	
	Student Asst. II	4.00	$2,177	
	Leave Accrual			
	Jewett, S.		$3,606	
	Technician		$1,225	
	Technician		$1,757	
	Lab. Asst. II		$747	
	Divers (2)		$1,115	
	Student Asst. II		$0	
	Benefits			
	Jewett, S.		$7,137	
	Technician		$2,827	
	Technician		$4,056	
	Lab. Asst. II		$1,724	
	Divers (2)		$2,575	
	Student Asst. II		$0	
	TOTAL SALARIES AND WAGES			$73,309
TRAVEL				
	R/T Faibanks - Seward @$300/trip		$900	
	Per diem - Seward (@$147/day)		$1,323	
	R/T Fairbanks - Anchorage @$300/trip		$300	
	Per diem - Anchorage (@$170/day)		$510	
	R/T Fairbanks - San Diege @$800/trip		$0	
	Per diem - San Diege (@$115/day)		$0	
	TOTAL TRAVEL			$3,033
SERVICES				
	Subcontract to Coastal Resources Associates		$30,000	
	Vessel Charter - 15 days @$2500/day		$37,500	
	Freight/shipping		$1,700	
	HC analysis		$0	
	Compressor maintenance		$500	
	Microscope/balance maintenance		$300	
	Communications		$300	
			$0	
			$0	
	TOTAL SERVICES			$70,300
SUPPLIES				
	Field Supplies		$3,000	
	Laboratory Supplies		$1,000	
	TOTAL SUPPLIES			$4,000
EQUIPMENT				
	None requested			
	TOTAL EQUIPMENT			$0
TUITION				
	None requested			
	TOTAL TUITION			$0
	TOTAL DIRECT COSTS			$150,642
	INDIRECT COSTS (20% Total Direct Costs)			$30,128
	TOTAL FUNDING REQUESTED			$180,770

Budget
October 1, 1995 - September 30, 1996

SALARIES AND BENEFITS			
Wages	*Mos.*		
Jewett, S.	7.00	$34,877	
Technician	5.00	$15,025	
Technician	4.00	$11,493	
Lab. Asst. II	5.00	$9,159	
Divers (2)	0.00	$0	
Student Asst. II	4.00	$2,284	
Leave Accrual			
Jewett, S.		$6,627	
Technician		$3,215	
Technician		$2,460	
Lab. Asst. II		$1,960	
Divers (2)		$0	
Student Asst. II		$0	
Benefits			
Jewett, S.		$13,115	
Technician		$7,424	
Technician		$5,679	
Lab. Asst. II		$4,525	
Divers (2)		$0	
Student Asst. II		$0	
TOTAL SALARIES AND WAGES			$117,843
TRAVEL			
R/T Faibanks - Seward @$300/trip		$0	
Per diem - Seward (@$103/day)		$0	
2 R/T Fairbanks - Anchorage @$300/trip		$600	
Per diem - Anchorage (@$170/day)		$1,190	
2 R/T Fairbanks - San Diego		$1,600	
Per diem - San Diege (@$115/day)		$1,380	
TOTAL TRAVEL			$4,770
SERVICES			
Subcontract to Coastal Resources Associa		$35,000	
Vessel Charter		$0	
Freight/shipping		$0	
HC analysis		$7,000	
Compressor maintenance		$0	
Microscope/balance maintenance		$0	
Communications		$500	
Hemosiderosis analysis		$10,000	
Sediment analysis		$4,500	
TOTAL SERVICES			$57,000
SUPPLIES			
Field Supplies		$0	
Laboratory Supplies		$3,000	
TOTAL SUPPLIES			$3,000
EQUIPMENT			
None requested			
TOTAL EQUIPMENT			$0
TUITION			
None requested			
TOTAL TUITION			$0
TOTAL DIRECT COSTS			$182,613
INDIRECT COSTS (20% Total Direct Costs)			$36,523
TOTAL FUNDING REQUESTED			$219,136

Habitat Protection - Data Acquisition and Support

Project Number:	95110-CLO
Restoration Category:	Habitat Protection (closeout)
Proposed By:	Habitat Work Group
Lead Agency:	ADNR
Cooperating Agencies:	ADFG, DOI, USFS
Cost FY 95:	$144,000
Cost FY 96:	$0
Total Cost:	$144,000
Duration:	1 year
Geographic Area:	Prince William Sound, Kenai Peninsula, Alaska Peninsula, and Kodiak Archipelago
Injured Resource/Service:	Multiple resources

INTRODUCTION

This project is designed to support habitat protection activities of the Trustee Council and is a close-out of project 94110. In 1993 Habitat Protection Work Group conducted a survey and assessment of selected parcels of private land within the oil spill zone. The lands were scored, ranked and mapped using the Trustee Council approved Evaluation Process to determine the value of these areas to injured resources and services and the benefits that could be achieved through habitat protection. The evaluation was done using a variety of available data and information gathered from various agencies and technical experts, data collected during The Nature Conservancy Workshop, Natural Resource Damage Assessment reports, and site reconnaissance field visits.

In 1994, a method was developed for nominating, processing, evaluating and ranking parcels of private land less than 1000 acres, i.e., *The Small Parcel Process*. Responses to the solicitation for nominations of small parcels are currently being processed and evaluated. Evaluations, starting with field surveys, of large and small parcels submitted this Spring will also continue into the Fall.

NEED FOR THE PROJECT

The need for the close-out work on project 94110 is to complete evaluations of lands nominated during this summer and fall and to prepare reports. Results of large parcel evaluations will be submitted to the Trustee Council as a supplement to Volume I of the Comprehensive Habitat Protection Process document. The results of the Small Parcel Process will be submitted to the Trustee Council as a separate volume of the Process.

PROJECT DESIGN

A. Objectives

1. Evaluation, restoration unit design, scoring and ranking of selected private parcels.

2. Mapping of evaluation units.

3. Preparation of supplement to Volume I of the Comprehensive Habitat Protection Process document for Trustee Council review and negotiations with landowners.

4. Preparation of Volume III *Small Parcel Evaluation and Ranking Comprehensive Habitat Protection Process* for Trustee Council review and negotiations with landowners.

B. Methods

Existing data and data obtained by HPWG in 1993 and 1994 will be analyzed to fill data gaps to the maximum extent possible. This will include some additional programming, data base management, and GIS work to sort data and to map resource information where appropriate.

Primary and secondary evaluations, for large and small parcels, will be conducted by the HWG using evaluation formats developed by the group.

Volume III and the supplement to Volume I will be prepared in a format consistent with Volumes I and II.

C. Schedule

Evaluation and ranking of small parcels will occur during this summer and fall. It is anticipated that negotiations for small parcels will commence in January 1995. Field surveys of recently nominated large parcels will occur this summer. Evaluation results, including scoring and ranking, of both large and small parcels will be submitted to the Trustee Council in the fall.

D. Technical Support

The Alaska Department of Natural Resources LRIS group will produce all maps. The HWG will

produce all documents.

E. Location

The analysis will cover all selected lands within the oil spill zone. Lands are located within Prince William Sound, Kenai Peninsula, Kodiak/Afognak Archipelago and on the Alaska Peninsula.

PROJECT IMPLEMENTATION

The proposed project is a continuation of 94110. Habitat protection projects were started in 1992 by the Restoration Planning Work Group and outlined in concept in Volume I of the *Restoration Framework.* Implementation of this project would be by the Habitat Work Group. This group includes four members representing ADNR, USFS, ADFG and USFWS. The HWG includes three individuals who have been working on the spill since early 1989 and who participated in the genesis and development of habitat protection as a restoration strategy. All four members are authors of the *Comprehensive Habitat Protection Process* report and participated in the development of the *Small Parcel Process.*

COORDINATION OF INTEGRATED RESEARCH EFFORT

All habitat protection efforts including this project are dependent upon the results of on-going research and monitoring projects. For example, the Large Parcel Element used information from the anadromous fish stream catalog, colonial seabird catalog, bald eagle nesting maps, and data from Trustee Council funded studies on black oystercatchers, marbled murrelets and pigeon guillemots.

FY 95 BUDGET ($K)

Personnel	73.2
Travel	6.0
Contractual	48.0
Commodities	2.4
Equipment	0.0
Subtotal	129.6
Gen. Admin.	14.4
Total	144.0

FINAL VERSION. RFP & BPC serve in lieu of DPD.

Sound Waste Management Plan

Project Number:	95115
Restoration Category:	General Restoration (new)
Proposed By:	Prince William Sound Economic Development Council
Lead Trustee Agency:	ADEC
Cost FY 95:	$284,500
Cost FY 96:	$ 15,600 to complete Phase I. Additional funds may be needed for Phase II, see below for explanation.
Total Cost:	Unknown
Duration:	Unknown
Geographic Area:	Prince William Sound
Injured Resource/Service:	Intertidal and subtidal organisms, harlequin ducks, black oystercatchers, sea otters, harbor seals, and other seabirds, shorebirds and marine mammals. The services most likely to benefit are subsistence and recreation, both of which are affected by the visual recognition of pollution.

INTRODUCTION and NEED FOR THE PROJECT

Abstract: The Sound Waste Management Plan (SWMP) is a comprehensive plan to identify and remove the major sources of marine pollution and solid waste in Prince William Sound that may be affecting recovery of resources and services injured by the *Exxon Valdez* Oil Spill. The first phase of the plan will identify the major sources of marine pollution and solid waste, identify their significance, and recommend solutions to reduce the effects that can be implemented by municipalities, state and federal governments, private industry, or trustee agencies. The following phases of the plan will be to implement these solutions. Only the first phase is proposed for FY 1995.

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

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

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

The major waste types that appear to have the greatest potential to affect injured resources and services are below.

- **Waste Oil.** Engine oil and bilge water are sources of waste oil, much of which is discharged into the waters of Prince William Sound.

  Engine Oil. Vessels and communities in Prince William Sound generate large quantities of used motor oil and other lubricants. Nationwide, regulatory and financial issues have discouraged people from properly disposing of waste oil; more often than not, waste oil was illegally dumped in landfills, sewer systems, or other open sites. In 1992, the U.S. Environmental Protection Agency estimated that 170 million of the 190 million gallons of waste oil generated in the nation found its way into the environment due to improper disposal; this represents approximately 16 times the amount of oil spilled by the *Exxon Valdez.* Most areas of the country have more, or more convenient facilities than does the spill area.

  Cordova, Valdez, and Whittier all have at least one waste oil burner. The burners take waste oil and provide heat for community buildings or electricity for the municipality. In some cases, more capacity may be needed. These facilities have made it feasible for vessels and engine owners to conveniently dispose in a safe and non-polluting manner. For example, there are three waste-oil burners in Cordova, which is the site of a large fishing fleet. One burners, operated by Cordova Electric Cooperative, collected and burned 21,000 gallons of waste oil last year and used the heat for two buildings. Homer, though outside of Prince William Sound, typically serves 850 boats in the harbor at any one time, burned approximately 6,000 gallons per year of waste oil to heat two buildings.

  Tatitlek and Chenega lack waste oil burners. These two communities are currently installing docks facilities for handling more boat traffic. The increased activity is likely to increase the potential for inappropriate disposal of waste oil near the communities. For that reason, federal law requires that public docks with significant traffic have solid waste

and waste oil collection — a requirement that is frequently not met in small, rural communities because of the difficulty in disposing of the collected material.

Bilge Water. Bilge water includes grease and oil from engines and machinery. There is currently no feasible and convenient method in the Sound for fishing, commercial, or recreational vessels to legally dispose of bilge water. There is no community with facilities to conveniently accept bilge water, and as a result, much is probably dumped into Prince William Sound. Much of it is probably dumped in or near the small boat harbors.

- **Stormwater Runoff.** Stormwater runoff contains grease and oil from city streets, chemicals from laws and buildings, and other polluting residues. Cordova, Valdez, and Whittier all have stormwater systems that discharge directly into the bay, in some cases into habitats such as the Valdez Duck Flats that are essential for resources injured by the spill.

- **Oily Waste.** Oily waste is the residue of materials that contain oil. Oil filters, absorbent pads, and cleaning materials are examples of oily waste. In most communities there is no alternative but to place oily waste in the landfill. Valdez is working to acquire a crusher to press the oil out of old filters and material. This will reduce the amount of oil in other waste materials, but in most communities, the waste becomes part of the landfill. None of the landfills or dumps in Prince William Sound have an impermeable membrane, and some portions of the oil migrates to water sources.

- **Sewage.** Sources of sewage include the communities, vessels, and land-based and floating remote lodges. There is no feasible or convenient method for the fishing, commercial, or recreational vessels to legally dispose of the sewage. While some of the large vessels have sewage disposal systems on board, most dump the waste overboard with minimal if any treatment. There have been reports that some remote camps are out of compliance and causing local habitat problems due to improper sewage disposal. In some locations, the amount of sewage may be safely dispersed without significant effect on the local environment. In other locations, there is potential for significant effect.

- **Solid Waste.** Currently each community in Prince William Sound is out of compliance with federal regulations as it relates to permitting of waste sites. Improper solid waste disposal has the potential to affect water sources and upland habitat used by injured resources. Blowing garbage is a problem in the two communities without a sanitary landfill (Chenega and Tatitlek). Cordova's landfill currently includes diked off tideland areas and the lower portion of the landfill is inundated by the tide. As a result, landfill leachate may contaminate Orca Inlet. In addition, leachate from Valdez's landfill probably reaches Port Valdez.

- **Household Hazardous Waste.** The three incorporated communities have methods of feasibly disposing of household hazardous waste, but collection is infrequent. The two unincorporated communities do not collect household hazardous waste. As a result, much hazardous waste is probably improperly dumped.

- **Fish Wastes.** Sources of fish waste include, shore-based processors, floating processors, and sports-fish cleaning stations (usually in small boat harbors).

  Shore-based Processors. There appears to be problems with accumulation of offal from fish processors in Valdez and Cordova. The accumulation of many year's of processing wastes in the shallow inlet off Cordova appears to have created an anaerobic zone on the inlet's floor — unusable habitat to the fish, subtidal, and marine mammal resources of the area. There have been recent incidents in Valdez where an unusual stench may be traceable to an accumulation of offal near the processors. In both cases, there are activities by the cities, state, EPA, and fish processors to solve the problems, but no solution is as yet apparent.

  Floating Processors. In some cases, there may be similar problems with floating processors accumulating wastes in one location. In other cases, the floating processors may distribute their fish wastes without significant harm to the local environment.

  Sport-fish Cleaning Stations. The largest sports fishery in Prince William Sound is based out of Valdez, though significant fisheries exists from Cordova and Whittier. In each case, cleaning occurs at sports fish stations in the small boat harbor, and the wastes concentrate in the boat harbor beneath the station. This can overburden waters of the small boat harbor and reduce water quality below federal or state minimums.

Two examples show the potential effects of these problems. The first, Valdez Duck Flats, is adjacent to the Valdez Small-boat Harbor. It is an Area Meriting Special Attention in the Valdez Coastal Management Plan because of its important habitat value. It includes 450 acres of mud flats and 460 acres of saltwater marsh. It provides habitat for rearing salmon and has been recognized by state and federal agencies as providing essential waterfowl habitat for species injured by the spill. The habitat of the Duck Flats may be degraded by the storm water runoff which empties into the area, or by discharges from boats outside the harbor, landfill contamination flowing down Valdez Creek, or sewage disposal in the Port.

Orca Inlet, outside Cordova has the largest pupping concentration of sea otters in Prince William Sound, and is also important for sport fishing, hunting, and is seasonally used by large concentrations of seabirds and waterfowl, including many resources injured by the spill. It is a part of the largest contiguous wetland in the western hemisphere which, during migrations, hosts the largest concentration of shorebirds in the world. The Cordova waterfront hosts most of the problems referenced above. The shoreline includes the solid-waste landfill, which is built in part on tidelands and is inundated by the tide twice each day; storm-water and sewer outfalls, and outfalls for fish-processing offal which has created an anaerobic zone on the inlet floor.

The table below summarizes problems in the communities of Prince William Sound.

Key
▣ = Some of waste stream likely enters marine waters.
ff = Facilities or community program available (though not necessarily adequate).

Waste Stream:	Cordova	Valdez	Tatitlek	Chenega	Whittier
Waste Oil					
Engine Oil	▣ ff	▣ ff	▣	▣	▣ ff
Bilge Water	▣	▣	▣	▣	▣
Stormwater Runoff	▣	▣			▣
Oily Waste	▣	▣	▣	▣	▣
Sewage					
Community	ff	ff			ff
Vessels	▣	▣	▣	▣	▣
Solid Waste	▣ ff	▣ ff	▣ ff	▣ ff	ff
Household Hazardous Waste	▣ ff	▣ ff	▣	▣	▣
Fish Wastes					
Processors	▣	▣			▣
Sport-fish cleaning	▣	▣			

The problems referenced above may be affecting resources and services injured by the spill, including disruption of important habitat. Any decrease in local pollution would have the effect of decreasing the stress on injured resources and services that rely on clean water. Those resources and services likely to benefit the most are those that feed in the intertidal or near-shore waters in the vicinity of community waterfronts and small boat harbors. These resources most likely to benefit include harlequin ducks, black oystercatchers, sea otters, harbor seals, and other seabirds, shorebirds and marine mammals. The services most likely to benefit are subsistence and recreation, both of which are affected by the visual recognition of pollution.

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

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

of this project, and is the overall approach of each phase of the project.

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

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

- Phase II will handle required ADEC/EPA permitting to implement solutions.

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

Contributions from Other Funding Sources. The funding contributed by the Trustee Council for Phase I would be coordinated with funding proposed by the City of Valdez, and that contributed by the Alaska Department of Transportation and Public Facilities. In addition, many of the solutions proposed as a result of Phase I, are likely to be funded all or in part by municipalities, villages, private industry, the federal government, and the State of Alaska. Some solutions may be appropriate for funding from the civil settlement.

The proposed budget for the City of Valdez for calendar year 1995 includes $100,000 to investigate long-term solutions to the solid waste problems in Valdez. The questions that study will investigate include some of those to be investigated by this proposal. Valdez will not act upon its budget proposal before Trustee Council action is expected. However, if passed, the Valdez appropriation would be coordinated by Bill Wilcox, Valdez City Engineer and Director of Public Works. Mr. Wilcox is also on Prince William Sound Economic Development Commission's Solid Waste Subcommittee that would oversee this project. Thus, the City's proposed appropriation is another financial contribution to this project.

The Alaska Department of Transportation and Public Facilities has given a contribution for a related project. The department has given $100,000 grant to each of Cordova and Valdez to implement a junk car and scrap metal recycling project. Valdez has an inventory of 1,500 old cars, and Cordova has 500. The grants would enable these communities to crush and recycle these cars and other scrap metals. This would eliminate waste stream from the landfills (and because of oil and other toxics associated with the cars, it may have some effect on eliminating those sources from entering marine waters). The two grants were coordinated by the Prince William Sound Economic Development Commission, and will be implemented so that the crusher can be used regionally — for materials from Chenega, Tatitlek, and if feasible, Whittier.

PROJECT DESIGN

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

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

1. Identifying options.

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

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

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

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

B. Methods

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

a. DEC will do the financial administration of the contract that is the major part of Phase I.
b. Prince William Sound Economic Development Council's Solid Waste Management Committee with participation from each of the Prince William Sound communities, DEC, and possibly with EPA and the US Coast Guard will manage the contract. This participation is important for the results of the project — that the recommended solutions will be agreed to and implemented by the appropriate communities and regulatory agencies.

2. *Technical Component for Phase I.* A Request for Proposals will solicit the most qualified firm to accomplish the objectives of Phase I.

C. Schedule (FY 95 - Plan of Work)

November 15, 1994	Begin writing RFP
November 30, 1994	Advertise RFP
February 1, 1995	Award Contract
August 1, 1995	Draft Report to the PWS Economic Development Council and ADEC
September 1, 1995	Final Report

D. Technical Support

All technical support will be provided by the Prince William Sound Economic Development Council's regional Solid Waste Management Committee, and by the Alaska Department of Environmental Conservation.

E. Location

Prince William Sound

PROJECT IMPLEMENTATION

For the most part, solutions to the identified problems will be implemented by communities and local groups. They must be the major part of the process to identify and choose these solutions. To maintain the direct link from development and implementation of the SWMP, Prince William Sound Economic Development Council's regional Solid Waste Management Committee in cooperation with DEC will implement this regional project in cooperation with ADEC.

The Contractor will be selected by competitive solicitation. PWS Economic Development Council will manage the contract under agreement to ADEC. The Economic Development Council is an Alaska Regional Development Organization (ARDOR) which under AS 36.30.850 may receive funds from the state without competitive solicitation. (The contractor will be selected using normal, State of Alaska competitive procedures.)

PUBLIC PROCESS

This project will be administered, in cooperation with DEC, by representatives of the affected communities. The Prince William Sound Economic Development Council includes representatives of each community, and industry representatives including the fishing, tourism, and petroleum industries. The process will continue with public review at local city council and village council meetings for comment as part of the SWMP. An integral part of the SWMP is community education.

COORDINATION OF INTEGRATED RESEARCH EFFORT

This project is not research, and integration with other Trustee research activities is unnecessary.

FY 95 BUDGET ($K)

Personnel	$12.8
Travel	6.0
Contractual	245.6
Commodities	1.0
Equipment	0.0
Capital Outlay	0.0
Subtotal	$265.4
Gen. Admin.	19.1
Total	$284.5

95117

DETAILED PROJECT DESCRIPTION
for
FY 95 RESTORATION PROJECTS

PROJECT TITLE:	Harbor seals and EVOS: blubber and lipids as indices of food limitation.
PROJECT NUMBER:	95117-BAA
LEAD TRUSTEE AGENCY:	NOAA
COOPERATING AGENCIES:	ADF&G
PROJECT START-UP/ COMPLETION DATES:	1 January - 31 December
EXPECTED PROJECT DURATION:	2.5 years
COST OF PROJECT	
FY95:	$82,948
FY96:	$68,709
FY97:	$34,347
GEOGRAPHIC AREA:	Prince William Sound and University of Alaska, Fairbanks

P.I.

PROJECT LEADER:

Dr. Michael A. Castellini \Date
Associate Professor
Institute of Marine Science
University of Alaska, Fairbanks
907-474-6825 (voice)
907-474-7204 (Fax)

PROJECT MANAGER:

BAA52ABNF400104/EVOS95117-BAA SFOS 94-186

A. INTRODUCTION

This proposal considers the theoretical impact of food limitation as a potential factor in the non-recovery of harbor seals (*Phoca vitulina*) in Prince William Sound (PWS) and northern Gulf of Alaska regions after the *Exxon Valdez* Oil Spill (EVOS) event of 1989. Prior to EVOS, population declines of 85% had been reported from Tugidak Island (Pitcher 1990), and declines may have occurred in the eastern Bering Sea and Aleutian Islands (Hoover-Miller 1994). Prince William Sound harbor seal populations, further impacted by EVOS (Frost and Lowry 1994a), have essentially stabilized at decreased levels, but have shown no signs of population recovery (Frost and Lowry 1994b). Trend-site counts in PWS have shown that declines were in both pup and non-pup portions of the population (Frost and Lowry 1994b). It is critical, yet difficult, to separate factors affecting the decline and non-recovery of PWS harbor seals if successful restoration measures are to be proposed. The hypothesis presented for testing in Broad Agency Announcement (BAA) 52ABNF400104 was that food limitation could have a multi-level impact on marine mammals, affecting their reproductive success, juvenile survival, and adult body condition. However, it may be virtually impossible to test this hypothesis, as stated, in wild populations of harbor seals in Alaskan waters. Full and complete testing of this food limitation hypothesis would require years of captive work on the impact of different feeding regimes on the energetics, feeding efficiency, reproductive success and body condition of animals. There are no facilities to do this type of work in Alaska. Furthermore, the application of those findings to the field would be difficult. In the field, harbor seals are elusive and difficult animals to capture. Repeated captures of the same individuals are essentially impossible. Marking and identification of specific pups in relation to weaning success by the mothers is not possible, nor can accurate determinations of diet or changes in diet be determined. For these reasons, body condition of adults may be the only way to address this question and even then, indirect methods to assess potential food limitations on animals must be considered. We propose to approach the question from a unique perspective; if the BAA hypothesis is valid, then harbor seal body condition should have changed. If it has, then addressing the difficult tasks of finding the cause of the shift becomes valid. Because accurate data on how food may impact reproductive success and juvenile survival cannot be obtained from Alaskan harbor seals in the wild, we propose that the hypothesis be reconsidered as follows:

If food limitation does indeed impact reproductive success, juvenile survival or adult body condition, then it follows that in regions of population decline there should be differences in the body condition of adult harbor seals between pre-decline periods and today.

Our lab is currently addressing the issues of adult harbor seal body condition in collaboration with Alaska Department of Fish and Game (ADF&G), and has been tentatively funded for additional support of this work through the EVOS FY95 program (95001). However, all of our current work utilizes standardized and clinical methods (such as body shape, size, and veterinary blood chemistry) in order to compare animals both in time and space. This

BAA/NOAA study proposes to utilize blubber analysis methods to test body condition status of harbor seals.

Blubber provides insulation and is also a critical fuel source for marine mammals. Therefore, its quality and energy density are prime descriptive characteristics of the energy available to the animal (Beck et al. 1993). By analyzing the blubber of harbor seals, a picture of metabolic status can be obtained. We propose to measure the quality of historical blubber samples collected pre-decline and archived by ADF&G, and compare these to samples collected from field projects during the next several years. This comparison should determine whether changes have occurred in the quality of this important body component. By combining these blubber data with ongoing body condition and health status studies of harbor seals in this region, we feel that the restated hypothesis can be tested. That is, we will determine whether or not there has been a shift in the body condition of harbor seals over time and space. *If there has been no change, then searching for mechanisms of how body condition could have been altered becomes irrelevant. On the other hand, if we show that there has been a shift, then detailed studies of the responsible factors can be explored.* Thus, we provide here a generalized test of the original BAA hypothesis: if no change can be shown, then there is no need to explore the mechanisms. If there is a change, then future studies can focus on the causes, whether related to EVOS, ecosystem changes, or food limitation.

B. PROJECT DESCRIPTION

1. Resources and Associated Services

The focus of this study is the harbor seal (*Phoca vitulina*). The results of this study, in conjunction with our other health assessment studies, will help elucidate the nature of harbor seal population decline and non-recovery in Prince William Sound. Specifically, it will provide an inferential test as to whether food limitation has had a role in changing population abundances. This information will be critical for future species restoration or management plans.

2. Relation to Other Damage Assessment Work

As samples will be collected from seals utilized for many projects, results from this project will be much more valuable than if it was a stand-alone study. This work will be central to interpreting results gathered under EVOS Project No. 95001, 'Recovery of harbor seals from EVOS: condition and health status'. In that project we will be quantifying gross differences in blubber stores of PWS harbor seals in relation to sex, age, season, location and year of sampling. The results from this study will provide quantitative blubber quality data and estimates of total blubber energy stores (when combined with Project No. 95001 data) to help interpret the nature of any differences found. The combined results of these two studies will

also help differentiate between multiple alternative hypotheses explaining declines presented by past (Project No. 93064, 'Habitat use, behavior, and monitoring of harbor seals in Prince William Sound) and current (Project No. 95064, 'Monitoring, habitat use, and trophic interactions of harbor seals in Prince William Sound) projects. The results from this study will also be interpreted in light of results generated from stable isotope research into dietary changes of harbor seals (Project No. 95320I, 'Isotope tracers-food web dependencies in PWS (fish, marine mammals and birds)').

3. Objectives

The essential elements of this proposal are contained in three tasks:

1. Obtain and analyze blubber from historical samples.
2. Obtain and analyze blubber from contemporary samples.
3. Model changes in blubber with independent data on body condition and change over time.

During the early part of this project, we will catalog and assess the quality of blubber samples archived by ADF&G. Once analytical equipment has been obtained, we will test our proposed methods using blubber samples currently in our collection, and make refinements as necessary. Subsamples of historical and recently field-collected blubber will be analyzed through the remainder of the year. See Schedule, below, for detailed time information.

4. Methods

General overview

Testing of the food limitation hypothesis will be accomplished by comparison of blubber quality between archived, historical blubber samples collected during the mid-late 1970's, to blubber samples biopsied during recent and current research projects in Prince William Sound. The determinations described below completely quantify the energetic state of blubber in terms of its potential as a fuel source. Our hypothesis is that since blubber is a major component of the body tissues of seals (27-30% of body mass (Pitcher 1986)), contains 90% of the lipid fuel sources in seals (Beck et al. 1993), and lipid utilization makes up approximately 85% of the energy utilized by seals (Ryg et al. 1990), then changes in the lipid content, blubber density and energy content should reflect seasonal and interannual changes in body condition of the seals. It is known that the blubber content of an animal and the lipid content of blubber varies with season, age and sex (Pitcher 1986; Ryg et al. 1990; Beck et al. 1993). The archived historical blubber samples have complete data sets on animal condition associated with them, and these data are also collected for the contemporary animals.

Collection of historical samples
Alaska Department of Fish and Game has archived, frozen samples of harbor seal blubber collected well before the population decline that are available for this analysis. They have given us permission to utilize this collection if personnel from UAF can travel to Anchorage to transfer and collate the samples. About 250-300 samples are archived and stored at -20 °C. There are potential difficulties associated with measuring blubber that has been stored for long time periods, and these are discussed below.

Collection of contemporary samples
Blubber samples will be acquired from live animals captured in conjunction with Project No. 95064, 'Monitoring, habitat use, and trophic interactions of harbor seals in Prince William Sound'. All field work, and associated costs of logistics are covered in that proposal and are not included here. Blubber samples will be collected by tissue biopsy using standard techniques already being employed. In the field, biopsy samples will be placed in cryovials and frozen at -80 °C in liquid nitrogen dry-shippers for transport to the laboratory.

Analysis of blubber
Samples of blubber will be analyzed for quality and density of energy. Four specific tests will be conducted on each sample; 1) density; 2) lipid content; 3) hydration state, and; 4) energy content.

Blubber density will be determined by simple mass and volume measurements of blubber samples. Total lipid content of blubber is determined by organic extraction of lipids using a Soxhlet apparatus and standard extraction techniques. Blubber hydration state is determined by mass difference between wet and dry weights of samples dried in a drying oven or freeze-drier.. Finally, the energy content of blubber is determined by bomb calorimetry of the sample to determine calories available. Because phocid blubber lipid content is homogenous both in location on the body and depth of sampling (Jangaard and Ke 1974; Beck et al. 1993), variability in sampling site should not confound analyses. One-way and multi-factorial analyses of variance will be performed to assess the affects of age, sex, season and year on these measures of blubber quality. Morphometric data available from the historical animals and from those sampled currently will enable calculation of total blubber energy stores for these same comparisons.

Potential analytical difficulties
Blubber samples stored for long periods may be subject to deterioration by dehydration and oxidation, depending on storage technique and temperature. Dehydration would directly impact water content and density analyses, but should not directly alter the lipid analysis or bomb calorimetry since samples are freeze-dried for those procedures. However, interpretation back to a wet-weight basis would be problematic. Historical samples will be visually examined for signs of dehydration, and subsamples will be taken away from edges. Massively dehydrated samples will be rejected. We will also use control samples of

recently-collected blubber to determine wet-mass to dry-mass ratios, and compare these to values measured from the archived samples to index dehydration. If some of the samples are dehydrated, then lipid and energy content will be compared to recent samples on a dry-mass basis only. It is also possible that because phocid blubber is typically less than 3% water (Beck et al. 1993), minor dehydration may not significantly effect results.

Oxidation of samples during storage (freezer-burn) alter lipids by reducing molecular chain length. This prohibits fatty acid identification, and we are not attempting these assays. However, oxidation of the lipid chains also reduces the energy content by a percentage of chain length that has been lost. We will minimize this problem by utilizing close visual inspection, and rejecting blubber samples that appear massively oxidized, and from which we can not sample away from the damage.

In the initial review of this proposal by the EVOS Trustee Council Chief Scientist, there were concerns about some of the methods and assumptions inherent in this work. In October 1994, we addressed these questions and sent back to the Council a detailed response to the concerns and issues presented to us by the Chief Scientist. The text of that response is attached as Appendix A.

Literature Cited

Beck, G.G., T.G. Smith and M.O. Hammill. 1993. Evaluation of body condition in the northwest Atlantic harp seal (*Phoca groenlandica*). Can. J. Fish. Aquat. Sci. 50:1372-1381.

Frost, K.J. and L.F. Lowry. 1994a. Assessment of injury to harbor seals in Prince William Sound, Alaska, and adjacent areas following the *Exxon Valdez* oil spill. Final Report, Marine Mammals Study Number 5, State-Federal Natural Resource Damage Assessment for 1 April 1989 through 31 September 1991. 154 p.

Frost, K.J. and L.F. Lowry. 1994b. Habitat use, behavior, and monitoring of harbor seals in Prince William Sound. Exxon Valdez Oil Spill Restoration Science Study 1994 Annual Report. 98 p.

Hoover-Miller, A.A. 1994. Harbor seal (*Phoca vitulina*) biology and management in Alaska. Marine Mammal Commission Contract Report T5134749, Washington, DC. 45 p.

Jangaard, P.M. and P.J. Ke. 1974. Principal fatty acids of depot fat and milk lipids from harp seal and hooded seal. J. Fish. Res. Board Can. 25:2419-2426.

Pitcher, K.W. 1986. Variation in blubber thickness of harbor seals in southern Alaska. J. Wildl. Manage. 50:463-466.

Ryg, M., C. Lydersen, N.H. Markussen, T.G Smith and N.A. Øritsland. 1990. Estimating the blubber content of phocid seals. Can. J. Fish. Aquat. Sci. 47:1223-1227.

5. Location

The principle area of study is Prince William Sound. Blubber samples from areas outside the Sound will be processed, as available, for comparative purposes.

6. Technical Support

Calorimetry of blubber samples will be performed by a technician from the University of Alaska Fairbanks School of Agriculture and Land Resources. All other analyses will be performed in our laboratory.

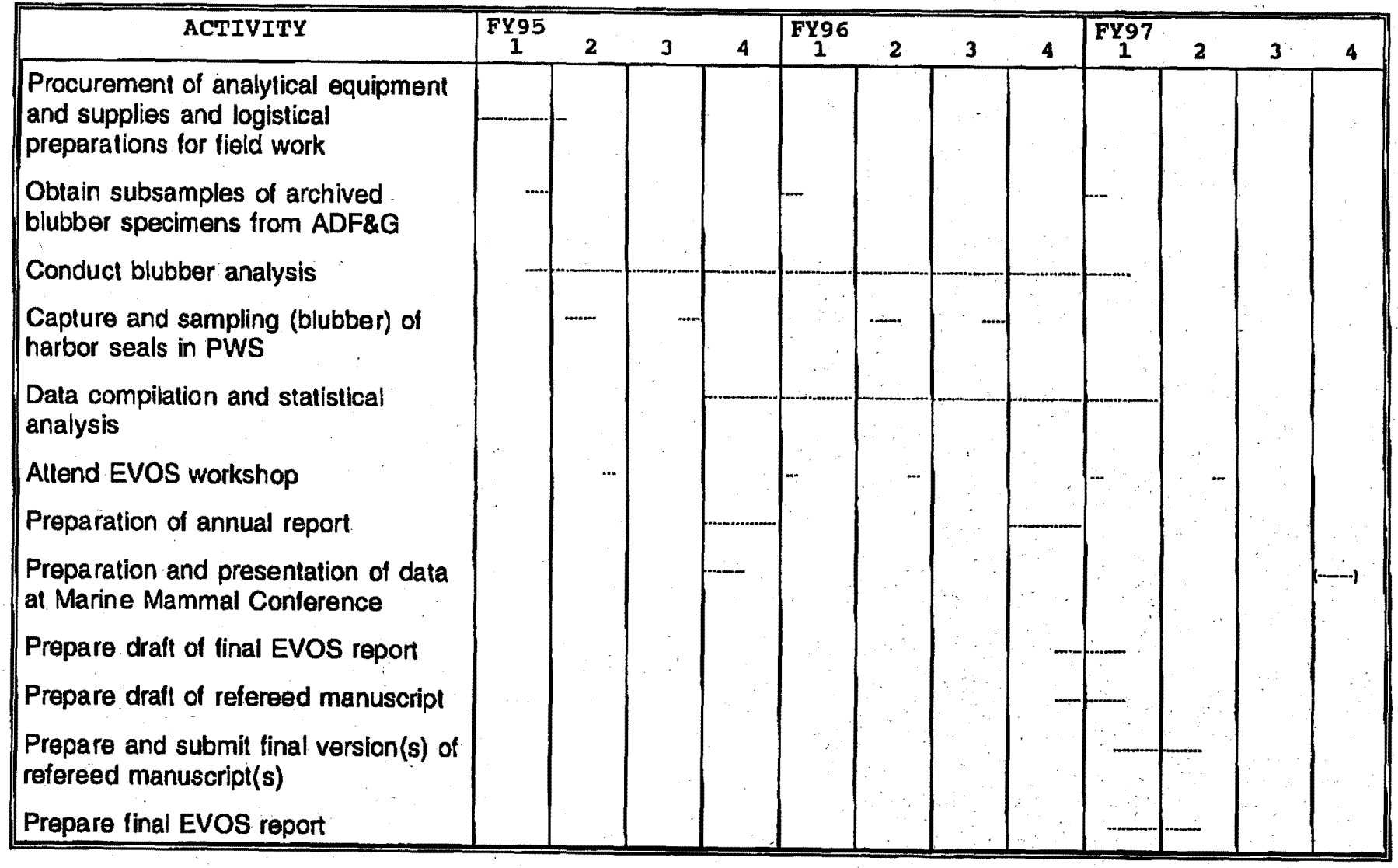
7. Contracts

The bomb calorimetry of blubber samples will be performed on a cost-per-sample basis by a technician with the School of Agriculture and Land Resources. They have the equipment and expertise to perform these analyses locally and in a timely manner.

C. SCHEDULE

1995 Project Activities

January-May:	Procurement of analytical equipment and supplies.
March:	Examine and obtain subsamples of archived blubber specimens from ADFG office in Anchorage.
March-May:	Begin blubber analyses.
May:	Capture and sampling of harbor seals in PWS.
May-July:	Continued blubber analyses.
June:	Attend EVOS workshop.
October:	Capture and sampling of harbor seals in PWS.
October-December:	Continued blubber analyses. Begin statistical analyses, and prepare annual report.



Personnel and Responsibilities

	Equipment/ supplies purchasing	Inventory/ subsampling historical blubber specimens	Capture/ sampling	Blubber analyses	Data analyses/ report preparation
M. Castellini			*	*	*
J.M. Castellini	*			*	*
B. Fadely	*	*	*	*	*
MS student (TBA)		*	*	*	
Heather McIntyre				*	

Logistical Needs

We need to purchase analytical equipment and reagents necessary for blubber analyses as early as possible. Travel to Anchorage to catalog, inspect and subsample the archived blubber specimens must also occur early in 1995.

D. EXISTING AGENCY PROGRAM

No other funding has been secured for this project.

E. ENVIRONMENTAL COMPLIANCE/PERMIT/COORDINATION STATUS

All permits required to conduct this research are currently active. This research will be performed under Marine Mammal Commission Permit No. 770 to Kathy Frost and Lloyd Lowry of ADF&G. We currently hold an active Animal Care and Use Permit from the University of Alaska, Fairbanks Institutional Animal Care and Use Committee for this research. No other permits are required.

F. PERFORMANCE MONITORING

Work performance is monitored at several levels for UAF research/academic laboratories:

A) Daily work: Students, staff and faculty are required to provide daily records of hours worked per funded project. Dr. Castellini is in the laboratory on a daily basis and oversees the student/staff workload and general functioning of the facility.

B) Project reports: Students and staff work closely with Dr. Castellini on the production of reports and project results. In addition, laboratory results are often discussed in teaching and seminar situations.

C) Budgetary reports. The UAF/SFOS business office provides monthly status reports on budgetary considerations and assigns a fiscal officer to each grant and/or contract. In addition, our own laboratory runs our own fiscal/software to follow daily costs and charges.

G. COORDINATION OF INTEGRATED RESEARCH EFFORT

This project utilizes the same research animals, ships and logistics provided to Project No. 95064, 'Monitoring, habitat use, and trophic interactions of harbor seals in Prince William Sound', and the same research subjects utilized by Project No. 95001, 'Recovery of harbor seals from EVOS: condition and health status'. These same animals will also be used by Project No. 95320I, 'Isotope tracers-food web dependencies in PWS (fish, marine mammals and birds)'.

H. PUBLIC PROCESS

Results of this study will be presented at appropriate EVOS workshops, as well as at professional meetings such as the Biennial Conference on the Biology of Marine Mammals, to be held in Orlando, Florida in December 1995. We have been in contact with several scientists for advice regarding our proposed methodologies.

I. PERSONNEL QUALIFICATIONS

Michael Castellini, Ph.D., specializes in metabolic chemistry problems associated with marine mammals. He is a tenured Associate Professor of Marine Science at UAF and has worked in this field for over 20 years. A one page selected CV is included in this package (Appendix B).

J.M. Castellini, M.Sc., is a UAF Research Associate and has worked on marine mammal biochemistry/physiology projects since 1986. She is currently the laboratory director and provides for daily project monitoring.

B. Fadely, M.Sc., the Ph.D student involved in this project, has previously performed studies involving nutritional physiology of northern fur seals and California sea lions. Currently he has been involved in assessing the health status of harbor seals in the Gulf of Alaska using morphometric and hematological techniques.

Heather McIntyre is an Agricultural Laboratory Assistant at the School of Agriculture and Land Resources, and has considerable expertise in the use of non-adiabatic bomb calorimeters. Recent work she performed for us involved bomb calorimetry of herring and pollock. She will be performing all bomb calorimetry.

We will also provide another MS graduate student for general laboratory help and field support.

J. BUDGET

FY95 BUDGET
Jan 1 - Dec 31, 1995

WAGES	Time	Amount		
M.A. Castellini	2 months	9466		
J.M. Castellini	3 months	7155		
B. Fadely	609 hours	8526		
MS Student (TBA)	634 hours	7291		
TOTAL WAGES			32438	
LEAVE				
M.A. Castellini		1902		
J.M. Castellini		1530		
TOTAL LEAVE			3432	
BENEFITS				
M.A. Castellini		3330		
J.M. Castellini		3534		
TOTAL BENEFITS			6864	
TOTAL SALARIES				42734
TRAVEL				
3 RT airfare/yr FBKS/Anchorage			1125	
EVOS workshop per diem/Anchorage B. Fadely 4 days @ $111			444	
Sample collection from ADF&G per diem/Anchorage B. Fadely 7 days @ $170			1190	
TOTAL TRAVEL				2759
SERVICES				
Bomb calorimetry (175 @ $20)			3500	
Phone			700	
Postage			400	
Cargo shipping			1000	
TOTAL SERVICES				5600

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COMMODITIES			
Organic solvents (lipid extraction)	500		
Soxhlet glassware (5 @ $225)	1125		
Extraction expendables	400		
Freezer inventory supplies	500		
Computer supplies	1000		
Density supplies	300		
TOTAL COMMODITIES		3825	
EQUIPMENT			
Sample shipper	1000		
Soxhlet heater	1025		
Shipping costs for above items	300		
TOTAL EQUIPMENT		2325	
STUDENT AID			
Master student - 2 semesters	2530		
TOTAL STUDENT AID		2530	
TOTAL DIRECT		59773	
INDIRECT			
(42.2% minus equipment and tuition)		23175	
TOTAL REQUESTED			82948

APPENDIX A SFOS 94-186

The following pages are the text of our response to the Chief Scientist in regards to scientific questions associated with this proposal. Budgetary considerations at that time have been incorporated into the current DPD.

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October 17, 1994

Dr. Bob Spiese
Chief Scientist
EVOS

REF: EVOS 95 proposal # 95117BAA

Dear Dr. Spiese:

We have received your comments and questions concerning our proposal # 95117BAA entitled *Harbor seals and EVOS: Blubber and lipids as indices of food limitation.* Basically, this proposal is to examine the blubber characteristics of harbor seals within and without the EVOS region and to examine historical samples compared to contemporary blubber samples. In the enclosed response, we have tried to address the questions that you have mentioned and have made some suggestions for budgetary considerations in light of our other much larger proposal (95001). In essence, 95117 is a daughter proposal relative to 95001 since we have not included any field component or logistics in the blubber proposal and would have to utilize the field work of 95001 to obtain contemporary samples.

We are providing this response so that you can use the information for your recommendations to Jim Ayers on the various proposals. We realize that final budgetary considerations would have to be conducted between our UAF business office and the Trustee Council, but we offer our suggestions here as to the directions such discussions could follow.

Sincerely,

Dr. M.A. Castellini
Institute of Marine Science
University of Alaska
Fairbanks, AK 99775-1080

cc: Molly McCammon

APPENDIX A SFOS 94-186

Review comments dated 9/2/94 by Bob Spiese, chief scientist.

Scientific questions:
1. Quality of historical samples. Have they been properly stored to allow these assays?
2. Possibility that quality of blubber may vary by season of collection, sex of animal, etc.
3. Blubber variation at different body sites.

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Scientific questions:

1. Quality of historical samples.

This is the most problematic issue for the historical work, although it is not an issue for the contemporary samples collected within and outside the EVOS region. We have gone to the holding facility for these samples in Anchorage and talked to the staff who stored the samples. Apparently, the samples were collected for contaminant analysis and wrapped in clean aluminum foil for preservation and then frozen and stored at -20°C. The most important questions are whether or not the samples have dehydrated or oxidized since they were collected. Clearly, dehydration would impact the water content and density analysis, but should not directed alter the lipid analysis or bomb calorimetry since samples are freeze dried for that work regardless. However, the interpretation back to wet weight would be problematic. From control samples we can easily determine what the wet weight/dry weight ratios for blubber should be and it will be a straightforward matter to determine by visual inspection and by water analysis to assess dehydration in the old samples.

If some of the samples are dehydrated, then they can only be used for the % lipid/dry weight and calories/dry weight analysis and then be compared to current samples using the same analysis. In fact, it might be most valid to just assume dehydration and to base all results on a /dry weight basis.

Perhaps the most important point here is that seal blubber is less than 3% water and the balance mainly lipid (Ref 1). Thus, even if there was dehydration, it would not have a major impact on the results.

Another major concern is whether or not self-oxidation of the samples would alter the lipid content. We know that oxidation during storage would ruin lipid and fatty acid identification and we are not attempting these assays. However, oxidation of the lipid chains would reduce the bomb calorimetry values by a percentage of chain length that has been lost. Our procedure here would be to avoid samples that are clearly massively oxidized (freezer burned).

We have been in contact with several scientists who work in this field and have received a variety of opinions. Dr. Graham Worthy from Texas A&M, who has worked in the field of pinniped energetics, feels that aluminum foil samples would be acceptable for % lipid and bomb calorimetry work, but that dehydration would be our biggest problem. Dr. John French, a food biochemist from UAF, FITC, feels that oxidation and dehydration would be a problem, but that bomb calorimetry could be used for gross measurements. We have contacted Dr. Christina Lockyer, who (Ref 2) is an expert on whale blubber. She was worried about the long time storage at -20°C and about oxidation and dehydration, but felt

that if sub-samples could be collected from within the major samples away from the edges, that these problems could be minimized.

Summary: Dehydration and oxidation of the samples could be a problem. Dehydration can be surmounted by expressing sample results on a /dry weight basis. Oxidation might not be a problem for gross total calorie values, but clearly oxidized samples would have to be avoided.

Conclusion: Samples will have to be closely inspected and ones suspected of clear oxidation avoided. Values for density and water content will probably be compromised, but since seal blubber is essentially water free, it is unknown if this will be a significant problem.

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2. Possibility of blubber varying by sampling date, sex, etc.

We are aware of this and in fact consider this an interesting question to model instead of a problem. We are currently working in close collaboration with ADF&G on harbor seal body condition indices and age, sex and time of year are all parameters that we use in the interpretation of our research. These data were all collected along with the historical blubber samples and are all collected with current samples. This type of analysis has proved very powerful in noting current body condition values for males vs females. We do not think that this is a negative problem and in fact use the data to better understand our indices.

Conclusion: Variance is part of the model and is currently used in our efforts to look at body condition of harbor seals.

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3. Variance in homogeneity of blubber by sampling site on the body.

This is a major concern for whale blubber (Ref 2) but is not for phocid blubber (Refs 1,3). Phocid blubber is remarkably homogenous by both location on the body and depth of sampling in terms of lipid content. This should not be a significant problem for this study.

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References:

1) Beck, G.G., T.G. Smith and M.O. Hammill. 1993. Evaluation of body condition in the northwest Atlantic harp seal (*Phoca groenlandica*). Can. J. Fish. Aquat. Sci. 50:1372-1381.

2) Lockyer, C.H., McConnell, L.C. and T.D. Waters. 1984. Biochemical composition of fin whale blubber. Can. J. Zool. 62:2553-2562.

3) Jangaard, P.M. and P.J. Ke. 1974. Principal fatty acids of depot fat and milk lipids from harp seal and hooded seal. J. Fish. Res. Board Can. 25:2419-2426.

Appendix B: Castellini CV

NAME: Michael Angelo Castellini
EDUCATION:
B.A. Biology 1975 University of California, San Diego
PhD. Marine Biology 1981 Scripps Institution of Oceanography

EMPLOYMENT RECORD:
1976-80 Research assistant, University of California, San Diego
1981 Postdoctoral research fellow, Scripps Institution of Oceanography
1982 NATO postdoctoral fellow, Univ. of British Columbia, Vancouver
1983-86 NIH postdoctoral fellow, University of British Columbia, Vancouver
1986-87 Visiting assistant research physiologist, UC San Diego
1987 Adjunct lecturer, Department of Biology, UC San Diego
1987-89 Assistant research biologist, University of California, Santa Cruz
1990-92 Research associate in Marine Sciences, Univ Calif Santa Cruz
1989-93 Assistant professor marine biology, Univ. of Alaska, Fairbanks
1993- Associate professor marine biology, Univ. of Alaska, Fairbanks

Publications relevant to proposal

Castellini, M.A., D.P. Costa and A.C. Huntley. Fatty acid metabolism in fasting elephant seal pups. Journal of Comparative Physiology B. 157(4):445-449. 1987.

Castellini, M.A., R.W. Davis and G.L. Kooyman. Blood chemistry regulation during repetitive diving in Weddell seals. Physiological Zoology. 61(5):379-386. 1988.

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

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Castellini, M.A. and L.D. Rea. The biochemistry of natural fasting at its limits. Experientia. 48: 575-582. 1992.

Castellini, M. and D. Calkins. Mass estimates using body morphology in Steller sea lions. Marine Mammal Science. 9: 48-54. 1993.

Castellini, M.A., R.W. Davis, T.R. Loughlin and T.M. Williams. Blood chemistries and body condition of Steller sea lion pups at Marmot Island, Alaska. Marine Mammal Science. 2: 202-208. 1993.

EXXON VALDEZ [illegible] E COUNCIL
1994 Federal Fiscal Y[illegible] roject Budget
October 1, 1993 - September 30, 1994

Project Description: 95117-BAA Harbor Seals and EVOS: Blubber and Lipids as Indices of Food Limitation

Budget Category:	1994 Project No. Authorized FFY 94	'94 Report/ '95 Interim* FFY 95	Remaining Cost** FFY 95	Total FFY 95	FFY 96	Comment
Personnal		$0.0	$39.3	$39.3	$35.9	
Travel		$0.0	$5.1	$5.1	$3.1	
Contractual		$0.0	$7.7	$7.7	$7.7	
Commodities		$0.0	$3.5	$3.5	$2.4	
Equipment		$0.0	$12.3	$12.3	$0.0	
Indirect Costs (41.8% minus equipment and t		$0.0	$0.0	$20.1	$19.5	
Subtotal	$0.0	$0.0	$67.9	$88.0	$68.6	
General Administration		$0.0	$6.4	$6.4	$5.9	
Project Total	$0.0	$0.0	$74.3	$94.4	$74.5	
Full-time Equivalents (FTE)		0.0	1.0	1.0		

Dollar amounts are shown in thousands of dollars.

Budget Year Proposed Personnel: Position Description	Reprt/Intrm Months	Reprt/Intrm Cost	Remaining Months	Remaining Cost
Program Manager, NOAA			1.0	$5.0
Principal Investigator			2.0	$9.5
2 Research Associates			9.0	$14.5
Leave Accrual				$3.4
Benefits				$6.9
Personnel Total	0.0	$0.0	12.0	$39.3

NEPA Cost: $0.0

*Oct 1, 1994 - Dec 31, 1994
**Jan 1, 1995 - Sep 30, 1995

8/01/94

1995

Page 1 of 3

Project Number: 95117-BAA
Project Title: Harbor Seal Blubber and Lipids
Agency: Institute of Marine Science, UAF

FORM 2A
PROJECT
DETAIL

Printed: 9/12/94 12:13 PM

☑018/020
☑002

EXXON VALDEZ TRUSTEE COUNCIL
1994 Federal Fiscal Year Project Budget
October 1, 1993 - September 30, 1994

		Reprt/Intrm	Remaining
Travel:			
Dpt			
Drm	4RT Fairbanks/Anchorage @ $375		$1.5
	EVOS Workshop - Per diem in Anchorage (14 days @ $170/days)		$2.4
	Sample Collection - per diem in Anchorage (7 days @ $170/day)		$1.2
	Travel Total	$0.0	$5.1
Contractual:			
Dept			
Intrm	Bomb Calorimetry (175 samples @ $20)		$3.5
	Phone		$0.5
	Postage		$0.2
	Cargo Shipping		$1.0
	Student Aid, 1 semester		$2.5
	Contractual Total	$0.0	$7.7

7/14/97

1995

Project Number: 95117-BAA
Project Title: Harbor Seal Blubber and Lipids
Agency: Institute of Marine Science, UAF

FORM 2A PROJECT DETAIL

Commodities:		Reprt/Intrm	aining

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Rept Intrm	Organic solvents (lipid extraction)		$0.5
	Soxhlet glassware (5 @ $225)		$1.1
	Extraction expendables		$0.4
	Freezer inventory supplies		$0.5
	Computer supplies		$1.0
	Commodities Total	**$0.0**	**$3.5**
Equipment:			
Rept Intrm	Sample shipper		$1.0
	Soxhlet heater		$1.0
	Density meter		$10.0
	Shipping cost for above items		$0.3
	Equipment Total	**$0.0**	**$12.3**

01/14/93

1995

Project Number: 95117-BAA
Project Title: Harbor Seals Blubber and Lipids
Agency: Institute of Marine Science, UAF

FORM 2B PROJECT DETAIL

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95121

FATTY ACID SIGNATURES OF SELECTED FORAGE FISH SPECIES IN PRINCE WILLIAM SOUND

DPD NOT YET RECEIVED

BY RESTORATION OFFICE

Habitat Protection and Acquisition Support

Project Number:	95126
Restoration Category:	Habitat Protection (continuation of 94126)
Proposed By:	Habitat Work Group
Lead Trustee Agency:	ADNR
Cooperating Agencies:	ADFG, DOI, USFS
Cost FY 95:	$1,099,500
Cost FY 96:	Unknown
Total Cost:	Unknown
Duration:	Ongoing
Geographic Area:	Prince William Sound, Kenai Peninsula, Alaska Peninsula, and Kodiak Archipelago
Injured Resource/Service:	Multiple resources

INTRODUCTION

This project is designed to support habitat protection activities of the Trustee Council and is a continuation of the Comprehensive Habitat Protection Process. These activities include evaluations by the Habitat Work Group (HWG), appraisals, title searches, hazardous materials surveys and other efforts necessary for the Trustee Council to achieve habitat protection objectives. In 1993 the Restoration Team, Habitat Protection Work Group conducted a survey and assessment of selected large parcels of private land (>1000 acres) within the oil spill zone. The lands were mapped, scored and ranked to determine the restoration value of these areas to injured resources and services and the benefits that could be achieved through habitat protection. Successful negotiations were conducted with owners of lands within Kachemak Bay State Park and on northern Afognak Island resulting in the purchase of the park inholdings and in the establishment of the Afognak Island State Park.

During 1994, technical support continues to be provided to the Executive Director, negotiators and appraisers engaged in negotiations with landowners. Parcel boundaries were refined by HWG in order to capture the key habitats within the smallest possible land area. Packages of ranked parcels, selected either by the negotiators or by HWG, as logical negotiation units, were evaluated and ranked. The results were provided to the negotiators and to the Executive

Director. Secondary evaluations were conducted on acquisition proposals wherein less than fee simple interests were negotiated. Additional large parcels were identified for site surveys, evaluation and ranking which will take place during the summer field season. Presentation materials including numerous maps were produced and used by the Executive Director and negotiators in presentations to the Trustee Council and the public.

In 1994, a method was developed for nominating, processing, evaluating and ranking parcels of private land less than 1000 acres, i.e., *The Small Parcel Process*. Responses to the solicitation for nominations of small parcels are currently being processed and evaluated.

NEED FOR THE PROJECT

The objective of habitat protection is to identify and protect essential wildlife and fisheries habitats and associated services and to prevent further environmental damage to resources injured by the *Exxon Valdez* oil spill. Nineteen resources and services injured by the spill are linked to protection of upland and nearshore habitats (See Project Design). Protection of lands containing these habitats prevents additional injury to resources and services and natural support systems while recovery is taking place. Active negotiations with landowners for packages of ranked parcels are currently taking place and anticipated to continue into the Fall. Evaluations, starting with field surveys, of large and small parcels submitted this Spring will also continue into the Fall. This project provides support for HWG to provide technical support to the negotiators and the Executive Director and to conduct these additional evaluations.

PROJECT DESIGN

A. Objectives

Habitat protection and acquisition is designed to protect lands linked to resources and services that were injured by the *Exxon Valdez* oil spill. Protection of these lands prevents additional injury to living resources and habitats, services and natural support systems while recovery is taking place. Habitat protection addresses cases where existing regulations affecting private land use are inadequate to protect essential habitats of recovering resources and services.

In situations where natural recovery is slow to occur or where direct restoration is neither technically feasible or cost effective, other measures need to be considered to mitigate injury. These may include replacement of injured resources and services with those that are equivalent The affected injured resources and associated services are listed below. Habitat protection objectives and benefits for each of these resources and services would differ depending on the particular parcel and the options acquired, however, general objectives and benefits are outlined below.

1. Pink salmon, sockeye salmon, cutthroat trout, Dolly varden, herring: ensure maintenance of adequate water quality, riparian habitat and intertidal habitat for spawning and rearing.

2. Bald eagle: ensure maintenance of adequate nesting habitat and reduce disturbance in feeding and roosting areas.

3. Black oystercatcher: reduce disturbance to feeding and nesting sites.

4. Common murre: reduce disturbance in nearshore feeding areas and near nesting colonies.

5. Harbor seal and sea otters: reduce disturbance at haul-out sites, pupping sites, and in nearshore feeding areas.

6. Harlequin duck: ensure maintenance of adequate riparian habitat for nesting and brood rearing, and reduce disturbance to nearshore feeding, molting, and brood-rearing habitats.

7. Intertidal/subtidal biota: maintain water quality along shoreline and reduce disturbance in nearshore areas.

8. Marbled murrelet: ensure maintenance of adequate nesting habitat and reduce disturbance to nearshore feeding and broodrearing habitats.

9. River otter: ensure maintenance of adequate riparian and shoreline habitats for feeding and denning.

10. Recreation: Maintain or enhance public access for recreational opportunities, reduce disturbances that would create visual impacts.

11. Wilderness: Maintain wilderness qualities, reduce impacts to wilderness qualities.

13. Cultural resources: Maintain or reduce disturbance to cultural resource sites.

14. Subsistence: Ensure subsistence opportunities in known harvest areas.

B. Methods

The *Habitat Protection and Acquisition Process* is the method for acquiring lands or partial interests in lands that contain habitats linked to resources and/or services injured by the oil spill. Protection tools that will be considered for use by the Trustee Council include: fee acquisition, conservation easements, acquisition of partial interests, cooperative management agreements, and others. Following purchase, acquired parcels will be managed by the appropriate resource agency in a manner that is consistent with the restoration of the affected

resources and/or services. The Trustee Council will decide which agency will manage the land or may create a new management authority.

Funds from this project will be used to acquire full title or partial interests in lands, subject to approval by the Trustee Council, that contain habitats/sites linked to resources and services that were injured by the *Exxon Valdez* oil spill. Acquisition of lands or interests in lands will be accomplished according to accepted realty principles and practices. All acquisitions will require title evidence, appraisals of fair market value, litigation reports, hazardous substances surveys, legal review of title, and negotiations. Some acquisitions may require land surveys and additional ecological and mineral surveys.

This project provides for these services and any other additional services which may be necessary to enable the Trustee Council to close final purchase agreements for habitat protection on parcels under negotiation. These services may be secured either in house or contractually depending upon agency regulations and staffing requirements.

The HWG will provide support to negotiators by conducting secondary evaluations and providing primary evaluations for any newly identified parcels which the Trustee Council may wish to consider. Evaluation formats developed by the group will be used, taking into account existing data and data obtained by HWG in 1993 and 1994. Data gaps will be filled to the maximum extent possible and practicable. GIS work will be needed to sort, manage, and analyze data and to map resource information where appropriate and in response to negotiator requests.

Site reconnaissance visits and post-acquisition management surveys will be determined on a site specific basis. Travel will be via air and boat charters.

C. Schedule

Support for negotiations and appraisals, for both large and small parcels, is dependent upon the progress of negotiations with landowners and the needs of the negotiators. Negotiations are currently taking place with large parcel landowners. Evaluation and ranking of small parcels will occur during this summer and fall. It is anticipated that negotiations for small parcels will commence in January, 1995. Field surveys of recently nominated large parcels will occur this summer.

D. Technical Support

The Habitat Work Group will provide technical support to agencies during their negotiations for large and small parcels. Alaska Department of Natural Resources and the appropriate federal agencies will provide support for title searches, appraisals, and hazardous substances surveys. Maps will be produced by HWG staff and by ADNR/LRIS.

E. Location

The analysis will cover all selected lands within the oil spill zone. Lands are located within Prince William Sound, Kenai Peninsula, Kodiak/Afognak Archipelago and on the Alaska Peninsula.

PROJECT IMPLEMENTATION

The proposed project is a continuation of 94126, habitat protection projects that were started in 1992 by the Restoration Planning Work Group and outlined in concept in Volume I of the *Restoration Framework*. Implementation of this project would be by the negotiating agencies and the Habitat Work Group. This group includes four members representing ADNR, USFS, ADFG and USFWS. The HWG includes three individuals who have been working on the spill since early 1989 and who participated in the genesis and development of habitat protection as a restoration strategy. All four members are authors of the *Comprehensive Habitat Protection Process* report and participated in the development of the *Small Parcel Process*.

The multicriteria evaluation methods used in *Imminent Threat Process*, the *Large Parcel Element* and the *Small Parcel Element* of the *Comprehensive Habitat Protection Process* utilize explicit subjective values and judgments made by a group of biologists/resource managers. This collective best professional judgment can vary as a function of the subjective weights applied by different individuals. Consequently, in order to maintain a consistent collective bias in these continuing evaluations, the same team should continue the effort.

It is appropriate that ADNR continue their technical support for mapping and GIS because of their demonstrated expertise, familiarity with the project and project participants and the in-house collection of relevant digital databases.

COORDINATION OF INTEGRATED RESEARCH EFFORT

All habitat protection efforts including this project are dependent upon the results of on-going research and monitoring projects. For example, the Large Parcel Element used information from the anadromous fish stream catalog, colonial seabird catalog, bald eagle nesting maps, and data from Trustee Council funded studies on black oystercatchers, marbled murrelets and pigeon guillemots.

FY 95 BUDGET ($K)

Personnel	363.5
Travel	51.8
Contractual	572.1
Commodities	16.2
Equipment	3.0
Subtotal	1006.6
Gen. Admin.	92.9
Total	1099.5

Project # 95127 (revised)

9/15

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
SUBSISTENCE RESTORATION PROJECT DESCRIPTION

Project Title: Tatitlek Coho Salmon Release Program
Project Leader: Tatitlek Village IRA Council
Lead Agency: Alaska Department of Fish & Game
Cost of Project: FY 95 $39.0
Start-Up/ Completion Dates: January, 1995 - June 1997
Project Duration: Ongoing
Geographic Area: Prince William Sound, Tatitlek Narrows
Contact Person: Gary P. Kompkoff, President
Tatitlek Village IRA Council
P.O. Box 171
Tatitlek, AK. 99677
Phone: (907) 325-2311
Fax: (907) 325-2298

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
RESTORATION PROJECT DESCRIPTION

Project Title: Tatitlek Coho Salmon Release Program

B. INTRODUCTION

Subsistence as well as commercial and sport fisheries were severely disrupted by the oil spill. This project is intended to enhance subsistence resources by permitted releases of coho salmon at designated locations near the Native Village of Tatitlek in order to provide a long term subsistence resource for the residents of Tatitlek. Additionally, the coho salmon made available through this project can serve temporarily as a partial replacement for other subsistence resources, such as harbor seals, which were injured by the spill. Valdez Fisheries Development Corporation presently maintains an enhancement project near the Village of Tatitlek, at Boulder Bay. This project would ensure the continuation of that project.

C. NEED FOR THE PROJECT

Subsistence harvests of all salmon resources have declined considerably since the oil spill, and continue to be affected by it. This project would enhance the recovery of the salmon resources and provide a means for lessening the impacts of continued harvests on other subsistence resources injured by the spill, such as harbor seals.

D. PROJECT DESIGN

I. Objectives:

-provide for the continued production of 50,000 coho salmon smolt at the Solomon Gulch Hatchery in Valdez for transport and release near the Native Village of Tatitlek (Boulder Bay).
-hold and feed coho salmon smolt at net pens at the release site for two weeks prior to release.
-harvest approximately 2,000 coho salmon annually upon their return to imprinting site.

II. Methods:

-Coho salmon will be taken from an ADF&G approved site for incubation and care and raised to smolt stage at the Solomon Gulch Hatchery in Valdez
-Smolt will be transported by boat in designated imprinting sites
-Smolt will be held and fed at net pens for approximately two weeks before releasing to improve survival rates and imprinting.

III. Schedule:

January 1995	Plans reviewed by the NEPA Process, salmon hatcheries
June, 1995	Eggs taken from salmon near the Native Village of Tatitlek
June, 1995	First salmon smolt transported, penned, fed and released
June, 1996	First adult salmon returns of coho salmon
June, 1997	First complete complement of all coho salmon age groups.

Each year smolts will he released in late May or early June.

IV. Technical Support:

Utilization of experience and technical support of Alaska Department of Fish & Fame is necessary for this project. Valdez Fisheries Development Corporation expertise will also be utilized.

V. Location:

The project will occur near the Native Village of Tatitlek. Salmon will be raised to smolt stage at the Solomon Gulch Hatchery at Valdez and released, after imprinting at Boulder Bay.

E. PROJECT IMPLEMENTATION

Valdez Fisheries Development Corporation, who have extensive experience in salmon enhancement activities, will continue their present enhancement of coho salmon near the village. ADF&G expertise will also be utilized.

F. COORDINATION OF INTEGRATED RESEARCH EFFORT

This project is intended to provide funds for the continuance of a salmon enhancement project presently undertaken by Valdez Fisheries Development Corporation and could be accomplished in conjunction with a Sockeye Salmon Release Project being proposed by the Tatitlek Village IRA Council. Developing this subsistence resource will provide a partial replacement for other injured resources, such as harbor seals, until they recover. This supports the efforts of several other proposed projects, such as 95244 (Seal and Sea Otter Cooperative Harvest Assistance) and 95001 (Condition and Health of Harbor Seals).

G. PUBLIC PROCESS

Public meeting in the Native Village of Tatitlek have been held periodically by the Tatitlek Village IRA Council addressing the prioritizing of restoration work.

H. PERSONAL QUALIFICATIONS

Valdez Fisheries Development Corporation personnel leave much experience and expertise in this field, they would work in cooperation with ADF&G personnel in accomplishing the goals of this project.

I. Budget ($K)

ADF&G

Personnel	$2.5
Travel	0.0
Contractual	21.5
Capital Outlay	10.0
SUB-TOTAL	**34.0**
Gen. Administration	3.0
NEPA Compliance	2.0
PROJECT TOTAL	$39.0

Exxon Valdez Oil Spill Trustee Council
FY 95 Detailed Project Description
revised 3/17/95

Project Title: Nanwalek/Port Graham/Tatitlek Clam Restoration

Project Number: 95131

Lead Trustee Agency: Alaska Department of Fish & Game

Cooperating Agencies: Chugach Regional Resources Commission
Native Villages of Tatitlek, Nanwalek and Port Graham

Project Start-up/Completion Dates: March 1, 1995 - February 28, 2001

Expected Project Duration: Five Years

Cost of Project FY 95: $208.3

Cost of Project FY 96: $327.1

Cost of Project FY 97 and beyond: $995.0

Geographic Area: Port Graham/Nanwalek and Tatitlek areas

Project Leaders:

Patricia Brown-Schwalenberg Date
Executive Director, CRRC
4201 Tudor Centre Drive, Suite 211
Anchorage, AK 99508 tel 562-6647

David Daisy, Consultant Date
3936 Westwood Drive
Anchorage, AK 99517 tel 243-8544

Jeff Hetrick, Consultant Date
Box 7
Moose Pass, AK 99631 tel 288-3667

Agency Project Manager:

Joe Sullivan, Project Manager Date
Alaska Department of Fish & Game
333 Raspberry Road
Anchorage, AK 99518 tel 267-2213

A. INTRODUCTION

The purpose of this project is to establish populations of clams in areas that are readily accessible from the villages of Tatitlek, Nanwalek and Port Graham. These clams will be used as a source for subsistence food to replace the natural clam resource that has been lost or depleted.

Clams were once an important subsistence food in the Native villages of Tatitlek, Nanwalek and Port Graham as well as most other Native villages in the *Exxon Valdez* oil spill area. Clam populations in areas that are reasonably accessible to Tatitlek, Port Graham and Nanwalek have decreased to very low levels in recent years. Consequently, the role of clams in the subsistence diet in these villages has been greatly reduced. And, with a few exceptions, the role of clams in the subsistence diet of most Native villages in the oil spill area is a lot less than it was historically.

There are likely a number reasons why local clam populations are currently at low levels. Since clams are basically an unmanaged resource in the oil spill area, there are no quantifiable data available that could point to the actual circumstances that lead to the sharp reduction in these clam populations. However, there are events that likely played a major role. These include changes in beach configurations resulting from the 1964 earthquake, increasingly heavy sea otter predation, human over-harvest and the *Exxon Valdez* oil spill.

The oil spill impacted the wild clam populations and their importance as a subsistence food in two ways. First, many clam beds suffered from direct oiling. The impact of the oil on the clam beds in Windy Bay, for instance, destroyed one of the more important clam beds in the lower Kenai Peninsula. With the current timber harvesting operations soon to provide road access from Port Graham and Nanwalek to the Windy Bay area, the loss of the clam resource there had a major impact on these villages. Second, even though many clams weren't killed from the oil, they have a tendency to accumulate and concentrate the toxic contaminants from non-lethal amounts of oil. This has badly eroded the confidence of the villagers in the healthfulness of the remaining wild clam populations as a subsistence food.

In order to reestablish local clam populations as a subsistence resource for the Tatitlek, Nanwalek and Port Graham villages a program needs to be developed to enhance the depleted stocks and the replace damaged ones. Over the past ten years the nursery systems and field growout technologies have sufficiently evolved to make clam enhancement and reseeding efforts feasible. This technology can be readily applied to increasing the clam resource near the villages to determine which applications would be best suited for the task at hand.

One of the main problems with clam enhancement in Alaska has been the availability of a sufficient supply of seedstock. Because of the potential for transporting disease into the state, seed stock for all other bivalve shellfish species except oysters must be obtained from in-state sources. Collecting seed from wild spawn is a relatively easy task with mussels, but nearly

impossible to do with other species of interest such as clams and scallops. To resolve this problem the Qutekcak Native Tribe of Seward is developing a shellfish hatchery that is working to develop the technology for producing clam seedstock and is currently working on the littleneck clam (*Protothaca staminea)*. This clam has never before been produced in a hatchery. However, the hatchery staff was able to bring small batches of littleneck clams through the most critical stages of development and it seems certain that the techniques for successfully producing littleneck clam seedstock in the hatchery can be developed. In addition to littleneck clams the hatchery has plans to do seedstock development work on cockles (*Clinocardium nuttalli*) and is considering butter clams (*Saxidomus giganteus*). The Qutekcak hatchery is very interested in becoming involved in a program that revitalizes the clam resources near Native villages.

With an Alaskan shellfish hatchery and nursery complex able and willing to produce seedstock for this program and the growout technology well understood, the time is right to begin the process of restoring the clam resources near Native villages in the oil spill area.

B. PROJECT DESCRIPTION

The proposed project will be a cooperative effort between ADFG and the Chugach Regional Resource Commission (CRRC). Participants are outlined in personnel section and appendices.

1. Resources and/or Associated Services

Local shellfish populations, especially clams have been severely reduced as a subsistence food source for Native villages. Part of the reduced use is a loss of confidence in the safety of consuming shellfish as a result of the Exxon Valdez Oil Spill. In addition, local shellfish populations have been greatly reduced as result of hydrocarbon toxicity, sea otter predation, human overharvest and beach changes from the 1964 earthquake.

2. Relation to Other Damage Assessment/Restoration Work

The project (95131) will complement Fish/Shellfish Study 13 Effects of Hydrocarbons on Bivalves conducted under State/Federal Natural Resource Damage Assessment. That project studied shellfish populations throughout the oil impacted area and conducted growth and mortality studies, collected age and size information and examined reciprocal transplants from oiled and control beaches. It was determined that littleneck clam populations were adversely affected through increased mortality and reduced growth rates.

The Clam Restoration Project (95131) will provide future resources for subsistence harvest and will be valuable for Projects 95279(Subsistence Restoration Projects Food Safety) and 95052 (Community Interaction/ Traditional Knowledge) to develop harvest plans. Information from 95052 can be used in the community survey, population assessment described in Objective 3.

3. Objectives

Objective 1. Hatchery Processes- Develop and improve hatchery techniques for the littleneck clam (*Protothaca staminea*), the cockle (*Clinocardium nutalli*) and, if hatchery resources allow, the butter clam (*Saxidomus gigantus*). Produce a 5mm seed in the hatchery within 19 weeks after spawning.

Objective 2. Nursery- Develop techniques to grow 5mm seed from the hatchery to an outplanting size of 10mm - 15mm within 12 weeks.. Review needs and possible alternatives of substrate for nursery and growout.

Objective 3. Growout - describe current populations through interviews and resource assessments. Locate sites and develop growout techniques and evaluate the efficacy of proposed methods. Develop a permanent subsistence beach.

4. Methods

SECTION 1. HATCHERY

The Qutekcak Shellfish Hatchery has been in operation since October 1993. During this time the hatchery was designed and assembled and has evolved into a production scale operation. The staff has successfully set larvae of the Pacific oyster *Crossastrea gigas* and raised them to 15mm for the aquatic farm industry. In addition, the hatchery has successfully conditioned, spawned, set and raised the native littleneck *Protothaca staminea* to 10mm and will attempt to overwinter the clams both in the hatchery and on local beaches. This project will also attempt to develop broodstock and produce cockle *Clinocardium nutalli* seed, and, if possible, butter clam *Clinocardium nutalli* seed.

The systems and techniques that will be used to produce seed for growout under this project are outlined below.

A. Water system

The water source for Qutekcak Shellfish Hatchery is from a 60 meter deep intake which brings up nutrient rich seawater void of many organisms and is well suited for shellfish culture. The hatchery has two head tanks with electric heaters, an on demand heater, bag filters, 2mm and 10mm cartridge filters and ultraviolet light for additional disinfection. Water from shellfish held in quarantine is chlorinated before discharge into Resurrection Bay.

B. Algae

Hatchery production of larval and juvenile bivalves requires a reliable supply of high quality algae. The Qutekcak Shellfish Hatchery (QSH) cultures four species: *Chaetoceros calcitrans, Thalassiosira psuedonana, Tetraselmis suecica and Tahitian isochrysis.*

The techniques for raising these species are well documented. Algae is cultured in three phases 1) stock cultures, 2) 20 liter carboys, and 3) 200 liter Kalwal tanks.

Water for stock cultures and for inoculating carboys is sterilized in a microwave for several minutes. Stock cultures are maintained under strict conditions and are handled only under a laboratory hood. The seawater is inoculated with nutrients such as nitrogen, phosphorous, vitamins and trace minerals. Light intensity and wavelengths are controlled for each species to manipulate growth depending on the need for each. The pH is adjusted with carbon dioxide to maintain the optimum range of 7.8 to 8.4.

Algae cultures go through three phases of growth; lag phase, exponential phase and stationary phase. Algae in the exponential phase is of the highest quality for inoculating additional algae cultures and for clam nutrition.

QSH uses batch culture techniques for producing algae. 20 liter carboys are used to inoculate 200 liter Kalwal tanks for production feeding. Water used for the Kalwal tanks is chlorinated (2-5ppm) for 24 hours and deactivated with sodium thiosulfate. Generally, it takes 4-6 days for a culture to reach its maximum density and several more days to harvest the culture for feed. Several species are always in production to insure all nutrient requirements are met for the juvenile shellfish under culture.

The hatchery staff also keeps several liters of preserved *Chaetacerous* on hand to supplement feeding of setting larvae and as a back up in case cultures become contaminated.

C. Broodstock Conditioning

The gonadal development of shellfish can be controlled by adjusting feeding rates and temperatures. When properly conditioned, shellfish can be induced to spawn by manipulating the temperature.

At QSH broodstock are conditioned in static 60 liter tanks. Water temperature is controlled through aquarium heaters and changed daily. During the spawning season the clams are held at 16° C - 18° C. During the winter months the temperature is lowered to 8° C - 10° C. Broodstock are held in family units of ten in mesh bags which help keep pressure on the hinges. Families are marked to record the spawning history and track the development of the progeny. Broodstock are fed daily to maintain body weight and when ready to spawn are fed to saturation. Prior to the spawning cycle temperatures are raised to accelerate gametogenesis. Gamete development is tracked by dissecting broodstock to assess development. Gamete quality has been the most important factor at QSH in determining the success at setting.

D. Spawning and Larvae Culture

Spawning episodes have occurred at regular cycles throughout the production year. To induce spawning, clams are removed from the broodstock tanks and allowed to dry for several hours. They are then placed in water baths at 22° C -24° C. Hatchery personnel watch for the

appearance of spawn in the spawning tank. This process is often repeated several times until the clams are induced to spawn.

When the shellfish have finished spawning the water is filtered and the fertilized eggs placed in larval culture tanks. Notations are made identifying the families and if possible the individuals involved in spawning.

The larvae are fed several times a day at 50,000 cells/ml. The development of the larvae are tracked daily. After almost four weeks of development, the larvae reach 240 microns and are ready to set.

E. Setting

The setting process is slow with littleneck clams. One of the most important variables for successful setting appears to be the time in which the clams are placed from the larvae tanks to the setting system. When the majority of the larvae are sessile and appear to be pedal feeding they are transferred to the airlift system on the down welling mode. Ground oyster shell sifted at 150mm is placed on a 120mm nitex screen. Up to 2 million larvae are placed on the 1500cm^2 screen in a 130 liter airlift system. The clams are fed 70,000 cells/ml three times daily and finish the setting process in approximately seven days.

F. Primary Culture

The airlift system is also used for primary culture to raise the clams to 2+mm. The flow is alternated between the upwell and downwell mode. Although the clams feed better on the downwell mode, elimination of metabolites are flushed during the upwell cycle. Clams are fed to saturation by feeding enough algae so that the clams "clear" the water within two hours. The amount of feed needed increases to 150,000 cells/ml.

G. Secondary Culture

After almost six weeks of culture the clams are sorted through screens. Those that are 2mm or greater are transferred to a "Heath Tray" incubation system. The vertical incubator allows water to flow through a stack of ten trays of shellfish. The water is recirculated through the stack to maintain water temperature and changed daily to remove metabolites. Feed is added to a headbox and the clams are fed to saturation. 200,000 clams require up to 40 liters of algae at densities of 3 million cells/ ml.

Growth rates of the clams are highly variable requiring constant sorting to insure that smaller clams are not out competed by their cohorts. Size groups are maintained in different trays of the heath systems.

H. Hatchery Production Summary

A. Broodstock Conditioning	8 weeks
B. Spawning- Larvae culture	4 weeks
C. Setting	1 week
D. Primary Culture to 2mm	6 weeks
E. Secondary Culture to 5mm	8 weeks

The hatchery production schedule has been determined from 1994 data. Hatchery personnel believe the time the clams spend in the primary and secondary systems can be reduced significantly if more feed were available. The 1995 production plan calls for tripling the algae capacity.

SECTION 2. NURSERY SYSTEM

A. Algae Production Pond

The QSH utilizes a 1 million liter pond to culture algae for its nursery. The 10m by 10m pond is 3 meters at it's deepest point. Raw seawater from a 60 meter deep intake is pumped into the pond to bring in nutrient rich water. The flow is controlled to allow for adequate flushing yet maintain the ambient air temperature. An air pump is used to bubble and circulate water in the pond for adequate mixing and prohibit stratification. Water temperature and salinity are monitored daily and nitrogen phosphorous and silica levels checked weekly. The pond is fertilized daily in an attempt to keep nitrate levels at 3.0 ppm to 3.5 ppm and phosphate at 1.2 ppm to 1.5 ppm. Equally important is to keep the ratio at 7N:P.

The flora of the pond changes seasonally with *Chatecerous* dominating in the early months of the summer and pennate diatoms taking over after July. Natural cell densities of Resurrection Bay are 5,000 cells/ml while the pond is manipulated to produce 250,000 cells/ml for feeding the shellfish.

Two 8,000 liter tanks have been installed at the nursery complex to produce mass volumes of axenic cultures outdoors. Preliminary results in 1994 were encouraging and these tanks may be an additional source of large volumes of algae.

B. Nursery Phase

Clams from the hatchery that are 5mm or greater are transferred to shallow raceways adjacent to the pond. Water is pumped into the raceways and flows passively through the clam upwell

tanks. The clams are seeded at 50 cm^2 initially on 1mm vexar screen. The screens are cleaned and the clams stirred several times a week. Experimentation is ongoing to determine which system and substrate perform the best.

Many species of clams require substrate to support their hinges when they reach a certain size. To date, this has not been noticed in the native littlenecks, however this will be closely observed and if necessary substrate both natural and artificial will need to be employed.

SECTION 3. GROWOUT

A. Baseline Data

1. Historical Information

It will be necessary to do baseline research on the local beaches prior to planting the clams for growout. Local residents, especially elders, will be canvassed to gather information on old and existing beaches near the villages. An individual, most likely a team leader, from each village will be selected to be the focal point for collecting information.

Staff at the University of Alaska, biologists from ADFG and project leaders from pertinent EVOS research projects will be interviewed and a literature search conducted to see what information is available on species composition and local abundance of shellfish. This will include work conducted by EVOS funded project Fish/Shellfish 13.

2. Field Surveys

Three person field survey crews will be selected and trained from each of the villages of Tatitlek and Port Graham/Nanwalek. ADFG will assist with the sampling design and statistical analysis.

1. For each area surveyed the following information will be gathered:
    a. type and abundance of benthic organism both mobile and sedentary will be gathered using the random plot sampling method.

    b. Composition of substrate will be evaluated using the graduated sieve method.

2. From the surveys an estimate will be made on the abundance of clams that are currently in the area and a profile developed of what constitutes a good clam growing area such as substrate composition, exposure, slope, tide height and other factors.

B. Growout Techniques

Several methods for growout will be tested and analyzed. These include seeding candidate intertidal areas, adapted hanging culture techniques and tray culture. Seeding and hanging culture methods will be explored to determine how suitable they would be in developing clam resources for subsistence use. Although tray culture may prove to be a viable method for producing harvestable quantities of clams, it initially will be used to evaluate various substrate compositions to determine which mixtures are best for seeding clams.

1. Seeding Intertidal Areas

Seeding beaches is the most common and probably least expensive method for developing a clam resource. For developing a subsistence clam resource near the Native villages beach seeding appears to the most reasonable approach.

Because of the predation problems clams encounter, from starfish and crabs on seed to sea otters on large sized clams, protecting seeded beds against predators is a must. The nylon or plastic screening that has been developed for this purpose should be satisfactory. The following steps will be followed for seeding and monitoring intertidal areas:

1. Locate areas for clam seeding
    a. Two criteria will be used to locate intertidal areas for seeding.
        i. Ease of access- Location must be easily accessible from the villages in most weather. Areas that can be accessed by walking from the village would be the best, but easy boat access is acceptable.

        ii. Good chance of successful seeding- Profile developed from abundance surveys will be used to identify potential beaches.

2. Obtain permits for seeding selected intertidal areas

3. Prepare intertidal area for seeding.
    a. Individual plots will be 10 feet by 50 feet. A plot this size should produce approximately 5,000 harvestable clams. Initially there will be one plot installed in each area. Successful sites will eventually be expanded. The following steps will be taken in seeding an area:
        i. Removal of logs and other debris and obstacles.

        ii. Rake the area to prepare the ground for seed.

    b. The process of baking the first few inches of the substrate in growout areas to remove unwanted organisms, yet retain the natural chemistry is a technique that may have application here. The project will conduct tests of this process to determine its ease of application, level of success and cost/benefit ratio.

4. Seeding

a. The prepared area will be seeded at a density of 75, 10mm+ clams per square foot. Tests will later be conducted to help determine optimum seeding densities for these beaches

5. Predator control

a. Predator netting, ("car cover") will be placed on top of the clams and securely anchored. The cover is usually trenched 6 inches or more around the perimeter to dissuade crabs and other animals which cannot burrow too deeply. The mesh of the car cover can be changed as the clams increase in size.

b. In order to validate the need for predator netting and determine the impact that netting may have on clam growth, a prepared beach area adjacent to the area with the predator cover will be seeded with clams at the same density but not covered with netting.

c. To evaluate the potential for increasing clam populations by affording them protection against predators, another prepared beach area near a. and b. will be covered with predator netting but not seeded.

6. Inspection/Sampling

a. The growout sites will be inspected weekly by the field teams to insure that the area remains as designed.

b. Clam samples will be collected monthly and be measured for length and weight increases. Water and substrate temperatures will also be collected.

c. Local shellfish will be analyzed for Paralytic Shellfish Poisoning (PSP) on a regular basis as recommended by the Alaska Department of Environmental Conservation.

2. Hanging Culture Techniques

Hanging culture involves growing bivalve shellfish in a subtidal area in culture gear suspended from a floating longline. Hanging culture is commonly used for growing oysters, mussels and scallops. It is rarely used for extended clam culture but may work well for species such as cockles whose natural habitat is at or near the substrate surface. It may also be possible to adapt hanging culture to work with burrowing clams.

Hanging culture methods could be useful from a subsistence standpoint for two reasons. First, hanging culture would make it possible to locate a source of clams within easy reach of a village regardless of local beach conditions, and second, if an oil spill or some other catastrophic pollution arises, the hanging culture operation can be moved to a safe location or even brought to

shore and stored in a moist environment. The disadvantage of the hanging culture method is that it would require more equipment and maintenance than beach culture methods.

Types of Hanging Culture

a. Floating Racks Floating racks are made of plywood with Styrofoam floatation. Gravel/rock substrate is placed in the plywood boxes and tidal flush and water movement provide feed for the clams.

b. Hanging Trays Stackable plastic trays are suspended from a longline and the clams feed from the water column. Trays can be filled with natural or artificial substrate or left without substrate.

Location of Suitable Sites

a. Both Tatitlek and Port Graham/Nanwalek areas already have hanging culture sites for commercial oyster culture operations (Tatitlek's are fully permitted; Port Graham has a site suitability permit). These sites will be used to locate hanging culture experiments with clams.

b. The permits at both Tatitlek and Port Graham will need to be altered to allow for hanging culture experiments with clams.

Growout Tests

a. The growout methods used will be evaluated on survival, growth rate as determined by weight and length measurements and ease and expense of culture. Methods may be altered or abandoned as appropriate.

3. Alternative Growout Methods

Other growout methods that are now being introduced will be tested here. An example of this is the biodegradable cone. Growout trays will be used to test the efficacy of different mixtures and types of substrate. Growout trays (2ft x 2ft) containing different substrate mixtures, but in all other ways the same, will be set up side-by-side on a beach and seeded at the same density. Differences in growth and survival will be measured. Growout trays will also be used to determine optimum beach locations and seeding densities.

C. Subsistence Beaches

Near the completion of the project, after sites are identified and techniques developed, a long-term management plans will be drawn up in concert with appropriate state resource management agencies and in compliance with regulations and policies of the Alaska Board of Fisheries. The plans will include permitting procedures, reseeding schedules, procedures for expanding to new areas and harvesting schedules for each species as appropriate.

The purpose of the plans is to help ensure that the beaches are managed in a manner that will sustain production over the long term.

5. Location

The hatchery and nursery work will be carried out at the Qutekcak Shellfish Hatchery/Nursery in Seward. Growout operations and sampling will occur in the area around the village of Tatitlek in Prince William Sound and in the Port Graham/Nanwalek area in Lower Cook Inlet. Pathology work will be conducted in Anchorage and Juneau. PSP sampling will occur at the DEC lab in Palmer. Data Analysis and project oversight will be conducted at CRRC offices in Anchorage and Moose Pass.

6. Technical support

Technical support for pathology, genetic, biometric services and project oversight will be provided by DFG.

7. Contracts

This will be a cooperative project conducted jointly by the Alaska Department of Fish and Game (ADFG), Chugach Regional Resource Commission (CRRC), and Qutekcak Native Tribe. Contractual services will be required for project review and oversight.

C. SCHEDULE

Schedule of activities for Tatitlek/Port Graham/Nanwalek Clam Restoration project (FY 1995 - 2000)

Date	Activity
2/95 - 3/95	identify and certify broostock for use in hatchery
3/95 - 4/95	collect broodstock and transport to hatchery
4/95 - 6/95	develop techniques to mature and spawn broodstock
5/95 - 3/96	develop techniques for producing 5 mm seed
12/95 - 4/96	transfer 5 mm seed to nursery
4/1/96	submit annual project report for FY 95
12/95 - 6/96	develop techniques for producing 10 mm to 15 mm seed for growout

2/95 - 4/95	collect information on past and current location, history, abundance, etc., of clam beds near Tatitlek, Port Graham and Nanwalek
2/95 - 4/95	obtain permits to sample areas near villages for current clam abundance and identification of intertidal areas for seeding
5/95 - 9/95	sample areas near villages for current clam abundance and identification of intertidal areas for seeding
8/95 - 4/96	identify areas for seeding experiments; obtain permits - also obtain permits for hanging culture tests at Port Graham.
5/96 - 11/96	initiate beach seeding and hanging culture experiments; set up monitoring schedule
12/96 - 2/97	seek permits for additional beach work
3/96 - 9/96	continue with broodstock collection, maturation and spawning
6/96 - 4/97	continue and expand seed production in hatchery and nursery
8/96 - 4/97	conduct artificial substrate experiments in nursery
4/1/97	submit annual project report for FY 96
4/97 - 9/97	initiate growth tests using various substrate mixtures in trays on intertidal beaches
4/97 - 9/97	initiate tests on other beach growout strategies
4/97 - 11/97	continue beach seeding and hanging culture experiments
12/97 - 3/98	analyze growout data; adjust testing as necessary
4/1/98	submit annual project report for FY 97
2/98 - 2/99	continue with hatchery and nursery seed production; refine production techniques
3/98 - 11/98	continue with beach and hanging culture growout development
1/98 - 4/98	begin to identify and obtain permits for permanent subsistence clam growout sites
4/98 - 11/98	seed in permanent growout sites; develop harvest management plan
4/1/99	submit annual project report for FY 98
2/99 - 2/00	continue with hatchery and nursery seed production; continue to refine production techniques
1/99 - 5/99	complete identification of permanent subsistence growout sites; obtain permits
4/99 - 10/99	complete seeding of permanent growout sites; expand harvest management plan
4/99 - 11/99	continue with tray, hanging culture and substrate mixtures growout tests
4/1/00	submit annual project report for FY 99

D. EXISTING AGENCY PROGRAMS

The framework for enhancing aquatic organisms is in place for salmonids in Alaska and will be the basis for similar activities with shellfish. Since the framework is not in place for private enhancement work, ADFG will have to be the lead agency and supervisor of this through contractual arrangements with CRRC.

ADF&G presently, provides oversight for the Hatchery and Nursery System through its Mariculture Coordinator (James O. Cochran). Shellfish Transport Permits are reviewed by all Departments of ADFG and rely on recommendations of the Pathology Section (Dr. Ted Meyers) and Genetics Section (Dr. Jim Seeb).

Review of efforts involving beach alteration or manipulation will involve interagency cooperation from ADFG, ADNR, and local upland owners. The framework for this activity is outlined in the Alaska Coastal Management Plan (ACMP) with a consistency review.

PSP samples will be analyzed by the DEC Palmer Lab (Dick Barret)

A final harvest management plan will be developed in concert with the Regional Shellfish Biologist.

E. ENVIRONMENTAL COMPLIANCE/PERMIT/ COORDINATION STATUS

The project will require an Environmental Assessment as part of the National Environmental Protection Act. (NEPA). This work will be initiated in year one of the project and be completed before any enhancement work is attempted. The lead agency is the National Oceanic and Atmospheric Administration (NOAA) under the Department of Commerce represented by Mr. Byron Morris.

Permits for operating the Shellfish Hatchery and Nursery are issued by ADFG and are current through 1996. Broodstock certification is complete for Tatitlek broodstock and will be requested for Port Graham/Nanwalek. DFG will oversee all transport permits.

Growout sites and activities will be coordinated by the Department of Governmental Coordination (DGC) and the Alaska Coastal Management Program review process. Initial work will be conducted under site suitability permits issued by DNR and DFG.

Long-term transport and seeding permits will be issued by DFG and DNR.

F. PERFORMANCE MONITORING

The performance of each objective outlined in the project description will be reviewed at the completion of each task outlined in the schedule in Part C. An annual report will be submitted by April 1 of each year and be reviewed prior to a DPD for a succeeding year and continuation of the project.

G. COORDINATION OF INTEGRATED RESEARCH EFFORT

The Clam restoration Project (95131) will require little coordination with other FY 95 projects. Interagency coordination will be necessary for the permitting and review process as discussed in Part D.

Previous work done and techniques utilized in the State/Federal Resource Damage Assessment project Fish/Shellfish Study 13 **Effects of Hydrocarbons on Bivalves** will be used as baseline data for beach assessment methods.

H. PUBLIC PROCESS

The project was developed through review of the impact assessment on the Exxon Valdez Oil Spill (EVOS) by the Chugach Regional Resource Commission (CRRC) in native villages in the Chugach region. Local villages requested assistance in reestablishing confidence in the subsistence harvesting of local Littleneck and Butter Clam populations. The CRRC board of directors endorsed the clam enhancement project at its 1994 annual meeting.

The project has gone through thorough public review as a result of the Exxon Valdez Oil Spill project proposal review process. Additional comment will be sought from local villages upon the completion of the Detailed Project Description. The ACMP process will allow the general public to comment of specific activities.

The residents of Tatitlek and Port Graham/Nanwalek will be interviewed on local knowledge of clam and shellfish resources.

I. PERSONNEL QUALIFICATIONS

PATRICIA BROWN SCHWALENBERG
6450 Andover Drive
Anchorage, Alaska 99516
907 345-2187

Employment:
June 1994 to Present: Executive Director Chugach Regional Resource Commission. Responsible for Natural Resource and Fisheries development for the seven native villages in the Chugach region. This includes administering office staff, village projects in mariculture and fisheries and protecting and enhancing subsistence opportunities.

October 92 to June 1994: Office Manager Bering Sea Commercial Fisheries Development Foundation. Responsibilities included maintaining all management systems for the organization including financial, personnel, property and central filing. Responsible for financial management and accountability of all grants of the Foundation payroll, taxes and financial statements, organizing and overseeing Foundation public relations.

October 1987 to June 1992 Society Administrator /Public Relations Director. Native American Fish and Wildlife Society. Assisted in the establishment and development of a national office for the Native American Fish and Wildlife Society. Implemented personnel policies and procedures, property management policies, record and financial management systems. Implemented strategies to obtain goals and objectives of the society.

Education:
Business Administration University of Alaska-Anchorage (ongoing).
Certification of Completion. 1977 Humboldt Institute

DAVID DAISY
3936 Westwood Drive
Anchorage, Alaska 99517
(907) 243-8544

Employment:
October, 1987-Present: Fisheries consultant with emphasis on aquaculture. Contractor to Chugach Regional Resource Commission developing salmonid hatcheries at Port Graham and Nanwalek and oyster mariculture operations at Tatitlek and Chenega Bay. Oversight and management of these projects involves grant writing and financial and activity reporting to granting agencies.

February, 1979 to October, 1987: Regional Program Manager, Region II, Fisheries Rehabilitation, Enhancement and Development (FRED) Division, Alaska Department of Fish & Game. Under general supervision of the FRED Director, responsible for the planning, development, operation and control of the State's salmonid enhancement and rehabilitation program in Region II which encompasses all of Alaska except Southeast.

November, 1977 to February, 1979: Regional Project Manager: Cook Inlet - Prince William Sound, Fisheries Rehabilitation, Enhancement and Development (FRED) Division, Alaska Department of Fish & Game. Under supervision of the Regional Program Manager responsible for the implementation and control of salmon enhancement research and development projects in the Prince William Sound and Cook Inlet areas. Assisted the Regional Program Manager in hatchery development planning.

April, 1968 to February, 1979: Management Biologist, Commercial Fisheries Division, Alaska Department of Fish and Game. Ketchikan, Cook Inlet and Upper Cook Inlet. Oversaw various management projects (weirs, counting towers, fisheries sampling) determined and set fishing periods for herring and salmon and responsible for meeting escapement and recruitment goals.

Education:
B.S. Fisheries, University of Massachusetts, Amherst, 1965.

JEFF HETRICK
P.O. Box 7
Moose Pass, Alaska 99631
(907) 288-3667

Employment:
1987- Present: Hatchery Manager Cook Inlet Aquaculture Association. Manage Trail Lakes Hatchery which produces 12 million sockeye salmon fry and 2 million sockeye salmon smolts annually.

1988-Present: Consultant for Shellfish Culture. Clients include:
Chugach Regional Resource Commission- develop oyster farms at Chenega Bay and Tatitlek. Included permitting, farm design, training and marketing.
Qutekcak Native Tribe- Design and develop first shellfish hatchery in Alaska.

1983-1987 Assistant Manager. Alaska Department of Fish and Game.
Assistant manager at Main Bay (Chum and Sockeye Salmon) and Cannery Creek (Pink Salmon) Hatcheries in Prince William Sound.

Education:
M.B.A. California Coast University- Thesis under review
B.S. Biological Sciences. University of Maryland, 1980

J. BUDGET

The following is a budget summary for the Nanwalek/Port Graham/Tatitlek Clam Restoration project for FY 95 through FY 99. Budgets for FY 96 and beyond may change as results from the first year are applied and as other villages, such as Chenega Bay, are added to the project.

Line Item	Estimated Cost				
	FY 95	FY 96	FY 97	FY 98	FY 99
Personnel	$21.5	$66.4	$68.7	$71.1	$73.6
Travel	$4.2	$7.2	$7.4	$7.9	$8.0
Contractual	$135.0	$103.0	$106.5	$110.3	$114.2
Commodities	$5.5	$27.0	$28.0	$28.9	$30.0
Equipment	$21.0	$15.0	$15.0	$15.0	$15.0
Indirect	$21.1	$26.2	$27.1	$28.1	$29.0
Totals	$ 208.3	$ 244.8	$ 252.7	$ 261.3	$ 269.8

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Prince William Sound Salmon Stock Identification and Monitoring Studies

Project Number:	95137
Restoration Category:	General Restoration (continuation of 94137)
Proposed By:	ADFG
Cost FY 95:	$277,500 (includes $55,800 for data analysis and report writing of FY 94 work)
Cost FY 96:	$278,200
Total Cost:	$555,700
Duration:	2 years
Geographic Area:	Prince William Sound
Injured Resource/Service:	Sockeye salmon and commercial fishing

PI Sam SHARR

INTRODUCTION

Recent annual production of wild salmon in Prince William Sound (PWS) has included from 800 to 900 thousand chum salmon (*Oncorhynchus keta*) and 300 to 500 thousand sockeye salmon (*Oncorhynchus nerka*). As with pink salmon, up to 75% of wild chum salmon spawn in intertidal areas. Oil from the *Exxon Valdez* Oil Spill (EVOS) was deposited in intertidal spawning areas for pink and chum salmon. Injuries from this contamination are well documented for pink salmon in PWS including direct lethal effects on embryos in the gravel and chronic reproductive impairment in subsequent generations exposed to oil. In addition, emergent fry and smolt of all salmon species from throughout PWS migrated through and reared in areas contaminated by oil. Willette and Carpenter (1993) demonstrated reduced growth and survival for pink salmon which reared in oiled portions of the Sound in 1989.

Chum salmon and sockeye salmon have life history similarities to pink salmon which may have also made them susceptible to injury from the EVOS. Chum salmon have both embryonic and early marine life history similarities and occur in many of the same streams as pink salmon. Sockeye salmon do not share intertidal natal habitat with pink salmon but they do spend portions of their early marine life history in areas of the Sound which were oiled. Given that both chum and sockeye salmon coexist with pink salmon during portions of the life history when EVOS related injuries occurred in the latter, it seems likely that sockeye and chum salmon were similarly injured.

Salmon stocks impacted by the EVOS are heavily exploited in commercial, sport, and subsistence fisheries. Many of these populations have been depressed in recent years and some, such as the Coghill Lake sockeye salmon population, are the subject of extensive EVOS Trustee Council restoration efforts. These restoration efforts are presently targeted at improving the productivity of the lake nursery area for juvenile sockeye salmon and cannot succeed without simultaneous efforts to improve management of the commercial fishery. The damaged populations exist in fisheries dominated by hatchery populations. The management of this mixed stock fishery has historically been based on maintaining good temporal and spatial distribution of spawning escapement for groups of wild populations (stocks) originating from eight major fishing districts and its success has relied upon the manager's ability to control stock specific exploitation rates. Restoration premised on such a management strategy will require accurate in-season catch stock composition estimates if lower harvest rates are to be achieved for damaged wild stocks.

The foundations for this project were firmly established in feasibility studies which were conducted beginning in 1986 and extending through 1988. During the damage assessment process large scale tagging and recovery projects were instituted and perfected by Natural Resources Damage Assessment (NRDA) Fish/Shellfish (F/S) Study #3. Damage assessment funds were expended for tagging hatchery releases of sockeye, coho and chinook salmon in 1989 and 1990 and releases of chum salmon in 1990. Tag recovery efforts for wild and hatchery salmon were funded by damage assessment funds in 1989, 1990, and 1991 and by restoration funds in 1993.

NEED FOR THE PROJECT

Although the extent of EVOS related injury to populations of sockeye and chum salmon in PWS is unknown, populations of wild pink salmon in PWS injured by the EVOS continue to experience poor reproductive success. Because they have life history similarities and overlap geographically with pink salmon it is likely that populations of chum and sockeye salmon were similarly injured. Populations of wild chum salmon in the northern portions of PWS are in serious decline as is the population of sockeye salmon in Coghill Lake in northern PWS. These populations must be protected from other sources of injury or mortality which could further jeopardize their ability to reproduce in adequate numbers for long term sustained yield.

Adult returns from injured wild populations mingle with other wild and hatchery populations in PWS waters and all are heavily exploited by commercial fisheries. Successful restoration of injured populations will require that they be exploited at a lower rate in these fisheries until their reproductive rates return to historic average levels. Minimizing the exploitation of injured wild populations will insure that sufficient numbers of adults enter streams to spawn for sustained yield. This project provides fisheries managers with real time estimates of the numbers of wild and hatchery fish in commercial harvests. These estimates enable managers to identify areas where exploitation of wild populations can be minimized while permitting the timely harvest of economically important hatchery returns.

PROJECT DESIGN

This project is designed to provide estimates of hatchery and wild fish contributions to commercial and cost recovery fisheries in Prince William Sound. These estimates will allow fisheries managers to monitor the size and health of wild salmon populations and lessen interceptions of wild fish in mixed stock fisheries. The project will be administered and supervised by the Alaska Department of Fish and Game.

A. Objectives

1. Make inseason estimates of the temporal and spatial contributions of tagged hatchery stocks of sockeye, chum, chinook and coho salmon to PWS commercial and hatchery harvests based on the number of tags detected in adipose clipped fish which are recovered during catch sampling;

2. Provide timely inseason estimates of hatchery and wild stock contributions to harvests by time and area to fisheries managers so they can closely regulate exploitation of injured wild stocks;

3. Use data from fully decoded tags recovered from commercial catches, cost recovery harvests, and hatchery brood stock to verify or adjust inseason contribution estimates and;

4. Estimate marine survival rates for each uniquely coded hatchery release group where possible.

B. Methods

Tag recoveries will be made from a stratified random sample. Fisheries will be stratified by district, discrete time segments and processor. For each stratum, 25% of the sockeye, chum, chinook and coho salmon commercial harvest and cost recovery harvest will be scanned for fish with a missing adipose fin. Catch sampling will be conducted in processing plants located in Cordova, Valdez, Anchorage and Whittier. Broodstock sampling will also occur at three PWS hatcheries. A minimum of 50% of the daily broodstock requirements at each hatchery will be scanned for fish with missing adipose fins.

In the catch, cost recovery and broodstock samples, the total number of fish scanned and the total number of fish with missing adipose fins will be recorded. The heads of fish with missing adipose fins will be removed, labelled and shipped to the Tag Lab in Juneau for tag removal and decoding. Tag recovery, scanning, and catch data will be merged in a computer data base and returned to Cordova for analysis.

C. Schedule

May 15 - Sept 30, 1995	Tag recoveries in commercial fisheries, cost recovery harvests, and brood stocks. Inseason catch stock composition estimates by time and area for management of commercial and cost recovery fisheries.
November 30, 1995	Draft summary report
January 15, 1996	Final Report

D. Technical Support

ADFG will supply biometrics support to ensure that project methods and data analyses will provide inseason stock contribution estimates at levels of accuracy and precision required for management of wild stocks in PWS.

E. Location

Sampling of salmon catches from commercial and cost recovery fisheries will occur in shore based processing plants in Cordova, Valdez, Whittier, and Anchorage. There will also be sampling in Seward, Kenai, and aboard floating processors if significant numbers of Prince William Sound salmon are processed at those locations. Extraction and decoding of tags will be accomplished by the ADFG coded wire tag lab in Juneau. All data analyses will be completed in Cordova with assistance from Anchorage based Alaska Department of Fish and Game biometrics staff.

PROJECT IMPLEMENTATION

This project is applied research which has direct and immediate applications to ADFG's statutory obligation to manage fisheries. Feasibility studies for the massive coded wire tagging and recovery operations required to manage PWS pink salmon were conducted by ADFG and the local, private aquaculture associations for two years prior to the EVOS. Concurrently, these agencies developed the methods described for the other species in this project, they have the infra-structure (e.g. the ADFG coded wire tag laboratory) in place for large scale tagging and tag recovery operations, and they are the logical choice for conducting this project.

The project is proposed as a cooperative effort to be funded by the Trustee Council, ADFG, and PWS aquaculture associations. Prince William Sound Aquaculture Corporation (PWSAC) and Valdez Fisheries Development Association (VFDA) spend approximately $50K annually to apply tags to sockeye and chum salmon. ADFG provides tagging equipment and technical expertise for tagging quality control. The Trustee Council will provide the funds for tag recovery in the commercial and cost recovery fisheries and in the hatchery brood stocks.

Overall project design, supervision, coordination, data analyses, and reporting will be the responsibility of Principal Investigator Sam Sharr, the ADFG Fisheries Biologist III Salmon Research Project Leader in Prince William Sound. Carol Peckham, an ADFG Salmon Research Biologist II in Cordova will act as the Project Leader, will supervise all the day to day project activities, complete inseason analyses for the ADFG Fisheries Biologist III Area Management Biologist and, take the lead on all post season analyses and reporting. The Principal Investigator and the Project Leader will receive approval of project design and quality control procedures, review of all data analyses, and editorial support for project reports from an ADFG Biometrician I based in the ADFG Anchorage Regional Office. The ADFG Principal Investigator together with the local and regional ADFG management staff are responsible for integration of information from this project into their inseason fisheries management decisions.

COORDINATION OF INTEGRATED RESEARCH EFFORT

The monitoring, research and restoration objectives of this project are integral to the success of ecosystem research and restoration efforts described in the Sound Ecosystem Assessment (SEA) plan. It is an integral part of a package of proposed projects including the SEA (95320), the Salmon Otolith Marking (95320C), and the Pink Salmon Egg and Alevin Mortality (95191) projects. This project monitors the total returns and survival rates of wild salmon populations which are known to be in decline and that may have experienced oil related injury similar to that demonstrated for pink salmon. Information from this project will be critical to the maintenance and restoration of populations which are exploited directly and indirectly in mixed stock salmon fisheries. This project provides survival estimates for individual release groups from PWS hatcheries. These estimates are critical to several components of SEA including those investigating:

1. The dependence of salmon survival on sea surface temperature and other oceanographic features of PWS during the fry and juvenile life stages.

2. The dependence of salmon survival on abundance, size, growth rate, and distribution of fry and juveniles and, zooplankton population distribution, abundance, and species composition.

3. The dependence of salmon survival on abundance, size, growth rate, and distribution of fry and juveniles and the abundance distribution, size, and species composition of predator populations.

This project is also directly linked to the proposed Otolith Marking project. Otolith marking is a logical extension of marking technology which will ultimately replace many of the functions of coded wire tags and provide more accurate and precise estimates of hatchery and wild contributions to salmon catches and escapements in PWS at less expense. However, until otolith marks can be applied, coded wire tagging and recovery projects will continue to provide those estimates.

This project will integrate tender fleet tracking, processor plant logistics, and crew scheduling with existing ADFG salmon port sampling projects. Local aquaculture associations which apply tags provide all tagging, fry release, sales harvest, and brood stock data necessary for data analysis. Aquaculture associations also provide room, board, and logistics support for brood stock samplers at their hatcheries. Air charter and boat transportation required to get samplers to remote locations in PWS will be shared with other projects having similar needs.

FY 95 BUDGET ($K)

Personnel	208.8
Travel	8.6
Contractual	20.4
Commodities	7.0
Equipment	0.0
Subtotal	244.8
Gen. Admin.	32.7
Total	277.5

Exxon Valdez Oil Spill Trustee Council
FY 95 Detailed Project Description

Project Title: Elders/Youth Conference on Subsistence and the Oil Spill

Project Number: 95138

Lead Trustee Agency: Alaska Department of Fish and Game

Project Start-up/Completion Dates: 1/1/95 through 9/30/95

Expected Project Duration: 1 year

Cost of Project FY 95: $76,400

Geographic Area: Prince William Sound, Lower Cook Inlet, Kodiak Island Borough, Alaska Peninsula

Name/Signature of Project Leaders:

Dr. James Fall/Rita Miraglia

Subsistence Division
Alaska Department of Fish and Game
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Restoration Project 95138

A. INTRODUCTION

The goal of this project is to promote the recovery of injured natural resources and subsistence uses of natural resources of the oil spill area through a conference that will involve elders, youth, and other representatives of spill area communities as well as selected scientists involved in spill area research. Conference goals will focus on the role of traditional knowledge in informing people about the spill's effects on natural resources and subsistence uses, in order to contribute to the recovery of natural resources.

Through a competitive bid process, a contract will be awarded for a conference facilitator. The successful bidder should have a background in sociology or anthropology, with an understanding of the psychological and societal effects of man-made disasters, as well as a demonstrated ability to work with the communities in the oil spill region. The facilitator will be responsible for working with the residents of the oil spill area and the appropriate Native organizations to organize the conference. This will include designing an agenda and structure for the conference. Under a separate competitively-awarded contract the conference will be videotaped. Conference proceedings are to be published and a video produced. Both of these products will serve as educational tools to further the recovery of natural resources and subsistence uses through the reintegration of subsistence uses, knowledge, and values into community life.

Subsistence uses of natural resources are essential to the economies and ways of life of communities of the oil spill area. After the spill, these uses were severely disrupted due to natural resource injuries and concerns about the safety of using subsistence foods that may have been contaminated by oil. Because of these reduced subsistence uses, opportunities to teach subsistence skills and traditional knowledge have also been diminished. As noted in the draft Oil Spill Restoration Plan, "the more time users spend away from subsistence activities, the less likely they will return to it" (p 32). The restoration strategy for subsistence, as presented in the draft plan (pp. 32-33), has four parts, including an objective "to accelerate recovery of subsistence resources and services." One means to achieve this goal is "through increasing availability, reliability, or quality of subsistence resources, or increasing the confidence of subsistence users."

Increasing the availability of subsistence resources and the confidence of subsistence users may be achieved by a gathering of knowledgeable individuals (including elders) and young people in order to identify the natural resource injuries and other issues raised by the spill and the means to address these issues. The

conference will draw upon traditional knowledge and the experience of community residents in facing past crises. It could result in a list of subsistence skills that need re-invigorating in light of the disruptions since the oil spill. Another goal of the conference is the sharing of observations about natural resources in the spill area, and the recommending of activities that can assist people in understanding the present conditions of these resources and contribute to recovery. Also, the conference may identify ways for communities to use their collective traditional knowledge and experiences to prepare for future environmental disasters, and to find ways subsistence users can help injured resource species recover from the oil spill. To date, there has been no similar opportunity for the residents of the communities of the spill area, who depend upon the natural resources for subsistence to discuss their common experiences, concerns and plans.

The Draft *Exxon Valdez* Oil Spill Restoration Plan (p.33) states that, regarding subsistence, "one indication that recovery has occurred is when the cultural values provided by gathering, preparing, and sharing food are reintegrated into community life" (p.33). The conference will contribute to this goal through the discussion and dissemination of traditional knowledge about resource conservation and subsistence uses and about the common experiences shared by subsistence users since the spill. Additionally, this project will assist with the restoration of subsistence through monitoring the recovery of subsistence uses. The information discussed at the conference will provide a picture of the present status of subsistence, which may in turn be used to direct future restoration actions.

B. PROJECT DESCRIPTION

1. Resources and/or Associated Services:

After the oil spill, subsistence uses of natural resources were severely interrupted due to natural resource injuries and concerns about the safety of using possibly contaminated subsistence foods. Because of reduced subsistence activities, opportunities to teach subsistence skills and traditional knowledge were diminished. By gathering together knowledgeable individuals and youth, the conference could increase the confidence of subsistence users by providing a forum in which to identify the issues and problems raised by the spill, and the means to address these issues. By using collective traditional knowledge, shared experiences and observations about natural resources in the oil spill area, activities could be recommended that might assist the people in understanding the condition of these resources and prepare for future environmental disasters.

2. Relation to Other Damage Assessment/Restoration Work:
At the Restoration Science Workshop held in Anchorage in January 1995, the need for identifying the means of incorporating local traditional knowledge into the restoration process was discussed at length, as was the need to include subsistence users as full partners in restoration. This conference can assist in the furtherance of these two goals by bringing together native people from throughout the spill-impacted area to discuss how best to achieve them. In addition, the information gathered in the conference can be used to help other restoration projects incorporate traditional knowledge and local people into their projects.

3. Objectives:
Objectives include participation by representatives of communities of the oil spill area in a conference during which injured natural resources and subsistence uses are identified and discussed. Means to assist in recovery of these resources and uses will be identified. Written conference proceedings and a video which summarize the conference and its findings and recommendations will be produced and distributed.

4. Methods:
The Division of Subsistence of the Alaska Department of Fish and Game will coordinate the implementation of this project under Restoration Project 95052. This entails preparing contract proposals for competitive bid, evaluating proposals, monitoring the performance of contractors, and handling conference logistics; including meeting facilities and participants' travel and accommodations.

A professional services contract will be awarded to design the conference agenda and serve as the conference moderator. The contractor will consult with spill area communities, Native organizations and the Trustee Councils' Science Coordinator as appropriate to set the agenda. The cont actor will also be responsible for preparing the conference proceedings. A separate contract will be awarded to video tape the conference and produce a video presentation of the conference for distribution to oil spill area communities and interested researchers.

Among the potential topics for discussion are:

a. What has been the common experience of subsistence users of spill-area communities since the oil spill? What has been lost? What has been gained? Are there differences between regions?

b. Is there traditional knowledge available to inform subsistence users and others about the spill's effect on natural resources? Possible topics include identification of alternative resources, traditional conservation methods, and efficient harvest and processing techniques.

c. What actions need to be taken by subsistence users to help injured resource species recover and how can the exchange of information about injured resources between communities, agencies, and scientists be facilitated in the future?

d. Is there traditional knowledge available to inform subsistence users about the spill's effects on the safety of subsistence foods?

e. What actions need to be taken by communities to re-invigorate subsistence uses? Are there particular skills and knowledge which need to be emphasized?

f. How have people of the spill area dealt with disasters in the past? What can we learn from those experiences?

RAM -- 95 ~~g.~~ How have people of the oil spill area dealt with disasters in the past? What can we learn from those experiences?

~~h.~~ g. Given what we have learned, how can communities prepare for the possibility of future disasters and threats to subsistence?

The conference will be video-taped and audio-taped. A proceedings volume will be prepared. A summary video, approximately 30 minutes in length, will also be produced to present the conference highlights and recommendations. It is intended that the proceedings and video be used as educational tools to promote an exchange of information and to strengthen subsistence traditions that have been weakened since the spill.

The conference will last one or two days. Each community of the spill area (approximately 20 communities) can nominate one elder, two students (high school or college aged), and one additional representative. The exact format of the conference will need to be determined by the contractor after consultation with the communities. It will likely entail several formats, including but not limited to formal presentations, panel discussions, round tables, and question/answer periods. Participants will be encouraged to report back to their communities about the conference. This could take the form of school papers and oral presentations, and community meetings and contributions to newsletters.

5. Location:
The proposed conference will take place in Anchorage, primarily because of its centralized location. If feasible in terms of cost and facilities, an alternative location can be considered.

6 Technical Support:
None required.

7.Contracts:
A professional services contract will be awarded to design the conference agenda, prepare the conference proceedings and serve as the conference moderator. A separate contract will be awarded to video tape the conference and produce an informational video presentation.

C. SCHEDULE

Feb-March 1995	Develop contract guidelines, evaluate bids, award contract
April-Aug 1995	Conference planning
September 1995	Conference
Oct-Nov 1995	Production of conference proceedings and videos
December 1995	Distribution of materials
April 1996	Complete project, final report

D. EXISTING AGENCY PROGRAM

The Division of Subsistence has conducted surveys of subsistence harvests in the oil spill region both before and after the spill. In addition, detailed information is collected on subsistence salmon harvests for many communities in the area. As part of a cooperative agreement with the National Marine Fisheries Service, Division researchers will be collecting information on harbor seal and sea lion harvests in 1995.

E. ENVIRONMENTAL COMPLIANCE, PERMITTING AND COORDINATION STATUS

Since there is no biological field work component to this project, it is categorically excluded under NEPA guidelines.

F. PERFORMANCE MONITORING

The Division of Subsistence will monitor the performance of the contractors. Researchers with the Division of Subsistence frequently visit communities in the oil spill region for community meetings, surveys and household visits. Feedback from these contacts will be used to evaluate the effectiveness of the project.

G. COORDINATION OF INTEGRATED RESEARCH EFFORT

Information about the status of injured natural resources and potential means toward recovery based upon scientific findings can be integrated into the conference. Conference findings, including observations by subsistence harvesters of natural resource populations, will be available for use by other researchers through written conference proceedings and videotapes. Other proposed subsistence restoration projects (e.g., 95244 - Seal and Sea Otter Cooperative Harvest Assistance, 95428 - Subsistence Planning) also have public information components that will benefit from the information which is shared through the conference and it's resultant products. This project will complement the work done under the Subsistence Foods Testing project (93017, 94279, 95279).

H. PUBLIC PROCESS

The communities in the oil spill region and the appropriate Native organizations will be consulted in the planning of the conference. The local governments will select the representatives who attend. Both the conference proceedings and a videotape summarizing the results of the conference will be available for public distribution.

I. PERSONNEL QUALIFICATIONS

James Fall: Dr. Fall is the regional program manager for the Division of Subsistence, Alaska Department of Fish and Game, for southcentral and southwest Alaska. He has held this position since 1981. Since 1989, he has supervised the division's oil spill response and research program. Also, he has served as the department's representative on the Oil Spill Health Task Force. Dr. Fall has written several articles and reports on the effects of the *Exxon Valdez* oil spill on subsistence activities and harvests, based upon division research.

Rita Miraglia: Ms Miraglia has served as the oil spill coordinator for the Division of Subsistence since 1990. As such, she has organized and participated in the subsistence resource collection and testing programs of 1990 and 1991. She has also been the lead communicator of study findings to communities through organizing community meetings and writing newsletters. She has also assisted the Oil Spill Health Task Force's activities.

Craig Mishler: Dr. Mishler has been a Subsistence Resource Specialist with the Division of Subsistence since 1989, with primary responsibility for Kodiak Island. He is project leader for the Division's seal and sea lion harvest monitoring program.

Ron Stanek: Mr. Stanek has been a Subsistence Resource Specialist with the Division of Subsistence since 1980, with substantial research experience in the lower Cook Inlet Region.

Bill Simeone: Dr. Simeone was added to the Division staff in 1995 as a Subsistence Resource Specialist. He has extensive prior research experience in most communities in the oil spill area.